REPORT – VOLUME 4B
BIODIVERSITY AND ECOSYSTEM SERVICES

CNOOC UGANDA LIMITED

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR THE CNOOC UGANDA LTD KINGFISHER OIL DEVELOPMENT, UGANDA

Submitted to:
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CNOOC UGANDA LIMITED

KINGFISHER OIL PROJECT, HOIMA DISTRICT, UGANDA - BIODIVERSITY IMPACT ASSESSMENT

Submitted to:
The Executive Director National Environment Management Authority, NEMA House, Plot 17/19/21 Jinja Road, P. O. Box 22255 Kampala, Uganda Biodiversity Impact Assessment for

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Executive Summary

CNOOC Uganda Limited ("CNOOC") has identified an opportunity to develop the Kingfisher Oil Field on the eastern shore of Lake Albert, Hoima District, Uganda. In accordance with Ugandan law, it is necessary for CNOOC to determine the potential environmental and social impacts of the project, and to demonstrate how these will be mitigated and managed. This chapter of the Environmental and Social Impact Assessment (ESIA) presents an assessment of the potential impacts of the Kingfisher development project (the Project) on biodiversity, and sets out recommendations for their avoidance and reduction, where necessary. This impact assessment has been developed with reference to the baseline terrestrial and aquatic biodiversity surveys, completed between February and March 2014, May and June 2014 and October and November 2014.

The aim of this biodiversity assessment was to collect scientifically defensible, high quality data of sufficient breadth that could be used to characterise the baseline conditions of the area and assess how the Project could affect that biodiversity. This was undertaken in consideration of Uganda's Wildlife Bill (2017) and *Wildlife Policy 2014* and *National Biodiversity Strategy and Action Plan* (NEMA 2016), and with reference to the IFC PS6, which seeks to protect biodiversity and ecosystem services from the adverse impacts of project activities, and support its conservation and sustainable use. Consequently, the objectives of the biodiversity impact assessment, as reflected in the Scoping Report (Golder Associates 2014c), were to:

■ Characterise the ecological integrity of the terrestrial and aquatic (including wetland) ecosystems in the Project's area of influence and ascertain seasonal variation.

■ Identify sensitive or unique habitats and species (as protected under Ugandan legislation and international obligations), which could suffer irreplaceable loss due to the Project.

■ Identify species of concern that could trigger critical habitat (as defined by IFC PS6).

■ Identify populations and trends of exotic and invasive species in the Project's area of influence.

■ Identify and describe potential sources of risk and impact associated with the development that could affect biodiversity of the Project's area of influence.

■ Identify the potential direct, indirect and cumulative effects (Volume 5: Cumulative Impact Assessment) on biodiversity associated with the Project.

■ Recommend suitable mitigation measures where applicable.

■ Develop a monitoring programme and action plan for the biodiversity affected by the Project's development.

Spatial Boundaries

For this assessment, and in order to satisfy IFC requirements, two areas of influence were considered in relation to assessing the potential effects on biodiversity:

a) Biodiversity local study area:

■ The assessment of impacts within the local area of the Project, or biodiversity local study area (LSA), was based on the spatial extent of a Project's footprint and an associated buffer zone that includes potential immediate, direct effects on the receiving environment. It was derived as a focus for the development of a baseline case where potential direct effects were predicted to occur.

■ The LSA incorporates: the wells, flowlines, central processing facility (CPF) and supporting infrastructure associated with the production facility including in-field access roads and flowlines, an upgraded jetty, and a water abstraction station on Lake Albert, a permanent camp, a material yard (or 'supply base'), and a safety check station at the top of the escarpment.; and the feeder line easement to Kabaale, roughly 46 km to the northeast of the field.

- A 1 km buffer was incorporated around the infrastructure in order to capture all potential direct effects, including those from noise, dust, changes to surface water quality (that is, streams and wetlands). At Lake Albert, the buffer was extended to 2 km in order to capture direct impacts on aquatic ecosystems of concern.

b) Critical habitat area of analysis.

- Critical habitat is present in many places globally, but is only relevant to a development project where the project may affect that habitat (both directly and indirectly) (IFC 2012a). Importantly, the determination of critical habitat is independent of the specifics of the proposed project footprint, and is present under baseline conditions and is not defined by the size of the project footprint, or other project effects.

- For the critical habitat area of analysis, an ecologically-relevant area of analysis surrounding, and including, the anticipated extent of the Project's influence, including broader or regional effects from the Project, in association with other anthropogenic activities (such as other projects) and natural factors was identified (ref. Volume 5: Cumulative Impact Assessment). These include indirect, induced and cumulative effects. The CHAA was defined as that area.

- The boundaries of the CHAA were devised cognisant of the need for an area where the ecological and land management issues have more in common with each other than they do with those in adjacent areas, and constitutes a sensible ecological and political boundary within which critical habitat can be defined (IFC 2012b, paragraph 65).

- This area was also used as the geographical extent to screen biodiversity features to be assessed for critical habitat based on discrete management units (DMU). Critical habitat was therefore identified and mapped at the CHAA-scale, which was inclusive of the LSA.

A baseline of the terrestrial and aquatic ecology of the LSA was determined through a desktop assessment and comprehensive, seasonal surveys. These assessments and surveys were then used as the basis for the description of the biodiversity of the CHAA. The detailed baseline study reports for the terrestrial and aquatic ecology are presented in APPENDIX B and APPENDIX C respectively.

One of the main purposes of an impact assessment is to provide answers to questions that people have about how a project could affect something that matters to them, such as a valued component. To ensure that this impact assessment clearly addressed the key issues raised by the stakeholders and the objectives set for this impact assessment, questions were formulated that captured the concerns relative to a particular issue. In this report, those concerns are expressed as 'key questions', and they form the basis of the investigations of potential effects and impacts of the Project.

Two key questions were established:

1) What effect could the Project have on habitats and ecosystem integrity?

2) What effect could the Project have on species of concern?

Under each of these key questions, sub-questions were developed that focused on the specific phases of the Project, in particular, the construction, operation and decommissioning phase.

Indicators for the impact assessment were selected to assess the level of potential impact. Changes to the indicators were analysed to determine the effectiveness of the mitigation hierarchy, and identify Project constraints and opportunities for additional avoidance and mitigation. Indicators and context for impact assessment are outlined for the key questions and associated valued components in the table below.

Key questions and indicators

Key Question	Valued Component	Indicator	Indicator Description	Context
What effect could the Project have on habitats and ecosystem integrity?	Ecosystem integrity Priority habitat	regional representative-ness	The uniqueness of an ecosystem or habitat in the CHAA and wider landscape. This rarity factor is related to the concepts of irreplaceability and vulnerability.	The persistence of species of concern in the CHAA and wider area. Maintain the distribution and abundance of species of concern such that self-sustaining and ecologically effective populations can be maintained. Achieve net gains for species of concern for which critical habitat is affected by the proposed Project, and at least no net loss for all other valued components. Maintenance of ecosystem processes and functions and connectivity.
		changes in soil, water flows and quality, and vegetation	Drivers of change affecting key processes	
		ecosystem composition	The diversity and complexity of an ecosystem or habitat – what is there and how abundant. Relates to species composition and abundance – keystone species are of particular relevance; changes in populations of these species have greater impacts on ecosystems than would be expected from its relative abundance or total biomass	
		ecosystem configuration	The structure or pattern of an ecosystem: the spatial structure and scale of the ecosystem in relation to the scale of the human intervention; food-web structure and interactions that shape the flow of energy and the distribution of biomass (relates to changes in food-web, e.g. those caused by introduction of invasive species); linkages and corridors to habitat of the same or different ecosystems	
What effect could the Project have on species of concern?	All species of concern	habitat quantity and quality	The extent and integrity of preferred foraging and breeding habitat	
		habitat connectivity	Connectivity to adjacent areas of suitable habitat and potential for dispersal	
		abundance and distribution	Expected vs actual population numbers and distribution	

Key Question	Valued Component	Indicator	Indicator Description	Context
		survival and reproduction	Likelihood of continued survival/reproduction compared to baseline	

As identified through stakeholder consultation, review of background biodiversity and environmental reports, published ecological literature, and consideration of the IFC's Environmental, Health, and Safety Guidelines for Onshore Oil and Gas Development (IFC 2007b) and the performance standards (that is, IFC 2012a, b and c), broadly, the key issues pertaining to the CHAA's biodiversity include:

- Habitats and ecosystems

    - Construction and operation of the pipeline and the potential effects that the construction and operation could have on wetlands, streams, woodlands, bushland and grasslands (including potential critical habitat), agricultural areas, and soils.

    - Construction and operation of the wells and CPF on the environment of the Buhuka Flats and Lake Albert.

    - The potential effects the construction and operation of the Project could have on Lake Albert, wetlands and environment of the Buhuka Flats. These include: vibration; pollution (oil, erosion and sedimentation, other run-off, effects to groundwater); increased fishing pressure from in-migration; long-term damage to the lake ecosystem.

    - Potential induced effects to the Bugoma Central Forest Reserve due to upgrade of the existing road, including the possible need for offsets.

    - Potential effects the construction and operation of the Project could have on the escarpment vegetation corridors connecting the wild areas along Lake Albert from Semliki to Murchison Falls National Park.

- Species of concern

    - Concern for the loss of animal species from the Buhuka Flats. Potential effects to the populations of Hippopotamus (*Hippopotamus amphibius*), Nile Crocodile (*Crocodylus niloticus*), and Grey Crowned Crane (*Balearica regulorum*), amongst others.

    - The identification of migratory and threatened species inhabiting the CHAA.

    - Potential effects to the populations of Chimpanzees (*Pan troglodytes*), Nahan's Francolin (*Ptilopachus nahani*) and African Elephant (*Loxodonta africana*) in Bugoma Central Forest Reserve.

In summary, the main issues related to potential effects to the biodiversity of the CHAA from the construction and operation of the Project relate to the potential changes in ecosystem composition (for example, species composition), configuration (for example, patch size and connectivity) and function of the wider CHAA through the direct loss, disturbance or change in condition of natural and modified habitats, including critical habitat.

The impact assessment was conducted separately for the Production Facility and the feeder pipeline. For each component, the possible interactions of biodiversity valued components with the Production Facility /feeder pipeline infrastructure and activities, and the resulting impacts during the construction, operation and decommissioning phases of the Project were addressed.

The biodiversity valued components for both the Production Facility impact assessment and Feeder Pipeline Impact Assessment are listed below. They include all of the species and habitats that trigger critical habitat designation within the CHAA, that have potential to interact with the Production Facility infrastructure and activities. In addition, ecosystems of concern that will be potentially affected by the Project, and Grey Crowned

Crane, were also included as valued components for impact assessment, for reasons outlined in the Table below.

Biodiversity Valued Components for Impact Assessment

Valued Component	Confirmed CH Trigger? (see Table 4)	Reasoning
Near-shore aquatic habitats of Lake Albert	■ Yes – Criterion 13 ■ Possibly Criterion 1 and Criterion 2 (G. candida)	■ The near-shore habitats are important fishing grounds that support 11 fishing villages on the Buhuka Flats and surrounds (see Ecosystem Services Review) ■ May support the CR and range-restricted species *Gabbiella candida*
Wetlands	No	■ Natural habitat – priority habitat according to IFC (2012) ■ Supports Endangered Grey Crowned Crane ■ Important in supply of ecosystem services to local communities (see Ecosystem Services Review)
Escarpment vegetation corridor	No	■ Natural habitat – priority habitat according to IFC (2012) ■ Forms part of a contiguous vegetation corridor that is part of the wider Murchison Falls National Park-Budongo-Bugoma-Kagombe-Itwara Forest Reserves-Semliki/Toro Wildlife Reserve corridor ■ The location of caves and cavities along the escarpment that could be important for cavity-roosting bats
Bugoma Central Forest Reserve	■ Yes – ■ Criterion 4 ■ Criterion 1 ■ Criterion 2	■ Triggers CH on the basis of being a highly threatened and unique ecosystem (Criterion 4) ■ Triggers Criterion 1 Tier 1 CH on the basis of support of a population of Eastern Chimpanzee, that is recognised as being one for the four largest in the region; apart from being an Endangered species, chimpanzees are also recognised as key stone species and ecosystem engineers ■ Triggers Criterion 2 Tier 2 CH on the basis of support of range-restricted Nahan's Francolin ■ Recognised area of old growth forest ■ The forest is recognised for its unique biodiversity values, including biome restricted species ■ Is an important ecosystem service supply area for local people who harvest timber, fibre, fuel wood and charcoal, and non-timber forest products from the forest. ■ Bugoma Central Forest Reserve is recognised as an Important Bird Area ■ Nationally recognised as a high conservation priority area (NEMA 2010)

Valued Component	Confirmed CH Trigger? (see Table 4)	Reasoning
Mud Snail (*Gabbiella candida*)	Possibly Criterion 1 and Criterion 2	■ Could occur on near-shore aquatic habitats (Bugoma Lagoon, large bays, open sandy shores, shallow river-associated water) ■ Has not been confirmed in LSA to date and is included on basis of precautionary principle
Grey Crowned Crane	No	■ Although Grey Crowned Crane is not present in numbers that would trigger CH designation, it is an Endangered species and has been confirmed present on the Buhuka Flats during baseline fieldwork in 2014 and 2017 ■ Any potential Project impacts on a globally-recognised and nationally-protected Endangered species are unacceptable and warrant addressing via the impact assessment process
Nahan's Francolin (*Ptilopachus nahani*)	Yes – Criterion 2	■ Occurs in Bugoma Central Forest Reserve, possibly one of less than 10 DMUs globally (including DRC) ■ Potential for CHAA to support >10% of this species' known global population
Eastern Chimpanzee (*Pan troglodytes schweinfurthii*)	Yes – Criterion 1	■ Occurs in Bugoma Central Forest Reserve ■ Great apes are an iconic species of anthropological and evolutionary significance ■ They generally immediately trigger CH designation (see GN 74 and footnotes in PS6, IFC 2012a and b)

During construction of the Production Facility, significant residual impacts on ecosystems of concern were predicted for near-shore habitats of Lake Albert, wetlands, and vegetation communities of the escarpment. For species of concern, significant residual impacts were predicted for the mud snail (*G. candida*) (based on the precautionary principle), and Grey Crowned Crane during construction of the Production Facility, largely as a factor of habitat loss and deterioration.

During the operation phase of the Production Facility, significant residual impacts on ecosystems of concern were predicted for near-shore habitats of Lake Albert due to potential water quality contamination by stormwater and the induced effect of increased population on the flats. Significant residual effects were also predicted for the escarpment vegetation corridor and Bugoma Central Forest Reserve, principally as a result of the induced effect of population influx to the locality and region. Similarly, significant residual effects were predicted for Grey Crowned Crane in the Buhuka Flats, due to habitat loss and degradation, physical and sensory disturbance and exacerbated by the induced effect of population influx to the area. For Nahan's Francolin and Eastern Chimpanzee, significant residual impacts were also predicted, again largely as a result of the difficult-to quantify project-induced effect of human population influx to the area.

During construction of the Feeder Line, significant residual impacts on ecosystems of concern were predicted only for wetlands, again in the context of the difficult-to quantify project-induced effect of human population influx to the area. For species of concern, significant residual impacts were predicted for Grey Crowned Crane only, principally as a result of the induced effect of population influx to the local study area.

During the operation phase of the Feeder Line, significant residual impacts on ecosystems of concern were predicted for the vegetation communities of the escarpment, again due to the fact that the indirect effects of population influx to the region are likely to result in further loss and degradation of escarpment vegetation communities, in particular in the vicinity of the short-stretch of easily traversed, grassed pipeline route which will be kept free of trees and shrubs. Moderate residual impacts on wetlands in the feeder line LSA are also predicted, again largely due to the induced effect of population influx to the area. For species of concern, significant residual impacts were predicted for Grey Crowned Crane only, again principally as a result of the induced effect of future population influx to the local study area.

In line with the IFC's PS6, offsetting has been considered as an option to achieve no net loss and, preferably, net gain, when residual impacts are identified for valued components that trigger critical habitat and/or natural habitat designations, and where reclamation following the Project's decommissioning are expected not to meet the no net loss philosophy for a valued component. Possible offsetting strategies for each affected valued component are discussed in Section 13.0. Actual offsetting strategies will be developed on a landscape-scale, in liaison with other partners and as part of a Biodiversity Action Plan.

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1.0   INTRODUCTION

CNOOC Uganda Limited ("CNOOC") has identified an opportunity to develop the Kingfisher Oil Field on the eastern shore of Lake Albert, Hoima District, Uganda. In accordance with Ugandan law, it is necessary for CNOOC to determine the potential environmental and social impacts of the project, and to demonstrate how these will be mitigated and managed. This chapter of the Environmental and Social Impact Assessment (ESIA) presents an assessment of the potential impacts of the Kingfisher development project (the Project) on biodiversity, and sets out recommendations for their avoidance and reduction, where necessary. This impact assessment has been developed with reference to the baseline terrestrial and aquatic biodiversity surveys, completed between February and March 2014, May and June 2014 and October and November 2014. The baseline was required to enable an appropriate assessment of the Project's potential impacts on biodiversity. The detailed results of the baseline surveys are included in the Appendices and summarised in Section 6.0.

Uganda is a signatory to the Convention on Biological Diversity (CBD); as such there is a governmental requirement to implement policies to protect biodiversity at all its different levels, including ecosystems, species and genes. That protection is embodied in the obligations the country imposes on entities operating within its borders. Nevertheless, as mentioned, biodiversity as a concept is very broad, and is typically defined as the variety of life at different levels of biological organisation and all the ecological and biological processes through which they are connected (for example, see Hill et al. 2005; Secretariat of the CBD 2006). In line with that definition of biodiversity, this impact assessment focuses on those different levels, as defined below.

Ecosystems are a dynamic complex of plants, animals, micro-organisms, and their non-living environment, interacting as a functional unit. Ecosystems can vary greatly in size, and in the biotic and abiotic elements of which they are comprised. However, ecosystems usually encompass specific, defined spaces. Ecosystems are distinct from communities in that the term "community" typically only refers to coexisting biotic populations, whereas ecosystems can include abiotic (that is, non-living) components and an array of environmental processes (Begon et al. 1990). Species can be defined as groups of morphologically similar organisms that have descended from a common ancestor, with common genetic make-up, and which produce fertile offspring only amongst themselves (Begon et al. 1990). Species are the basic components of ecological communities and are the most recognisable units of biodiversity. Efforts to conserve biodiversity often focus at the species level, and the efforts to conserve species diversity go some way to include the genetic component of biodiversity.

A fourth level of biodiversity has been derived fairly recently in the scientific and wider literature. This is the concept of ecosystem services (see Millennium Ecosystem Assessment 2005). Ecosystem services are the benefits to people generated by a functioning natural environment, the recognition of which has become increasingly important. The assessment of ecosystem services is primarily covered under the International Finance Corporation's (IFC) Performance Standard 6 (PS6), although it is also covered under PS1, PS3, PS4, PS5, PS7 and PS8. Nevertheless, for the intents of this impact assessment, the assessment of ecosystem services has been given its own report in recognition that the assessment is a cross-over discipline covering social, biological and physical disciplines, as reflected in its assessment requirement across multiple performance standards. That assessment can be found in Golder Associates (2014i). As such, the concept of ecosystem services, as a component of biodiversity under the IFC PS6, is not discussed further in this document.

In light of the above, and for the purposes of this assessment, "biodiversity" encompasses terrestrial and aquatic ecosystems (at the habitat, species and genetic level), and is in line with the definitions set out by Uganda's *National Environment Act 1995*, the CBD (Secretariat of the CBD 2006), and the IFC's PS6 (2012). Further clarification is set out in Section 2.0. Ecosystems services, although recognised as being part of, or dependent upon biodiversity, and covered under the IFC's Performance Standard 6, are not covered in this chapter. Instead, Golder Associates (2014i) is devoted to describing the baseline and impact assessment for ecosystem services.

This specialist study report includes the following sections:

■   Section 2.0 describes the terms of reference for the report.

■ Section 3.0 presents the methods used for the study that entail examining the study objectives, the approach employed and the limitations encountered.

■ Section 4.0 sets out the legislative background applicable to the study.

■ Section 5.0 Summarises the key issues in relation to biodiversity.

■ Section 6.0 summarises the results of the baseline studies.

■ Section 7.0 assesses the impacts to biodiversity arising from the CPF, wells and associated infrastructure.

■ Section 8.0 assesses the impacts to biodiversity arising from the Feeder line.

■ Section 9.0 recommends mitigation and management measures.

■ Section 10.0 provides recommendations for offsetting.

■ Section 11.0 includes a complete list of references consulted.

This assessment report is a preliminary version produced for client review.

2.0   TERMS OF REFERENCE

Historically, the biodiversity of the area has been assessed, in part, as part of the Environmental Impact Assessments (EIA) for various oil-related projects and developments over the last decade. However, those assessments tended to focus only on the footprint of the particular project components; for example, drill pads, access roads, etc. In the wider Albertine-Graben region, broad-scale landscape assessments have been completed (for example, NEMA 2010, AECOM 2013, MEMD 2013; TBC & FFI, 2017). Nevertheless, no comprehensive biodiversity impact assessment has been completed that covers the full scope of the developments on Buhuka Flats, the escarpment and feeder line corridor, which is the focus of this ESIA.

In determining the requirements of the biodiversity assessment, reference was made to the appropriate Ugandan legislation and guidance, as well as international standards and guidance. National policy and international standards pertaining to the Project are detailed in Section 4.0.

The biodiversity impact assessment concentrates on assessing changes in ecosystems, habitat and ecosystem function, changes in populations of species, including species of conservation concern, invasive species and species of high value to people.

2.1   Objectives

The aim of this biodiversity assessment was to collect scientifically defensible, high quality data of sufficient breadth that could be used to characterise the baseline conditions of the area and assess how the Project could affect that biodiversity. This was undertaken in consideration of Uganda's Wildlife Bill (2017) and *Wildlife Policy 2014* and *National Biodiversity Strategy and Action Plan* (NEMA 2016), and with reference to the IFC PS6, which seeks to protect biodiversity and ecosystem services from the adverse impacts of project activities, and support its conservation and sustainable use. Consequently, the objectives of the biodiversity impact assessment, as reflected in the Scoping Report (Golder Associates 2014c), were to:

■ Characterise the ecological integrity of the terrestrial and aquatic (including wetland) ecosystems in the Project's area of influence and ascertain seasonal variation.

■ Identify sensitive or unique habitats and species (as protected under Ugandan legislation and international obligations), which could suffer irreplaceable loss due to the Project.

■ Identify species of concern that could trigger critical habitat (as defined by IFC PS6).

■ Identify populations and trends of exotic and invasive species in the Project's area of influence.

■ Identify and describe potential sources of risk and impact associated with the development that could affect biodiversity of the Project's area of influence.

- Identify the potential direct, indirect and cumulative effects on biodiversity associated with the Project.

- Recommend suitable mitigation measures where applicable.

- Develop a monitoring programme and action plan for the biodiversity affected by the Project's development.

2.2   Scope of Work

In order to address the above objectives, and in line with the Scoping Report (Golder Associates 2014c), a description and regional contextualisation of the baseline terrestrial and aquatic ecology was undertaken. Using available regional ecological data and dedicated baseline studies, an assessment of the effects on the biodiversity of the Project's area of influence (i.e. the Local Study Area, and the Critical Habitat Area of Analysis – ref. Sections 3.1.1 & 3.1.2) was conducted to meet the requirements of IFC PS6.

The scopes for the baseline terrestrial and aquatic ecology, and overall biodiversity effects assessment are presented in the following sections.

2.2.1   Terrestrial Biodiversity

The baseline terrestrial biodiversity studies focussed on describing the seasonal variation (that is, the two wet seasons and a dry season) of:

- Vegetation communities and habitats within the Project's area of influence, including structure, condition, species composition, representativeness, irreplaceability and vulnerability.

- Populations of vertebrates, and selected invertebrates in the Project's area of influence, including their representativeness, irreplaceability and vulnerability.

- Current drivers of change in the terrestrial ecosystems of the Project's area of influence, including populations of pest and invasive species.

2.2.2   Aquatic Biodiversity

The baseline aquatic biodiversity studies focussed on describing the seasonal variation (that is, the two wet seasons and a dry season) of:

- Abiotic factors (that is, physical and chemical characteristics of the water quality) influencing the aquatic habitats and ecosystems supported in Lake Albert, wetlands on the Buhuka Flats, and watercourses draining the escarpment and flats.

- Aquatic habitats and ecosystems within the Project's area of influence, including structure, condition, species composition, representativeness, irreplaceability and vulnerability.

- Biotic components of the various aquatic habitats and ecosystems in the Project's area of influence; in particular, macrophytes, phytoplankton, zooplankton, macro-invertebrates and fish, and the condition of the populations of these groups, their representativeness, irreplaceability and vulnerability.

- Current drivers of change in the aquatic ecosystems of the Project's area of influence, including populations of pest and invasive species.

2.2.3   Overall Biodiversity Value

The effects that the Project could have on the terrestrial and aquatic ecosystems, habitats, and species in the Project's area of influence were identified and assessed at the scale of the overall biodiversity, that is, a landscape ecology and ecosystems approach, *viz.*, Secretariat of the CBD (2006), as embodied in IFC PS6 (IFC 2012a), the International Petroleum Industry Environmental Conservation Association's (IPIECA) (IPIECA 2005, 2007, 2010), and the Energy and Biodiversity Initiative's (EBI) (EBI 2006) guidance documents. Furthermore, in line with the requirements of IFC PS6 (IFC 2012a, b), the consideration of the effects of the Project on the biodiversity were based on the findings of the baseline terrestrial and aquatic ecology assessments and focussed on:

■ The identification of modified and natural habitat within the Project's Local Study Area (LSA), and the implications for no net loss of biodiversity.

■ The identification of species of concern occurring within the Critical Habitat Area of Analysis (CHAA) surrounding the Project, and the potential for these to trigger critical habitat.

■ The identification of protected areas, and other internationally recognised areas within and surrounding the Project's area of influence, and the potential for the Project to affect these.

■ Assessing the potential effects of the Project on the functions and processes of the ecosystems of the Project's area of influence.

2.2.4 Impact Assessment

The approach for impact assessment used in the biodiversity specialist study is described in detail APPENDIX E, and incorporates the sensitivity of a species or ecosystem in the assessment matrix. For the intents of this biodiversity impact assessment, sensitivity represents the valued component's irreplaceability and vulnerability. It was based on, amongst other aspects, the valued components resilience, as well as national and global conservation status. As such, sensitivity was based on scientific principles of biodiversity conservation and human values regarding valued components associated with ecosystem services.

The valued component sensitivity was combined with the CHAA-level magnitude classification to obtain an overall impact significance for the construction, operation and decommissioning cases, for each valued component. Comprehensive details on the impact assessment terms of reference for biodiversity are provided in APPENDIX E.

This approach was agreed in principle over the course of meetings held between Golder and NEMA during 2014/2015. It is recognised that this approach deviates slightly from the general impact assessment method outlined in the Scoping Report (Golder Associates Africa, 2014); however, the ratings presented in the ESIA chapters (Volumes 3 and 4) were aligned with the findings of this biodiversity specialist study and are deemed to be representative of the specialist study outcomes.

3.0 METHODOLOGY

This section presents the methods used to identify and assess the potential effects and impacts to the biodiversity values of the Project's area of influence. This followed a six-part process, broadly following those outlined in Treweek (1999) and Secretariat for the CBD (2006):

1) Identify key issues.

2) Delineate study areas.

3) Identify the timeframe for the assessment.

4) Describe the baseline (including current direct and indirect drivers of change to ecosystem processes and functions, composition and structure).

5) Identify valued components, key questions, and indicators.

6) Conduct the impact assessment:

   a) identify Project interactions with the environment;

   b) consider environmental design features and mitigation;

   c) assess effects and classify direct and indirect impacts;

   d) describe the confidence in the impact predictions; and

   e) determine follow-up and monitoring activities.

The impact assessment shows clearly to the reader all of the steps taken to arrive at the overall impact level score for any key issue or question. Hence, a reader should be able to use these same tools to repeat the analysis if they desired to do so.

The methods used for each of these steps are presented below.

3.1 Key Issues

Key issues in relation to the biodiversity within the immediate footprint of the Project, and the wider region surrounding the Project footprint, were identified through stakeholder consultation (Golder 2014a), review of background biodiversity and environmental reports (that is: RPS (2006); AWE (2008a, b, c, 2013a, b, 2014a, b); AECOM (2012, 2013); EACL (2013, 2014), NEMA (1996, 2002, 2010), MEMD (2013), and TBC & FFI (2017)), published ecological and social literature, consideration of the IFC's Performance Standards (IFC 2012a), and applying the expertise of the biodiversity impact assessment team.

3.1.1 Delineation of the Study Area

As with any environmental impact assessment, the spatial and temporal boundaries for the analysis need to be set. Described below are those bounds.

3.1.2 Spatial Boundaries

The spatial boundaries within which potential effects arising from the Project may have on biodiversity were set. For this assessment, and in order to satisfy IFC requirements, two areas of influence were considered in relation to assessing the potential effects on biodiversity:

c)   Biodiversity local study area.

d)   Critical habitat area of analysis.

For the assessment of local impacts, the area should be large enough to analyse and mitigate efficiently the potential effects from the project on the receiving environment, but not too large as to dilute or confound the potential project-related effects with other human-induced and natural influences.

Described below are how the spatial bounds for each of those areas were determined.

a)   Local Study Area

- The assessment of impacts within the local area of the Project, or biodiversity local study area (LSA), was based on the spatial extent of a Project's footprint and an associated buffer zone that includes potential immediate, direct effects on the receiving environment. It was derived as a focus for the development of a baseline case where potential <u>direct</u> effects were predicted to occur.

- The LSA incorporates: the wells, flowlines, central processing facility (CPF) and supporting infrastructure associated with the production facility including in-field access roads and flowlines, an upgraded jetty, and a water abstraction station on Lake Albert, a permanent camp, a material yard (or 'supply base'), and a safety check station at the top of the escarpment.; and the feeder line easement to Kabaale, roughly 46 km to the northeast of the field.

- A 1 km buffer was incorporated around the infrastructure in order to capture all potential direct effects, including those from noise, dust, changes to surface water quality (that is, streams and wetlands). At Lake Albert, the buffer was extended to 2 km in order to capture direct impacts on aquatic ecosystems of concern.

- The LSA is depicted in Figure 1.

b)   Critical Habitat Area of Analysis (CHAA)

- Critical habitat is present in many places globally, but is only relevant to a development project where the project may affect that habitat (both directly and indirectly) (IFC 2012a). Importantly, the determination of critical habitat is independent of the specifics of the proposed project footprint, and

is present under baseline conditions and is not defined by the size of the project footprint, or other project effects.

▪ For the area, a first step in defining critical habitat was to identify an ecologically-relevant area of analysis surrounding, and including, the anticipated extent of the Project's influence, including broader or regional effects from the Project, in association with other anthropogenic activities (such as other projects) and natural factors. These include indirect, induced and cumulative effects. The CHAA was defined as that area.

▪ The boundaries of the CHAA were devised cognisant of the need for an area where the ecological and land management issues have more in common with each other than they do with those in adjacent areas, and constitutes a sensible ecological and political boundary within which critical habitat can be defined (IFC 2012b, paragraph 65).

▪ This area was also used as the geographical extent to screen biodiversity features to be assessed for critical habitat based on discrete management units (DMU). Critical habitat was therefore identified and mapped at the CHAA-scale, which was inclusive of the LSA.

▪ The screening was initially undertaken at a desktop level using the following attributes:

  – Presence, abundance, and distribution within, or relevance to, the area associated with the CHAA.

  – Potential for interaction with the area and proposed project development.

  – Conservation status or concern; in particular, IUCN-listed Critically Endangered and Endangered species, range restricted and endemic species, congregatory and migratory species, as well as, nationally listed threatened and priority species.

  – Ecological and/or socio-economic value.

  – Identified importance to interested public, government agencies, the scientific community, NGOs and/or CNOOC.

▪ secondary data sources were used, especially for the CHAA away from the LSA; these included:

  – SPOT6 imagery for the determination of land cover, land use, natural and modified habitats.

  – Global Biodiversity Information Facility (GBIF) (GBIF 2014; GBIF 2017).

  – Integrated Biodiversity Assessment Tool (IBAT), including the available data on Red List species, Key Biodiversity Areas (KBA), Endemic Bird Areas (EBA), Important Bird Areas (IBA), protected areas, wetland areas (IUCN 2014b).

  – Catchments and hydrology.

  – Soils and geology mapping.

  – Existing infrastructure and disturbance.

  – Proposed Project infrastructure.

▪ A biodiversity constraints/sensitivity map of the wider area was then generated, which became the CHAA. This map also formed the basis to identify modified and natural habitats (as per IFC 2012b), focus the assessment of the valued components, and guide field surveys.

▪ For the intents of this biodiversity impact assessment, the CHAA encompasses: the Buhuka Flats; the catchments of: the Masika River, the two unnamed watercourses to the south of the Masika River, the Kamansinig River, and the four unnamed watercourses to the north of the Kamansinig River; the pipeline corridor, extending to the eastern boundary of the natural vegetation on the escarpment (as derived from SPOT6 imagery); and the Bugoma Central Forest Reserve (CFR).

– DMUs are defined as an area with a clearly demarcated boundary within which the biological communities and/or management issues have more in common with each other than they do with those in adjacent areas (IFC 2012b).

– DMUs forming the CHAA included: the Buhuka Flats; the catchments of the Masika River, the two unnamed watercourses to the south of the Masika River, the Kamansinig River, and the four unnamed watercourses to the north of the Kamansinig River; the Bugoma Central Forest Reserve; the subsistence agricultural areas between the escarpment and the Bugoma Central Forest Reserve.

■ Figure 2 depicts the CHAA.
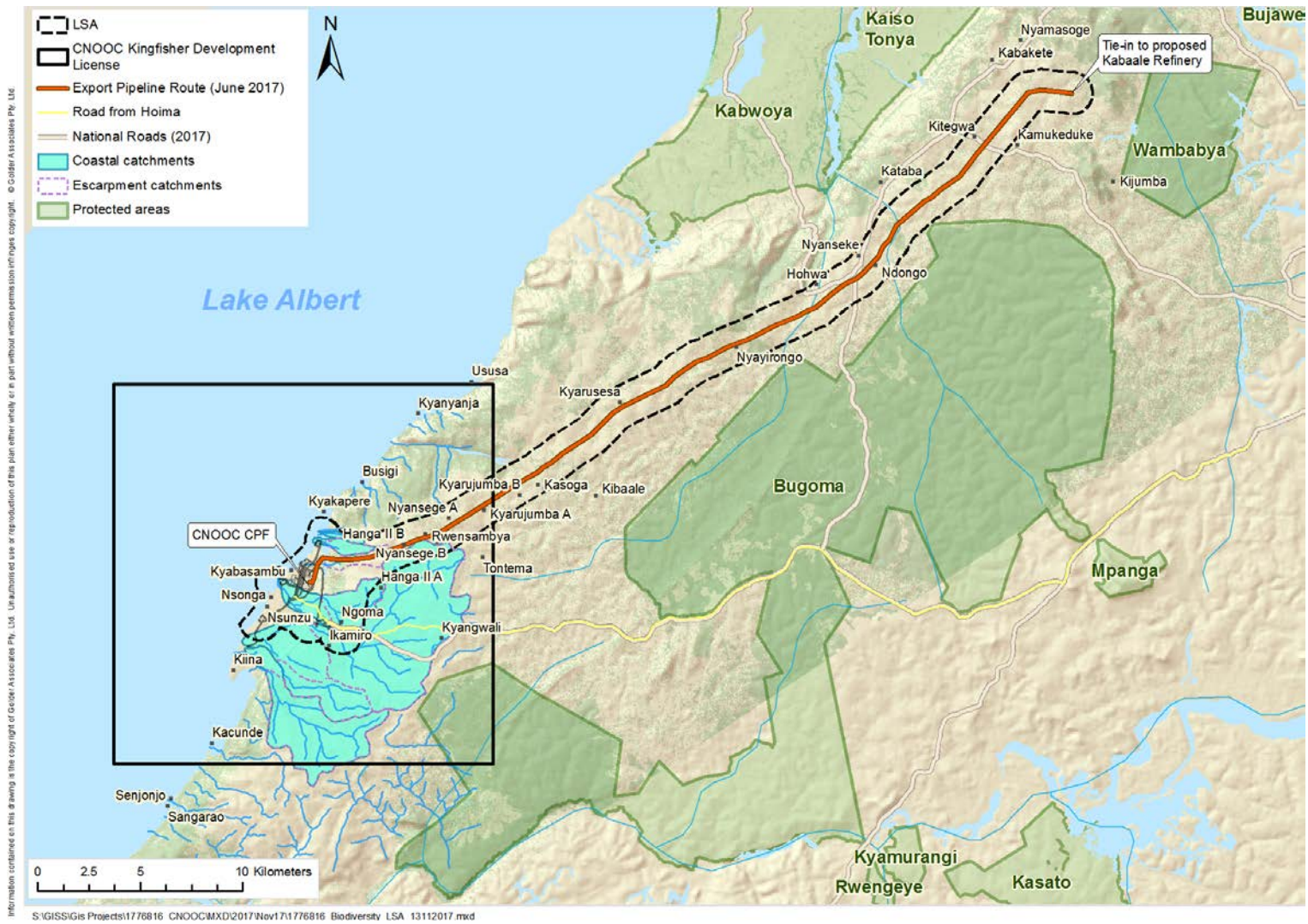
Figure 1: Biodiversity LSA
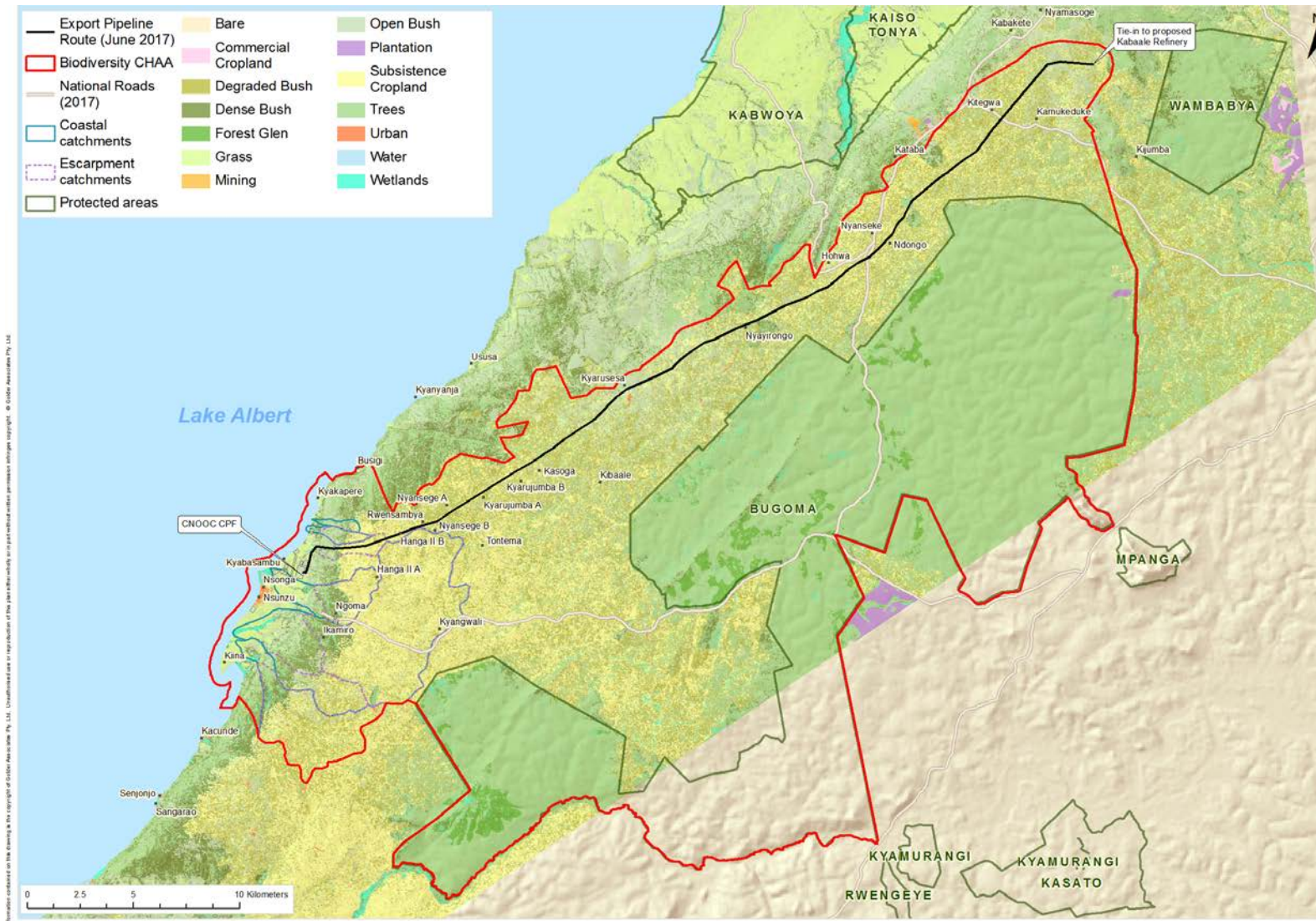
Figure 2: Biodiversity CHAA
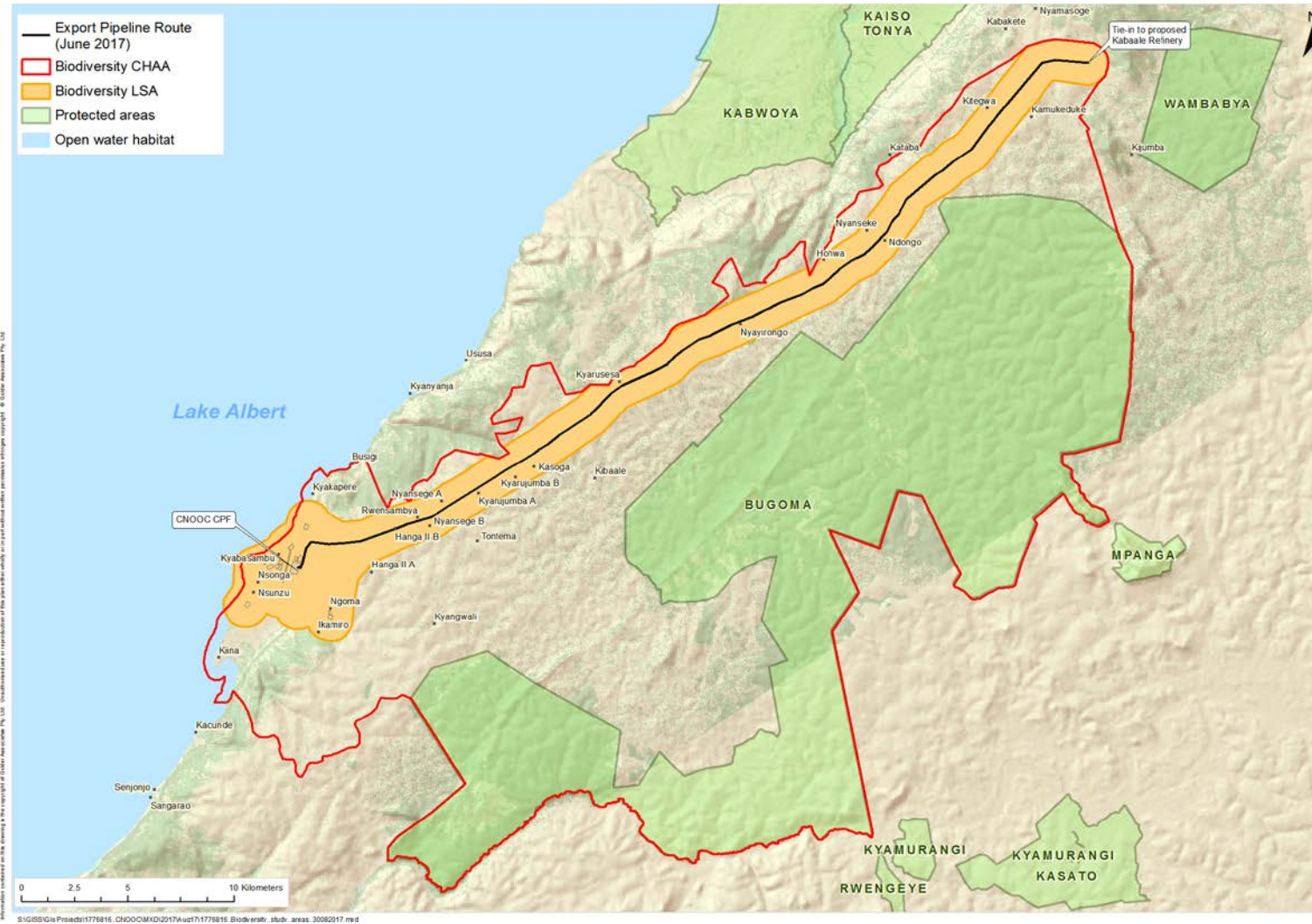
Figure 3: Biodiversity LSA and CHAA

3.2 Baseline

A baseline of the terrestrial and aquatic ecology of the LSA was determined through a desktop assessment and comprehensive, seasonal surveys. These assessments and surveys were then used as the basis for the description of the biodiversity of the CHAA. The approach and methods for those baseline surveys and derived studies are presented below. The detailed baseline study reports for the terrestrial and aquatic ecology are presented in Appendix C.

3.2.1 Terrestrial Biodiversity

In addition to a detailed review of existing literature and databases, multi-season surveys of the terrestrial ecology of fixed sampling locations within the LSA were completed to describe the baseline conditions. The field surveys focused on the Production Facility areas of the wells, central processing facility (CPF) and supporting infrastructure associated with the production facility including in-field access roads and flowlines, the upgraded jetty, the water abstraction station on Lake Albert, the permanent camp, the material yard (or 'supply base'), and the safety check station at the top of the escarpment; and the feeder line easement to Kabaale.

Seasonal variation in terrestrial ecology was assessed through multi-season surveys. The first field surveys captured the dry season, and occurred from 25 February 2014 to 8 March 2014. The second set captured the first wet season, and occurred from 28 May 2014 to 23 June 2014. The third set captured the second wet season, and occurred from 28 October to 20 November 2014.

The surveys focussed on:

■ vegetation communities and flora species;

■ invertebrates;

■ reptiles and amphibians;

■ birds; and

■ mammals.

The methods of survey for each of these groups are summarised below, and presented in detail in the Appendices.

3.2.1.1 *Vegetation Communities and Flora Species*

A desktop search and review was made of available literature about the vegetation and flora of the CHAA, in particular the vegetation communities of the Albertine Graben, the escarpment and beyond, and the conservation status of species. Data sources included: Langdale-Brown et al. (1964); Plumptre et al. (2003, 2007); Kalema and Beentje (2012); and the IUCN's RedList (IUCN 2017). The data thus obtained were used to identify sampling and survey sites on satellite imagery for later ground-truthing during the field surveys. These data were also used to inform the assessment of the probability of species of concern occurring in the CHAA (see Section 3.3.3.2 Species of Concern).

Two-hundred-and-seventy-five sampling plots were identified for survey; in particular: on the Buhuka Flats, 13 line-transects were run, with 150 sample plots; on the escarpment, seven transects were run, with 40 sample plots; and along the pipeline route, 23 transects were run with 153 plots.

The precise locations of each of those plots are displayed in the baseline reports in Appendix C.

Areas of natural and modified vegetation were surveyed in the wet and dry seasons, with focus given to the main vegetation communities on the Buhuka Flats, the escarpment and along the pipeline route. Along the pipeline route, only relic patches of vegetation were selected for survey that were deemed natural or near-natural, because most of the area along the route is under cultivation and settlement. Sampling was undertaken based on the gradsects approach (after Gillison and Brewer 1985), taking into consideration the variation in such aspects as slope, observable indicators of soil moisture and soil type, as well as the plant community assemblages. All species of plants present were identified and recorded, and their relative

abundance was assessed using the DAFOR scale (D = dominant, A = abundant, F = frequent, O = occasional, R = rare) (after Kent and Coker 1992). Azonal habitats believed to be unique within a given area were also sampled. These included such areas as shallow depressions, old termite mounds, drainage channels, and others. This sampling regime was chosen with a view of capturing as wide a range of the vegetation types and species in the area as possible (Gillison and Brewer 1985, Økland 1990, Austin and Heylingers 1989 in Wessels et al. 1998, de Blois et al. 2002).

The general vegetation type in each of the selected sites was characterised. This characterisation was based on the floristic and landscape features observed in the different habitat types. Dominant species of plants in the woody and herbaceous layers were identified and used for this purpose. The general terrain and proximity to important features, such as the lake or streams were noted. From this sampling, species of conservation concern and invasive species occurring in the area were identified and the geographical coordinates of their areas of occurrence recorded.

Specimens that could not be identified in the field were collected as vouchers for subsequent identification and deposition in the Makerere University Herbarium (MHU).

3.2.1.2 *Invertebrates*

Insects and other invertebrates dominate the terrestrial and aquatic ecosystems in terms of species richness, individual abundances and biomass (Wilson 1985, Stork 1988, Gaston, 1991). Their temporal and spatial distributions span the ranges occupied by many vertebrate and plant species, including finer-grained patch sizes and geographical distributions, more complex seasonal and successional sequences and patch dynamics with more rapid turnover (Gaston and Lawton 1988). Insects are also highly susceptible to the adverse effects of disturbance and land use change; this makes them useful as indicators of ecosystem change (Terborgh 1992).

Although insects and other invertebrates dominate the terrestrial and aquatic ecosystems, including the savannah and forest systems of the CHAA, and they are useful indictors, there are often severe limitations in terms of sampling and assessing the insect populations in biodiversity impact assessments. Of primary concern are the taxonomic restrictions for most invertebrate groups; specifically, the lack of a complete catalogue of knowledge of species, and the paucity of experts able to identify invertebrate taxa.

Although all species occurring in an area of interest are a component of overall ecological value, it is neither practicable, nor necessary, to assess potential effects of a project on every species that might be affected. This is particularly the case for most invertebrates, and lower plants (that is, bryophytes and pteridophytes), where, as mentioned, the taxonomy and ecology is often poorly established. As such, and in line with global conservation priority-setting, for this biodiversity impact assessment, vertebrates were largely used as a surrogate for all animal species, and vascular plants as a surrogate for all plants (Secretariat of the CBD, 2006). The selection was based upon a higher level of knowledge (ecology and conservation status) of these surrogates, and adopts the hypothesis that conditions which support restricted range vertebrates and/or vascular plants are likely to also support rare species of other taxonomic groups. Although this is an approximation of the likely situation, it provides manageable and meaningful conclusions.

Nevertheless, Uganda and the Albertine Graben are fortunate in that detailed taxonomy is available for some invertebrate groups. In particular, the butterflies (Order: Lepidoptera) and the dragonflies and damselflies (Order: Odonata).

Butterflies are known sensitive indicators of environmental change associated with natural and human-induced disturbances. Their populations are influenced by changes in local climatic conditions and the availability of host plants for larval and adult stages (Ehrlich et al. 1972, Thomas et al. 1998). Frequently disturbed environments are considered unstable and unpredictable and, as a result, have low species diversity, whereas less disturbed, more stable environments are expected to promote high species diversity (Odum 1985).

Dragonflies and damselflies utilise both aquatic and terrestrial habitats, and hence these groups can contribute greatly to the evaluation of environmental quality (Miller and Miller 2003). They are known to be very sensitive to structural habitat quality, and are used as indicator groups to evaluate landscape degradation.

Given their established taxonomy (*viz.*, Kielland (1990), Larsen (1991, 2005), Davenport (1996, 2003), Carder and Tindimubona (2002), Clausnitzer (2002), Miller and Miller (2003), and Picker et al. (2004), Molleman (2012), and the resources available at www.africa-dragonfly.net), a baseline of butterflies, dragonflies and damselflies was established for the LSA. The IUCN's RedList (IUCN 2014a) was consulted to establish a list of potential species with conservation significance, which informed the analysis of probability for these species to occur in the CHAA (see Section 3.3.3.2 Species of Concern).

Butterfly, dragonfly and damselfly surveys were carried out at 12 sites across the LSA in suitable habitat, including: locations corresponding to the various pieces of Project-related infrastructure on the Buhuka Flats, encompassing the stream and seasonally flooded wetland located near the airstrip, and the well pads; the lake shore of Lake Albert and the Bugoma Lagoon area; the lower reaches of the Masika River and the associated wetland; the escarpment; and along the pipeline route to the refinery area and Kabaale (which consists mainly of cultivated land, fairly degraded seasonal wetlands, riverine vegetation along Hohwa River and pockets of natural woodlands) (Appendix C, Table 2.1).

For butterflies, at each sampling site, survey methods employed included time- and distance-constrained sweep netting and baited traps (after Samways et al. 2010). Eighteen traps, baited with fermenting banana, were set along transect lines at each sampling location and left in place for two days. All specimens captured in the sweep nets and traps were identified in the field and released; only specimens with difficult identification were collected for further processing at Makerere University. Each of the butterfly species was assigned to one of the ecological categories as described by Davenport (1996); that is, forest-dependent species (F), forest edge/woodland species (f), open-habitat species (O), widespread species (W), migratory species (M), and wetland species (S).

Adult dragonflies and damselflies were sampled at each sampling site using time- and distance-constrained sweep netting (after Samways et al. 2010). In most instances, only mature males were sampled to minimise impacts on breeding populations. Familiar local species were recorded by observation only or by catch-and-release after confirmation. Voucher specimens were collected and preserved for further laboratory identification. Particular attention was given to the local habitat where the species were found.

3.2.1.3   *Amphibians and Reptiles*

A desktop search and review was made of available literature about the reptiles and amphibians of the CHAA. Data and information sources included: Plumptre et al. (2003, 2005, 2007); RPS (2006); AWE (2008a, b, c, 2013a, b, 2014a, b); AECOM (2012); EACL (2013, 2014), IUCN (2017); and GBIF (2017). The data thus obtained were used to identify sampling and survey sites on satellite imagery for later investigation during the field surveys. These data were also used to inform the assessment of probability of species of concern occurring in the CHAA (see Section 3.3.3.2 Species of Concern).

Nineteen survey sites were selected across the LSA as a representative sample of habitats that could be affected by the Project development (Appendix C, Tab. 3.1, Fig. 3.1). Eight of these were surveyed for amphibians and reptiles, five exclusively for amphibian fauna, and six exclusively for reptilian fauna. A control site within Bugoma Forest Reserve was selected, because several sites surveyed along the pipeline route, outside the forest, were considered to be analogous with the habitats present within the forest, yet were severely degraded and under heavy cultivation. The reptile and amphibian species composition of the Bugoma Forest Reserve was expected to be close to the original composition, while that along most of the pipeline and refinery areas could constitute a mixture of a few forest and grassland generalists.

Visual encounter and opportunistic survey approaches (after Heyer et al. 1994, and McDiarmid et al. 2012) were the main methods employed at each sampling site during the survey. These methods are well-tested and robust methods for surveying reptiles and amphibians. Visual encounter surveys are time constrained and are effective for most amphibians in most habitats. The data gathered using this method provides information on species richness of a habitat, with the best results for amphibians achieved in the evening between 7 pm and 9 pm, when most amphibian species expected to occur in the CHAA (refer to Channing and Howell 2006) would be active. Opportunistic surveys recorded those species outside of the systematic sampling locations and times.

Species estimators (as species accumulation curves) were used to calculate the possible maximum number of species that could occur in the LSA. Four estimators: Chao 1, Chao 2, Jacknife 1, and Jacknife 2 were used (after Gotelli and Colwell 2011).

3.2.1.4   Birds

Birds can represent a significant component of the biodiversity of an area, and they are ecologically versatile, representing herbivores, carnivores and omnivores, as such, they have been shown to be effective indicators of general biodiversity (Sutherland et al. 2004). They also lend themselves well to the identification of conservation priorities (Pain et al. 2005), and are a good indicator group for monitoring (Pearson 1994, Pearson and Carroll 1998).

A desktop search and review was made of available literature about the birds of the CHAA. Data and information sources included: Bennun and Njoroge (1996); Byaruhanga et al. (2001); Plumptre et al. (2003, 2007); RPS (2006); AWE (2008a, b, c, 2013a, b, 2014a, b); AECOM (2012); EACL (2013, 2014), IUCN (2017); and GBIF (2014; 2017). The data thus obtained were used to identify sampling and survey sites on satellite imagery for later investigation during the field surveys. These data were also used to inform the assessment of the probability that species of concern could occur in the CHAA (see Section 3.3.3.2 Species of Concern).

Birds, being highly mobile, tend to reflect the nature of larger areas rather than points within the landscape, except in instances where there are key nesting or roosting sites. Land birds and their habitats were generally surveyed along 2 km transects, each of ten 200 m sections (NatureUganda 2010). Each transect was predominantly within a single habitat, and collectively covered each of the main habitats in the LSA. Waterbirds and waders were recorded at fixed time-constrained, point-count sites (after Gregory et al. 2005). Data were recorded in a standard format, as used by Nature Uganda (2010) for the national bird monitoring programme. Field surveys were conducted during February, March, May, October and November 2014.

All birds were identified by sight (or sound) in the field, with taxonomy following Stevenson and Fanshawe (2002).

3.2.1.5   Mammals

A desktop search and review was made of available literature about the mammal fauna of the CHAA. Data and information sources included: Kityo et al. (2003), Plumptre et al. (2003, 2005, 2007); RPS (2006); AWE (2008a, b, c, 2013a, b, 2014a, b); AECOM (2012); EACL (2013, 2014), IUCN (2017); and GBIF (2017). The data thus obtained were used to identify sampling and survey sites on satellite imagery for later investigation during the field surveys. These data were also used to inform the assessment of the probability that species of concern could occur in the CHAA (see Section 3.3.3.2 Species of Concern).

Standard survey methods, as described in Isabirye-Basuta and Kasenene (1987), Wilson et al. (1996), and Claustinitzer & Kityo (2001), were employed to sample the mammal fauna and their habitats in the LSA. Due to the paucity of large mammals in the LSA due to human disturbance (for example, see AWE (2008a, b, c, 2013a, b, 2014a, b)), intensive surveying was only conducted for small mammals.

In particular, rodents and insectivores (e.g. shrews) were surveyed using Sherman traps deployed in 11 trap lines of 40 traps each on the Buhuka Flats, and 80 traps each in the Bukona area. The trap lines were open for three to five days in the Buhuka Flats, two days in the Bukona area, and baited with a standard bait mixture (after Claustinitzer and Kityo (2001), Isabirye-Basuta and Kasenene (1987)). Traps were re-baited every evening, while checking, recovering and processing any captured animals completed in the morning. Bats were surveyed using mist nets, harp traps and acoustic methods (using the AnaBat II and SM2 bat detectors). Surveys started at dusk and continued until 10 pm on nights when this was possible. Surveys for large mammals were largely opportunistic, that is, tracks and signs (spoor or faecal material), observation, and informant interviews with local people. Informant interviews with local people were the main methods used along the pipeline route.

3.2.2   Aquatic Biodiversity

In addition to a detailed review of existing literature and databases, multi-season surveys of the aquatic ecology of fixed sampling locations within the LSA were completed to describe the baseline conditions. The field

surveys focused on the near-shore zone of Lake Albert opposite the well pads (that is, Pad 1, Pad 2, Pad 3, Pad 4A, the upgraded jetty, the water abstraction station on Lake Albert), and the general Kingfisher Development area (that is, the wells, CPF and supporting infrastructure associated with the production facility including in-field access roads and flowlines, the permanent camp, and the material yard (or 'supply base'). Watercourses and wetlands of the Buhuka Flats were sampled, including the Masika River (upper, mid and lower reaches and wetland), the Kamansinig River[1] (upper, mid (airfield wetland) and lower reaches, including the lagoon), and Well Pad 2 stream[2].

Seasonal variation in aquatic ecology was assessed through multi-season surveys. As mentioned above, the region of the CHAA experiences two wet seasons . The first field surveys captured the dry season, and occurred from 23 February to 8 March 2014. The second set of field surveys captured the wet season, and occurred from 23 to 28 May 2014. The third set of surveys captured the second wet season, and occurred from 15 to 20 November 2014.

The surveys focussed on Lake Albert and the watercourses and wetlands, and included:

■ water quality;

■ phytoplankton;

■ zooplankton;

■ macro-invertebrates; and

■ fish.

The precise methods of survey for each of these groups are summarised below, and presented in detail in Appendix D.

3.2.2.1 *Water Quality*

Data for studies on lake water quality were collected at two fixed sites on each of five transects of 2 km length (from the shore lake-ward) opposite each of the five well pads. Samples from each transect were collected at about 10 m from the shoreline (inshore) and at the end of the transect, 2 km from shore (offshore).

In the Bugoma Lagoon, the samples were taken about 10 m from the shore and at a point approximately midway across the lagoon. Within the other wetlands associated with Kamansinig River, Masika River and Well Pad 2 stream, samples were collected in the water column.

For each transect and sampled site, the following physical characteristics were recorded: shoreline topography; soil type; vegetation cover; water depth, nature of bottom sediments and GPS location.

Water quality samples were collected using a 5 L van Dorn sampler from a depth of ~50 cm. In-situ and laboratory physical and chemical parameters were recorded at each sampling location. In-situ parameters included: dissolved oxygen (mg.L^{-1}), temperature (^{o}C), pH and conductivity (µS.cm^{-1}) as measured using a Hach HQ40d Multiprobe. Laboratory-determined parameters included: ammonia-nitrogen and nitrate-nitrogen; ortho-phosphate; total phosphorus (TP); total nitrogen (TN); soluble reactive silica; chlorophyll a; and faecal coliform.

3.2.2.2 *Phytoplankton and Macrophytes*

Data for studies on phytoplankton were collected at two fixed sites on each of the five transects of 2 km length (from the shore lake-ward). Samples from each transect were collected at about 10 m from the shoreline (inshore) and at the end of the transect, 2 km from shore (offshore).

In the Masika and Kamansinig Rivers, phytoplankton samples were collected mid-stream in the upper, mid and lower reaches. In the Bugoma Lagoon, which is in the lower reaches of the Kamansinig River, the samples

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[1] This watercourse is referred to as the Airfield Stream in the baseline studies.

[2] This stream is not formally named on any maps; it drains off the escarpment and flows to the immediate south the

were taken about 10 m from the shore and at a point approximately midway across the lagoon. Macrophytes were assessed in conjunction with the vegetation and flora assessments, and focused on major vegetation formations and the extent of surface water flows.

Twenty millilitres of water were sampled at each location from a depth of ~50 cm. Each sample was fixed with Lugol's solution (Utermöhl 1958), and stored away from light (Wetzel and Likens 2000). The sedimentation method of Utermöhl (1958) was used to count the phytoplankton under an inverted microscope, while taxonomic identification was made with the help of Komarek and Anagnostidis (1999) and John et al. (2002).

3.2.2.3   *Zooplankton*

Data for studies on zooplankton were collected at two fixed sites on each of five transects of 2 km length (from the shore lake-ward). Samples from each transect were collected at about 10 m from the shoreline (inshore) and at the end of the transect, 2 km from shore (offshore).

In the Masika and Kamansinig Rivers, samples were collected mid-stream in the upper, mid and lower reaches. In the Bugoma Lagoon, which is in the lower reaches of the Kamansinig River, the samples were taken about 10 m from the shore and at a point approximately midway across the lagoon.

Vertical zooplankton hauls were taken from ~50 cm above the bottom sediments to the surface using a conical net of 0.25 m mouth opening and 60 µm mesh. Three hauls were taken to make a composite sample for each site, which was preserved with 4% sugar-formalin solution. In the laboratory, samples were identified based on published keys (*viz.*, Rutner-Kolisko 1974, Brooks 1957, Pennak 1953, Sars 1985).

3.2.2.4   *Macro-invertebrates*

A desktop search and review was made of available literature about the macro-invertebrate fauna of the CHAA. Data and information sources included: AECOM (2012), IUCN (2017); and GBIF (2014, 2017). The data thus obtained were used to guide sampling and survey sites on satellite imagery for later investigation during the field surveys. These data were also used to inform the assessment of the probability that species of concern could occur in the CHAA (see Section 3.3.3.2 Species of Concern).

Data for studies on macro-invertebrates were collected at two fixed sites on each of five transects of 2 km length (from the shore lake-ward). Samples from each transect were collected at about 10 m from the shoreline (inshore) and at the end of the transect, 2 km from shore (offshore).

In the Masika and Kamansinig Rivers, samples were collected mid-stream in the upper, mid and lower reaches. In the Bugoma Lagoon, which is in the lower reaches of the Kamansinig River, the samples were taken about 10 m from the shore and at a point approximately midway across the lagoon.

In Lake Albert, at each sampling site, composite, triplicate sediment samples were collected using a Ponar grab sampler (after APHA 1992). The physical characteristics (for example, soft mud, sandy, stony, etc.) were noted for each composite sample. The samples were processed in the laboratory according to published methods (that is, APHA 1992, Ferraro and Cole 1992, Ochieng 2006, and Ochieng et al. 2008) in order to sort, identify and quantify the macro-invertebrates. Identification was undertaken based on Mandal-Barth (1954), Merrit and Cummins (1984), and de Moor et al. (2003).

Three indices, namely: EPT (Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddis flies)) taxa richness; total taxa richness; and abundance of macro-invertebrate individuals (after Wenn 2008, Oghenekaro 2011) were determined and used for a description of macro-invertebrate status as indicators of environmental quality. EPT taxa are considered the least tolerant of pollution (for example, organic pollution) and, therefore, aquatic environments with the presence of a high richness of EPT taxa, are regarded to be of good quality. Total taxa richness refers to the total number of all macro-invertebrate taxa (for example, genera) in a sample, with a higher taxa richness having better environmental quality. Based on the works of Wenn (2008), samples with: an EPT score of two to three, and total taxa score of ten to 12, are considered to be indicative of moderate to good environmental conditions; those with EPT scores of one, and total taxa scores between five and 10, were considered to be indicative of fair environmental conditions; while those with EPT scores of zero and varying total taxa scores of one to seven, were considered to be of poor environmental condition.

3.2.2.5   *Fish*

Data for studies on fish were collected at two fixed sites on each of five transects of 2 km length (from the shore lake-ward). Samples from each transect were collected at about 10 m from the shoreline (inshore) and at the end of the transect, 2 km from shore (offshore).

In the Masika and Kamansinig Rivers, samples were collected mid-stream in the upper, mid and lower reaches. In the Bugoma Lagoon, which is in the lower reaches of the Kamansinig River, the samples were taken about 10 m from the shore and at a point approximately midway across the lagoon.

Data were obtained using multifilament gillnets, set perpendicular to the shore, ranging from 1 to 6 inches, increasing by ½ inch increments. Gillnets were set in the evening and hauled at dawn. On retrieval, fish species were identified using Greenwood (1966) and morphometrics (length, weight, and sexual maturity) recorded. Gut content and diet of individuals was determined in the laboratory. Species composition, relative abundance, population structure and relative condition were calculated from the catch statistics.

3.2.3   **Overall Biodiversity Value**

Biodiversity value is a term used by the IFC in PS6 *Biodiversity Conservation and Sustainable Management of Living Natural Resources* (IFC 2012a, 2012b), as well as by a number of other industry bodies; for example, The Energy and Biodiversity Initiative (EBI 2014), and the International Council on Mining and Metals (ICMM) (ICMM 2010). Those publications, together with the CBD's *Voluntary Guidelines on Biodiversity-Inclusive Impact Assessment* (Secretariat of the CBD, 2006), are recognised as standards of good practice for biodiversity impact assessment. Biodiversity values represent components of biodiversity at various levels of biological organisation, such as species or ecosystems that are important for conservation. Those values are reflected in CNOOC's corporate philosophy towards biodiversity conservation (see CNOOC 2014a, b).

To focus in on the key issues relating to biodiversity, as identified by stakeholders, the stakeholder's values placed on components of the biodiversity in the CHAA, and the potential risks posed to those biodiversity values by the Project, the concept of valued components was used. Valued components are physical, biological, economic, social, cultural, and health properties of the environment that are considered important by the proponent, public, government agencies, and/or the scientists involved in the assessment process (that is, the stakeholders) (Treweek 1999). These valued components identified and described during the baseline then become the focus for the impact assessment. In terms of the biodiversity of the CHAA, valued components are defined as the elements of an ecosystem that are identified as having scientific, social, cultural, economic, or aesthetic importance.

The biodiversity baseline concentrated on identifying two levels of biodiversity valued component in the CHAA, which are akin to the requirements of IFC PS6 (IFC 2012a) and the Secretariat of the CBD (CBD 2006); *viz.*: ecosystems and habitat and species of concern. It also describes the direct and indirect drivers of change to those values. In particular:

c)   The ecosystem and habitats level:

This focussed on the broad description and identification of natural and modified terrestrial and aquatic ecosystems and habitat and critical habitat in the CHAA, and the direct and indirect drivers of change to those ecosystems and habitats at the spatial and temporal scale, and the processes and functions that drive those ecosystems and habitats; particularly, the integrity of those systems.

d)   The species level:

The focus was on populations of species of concern; in particular, species of high value to people. These species included, amongst others: species of high conservation concern, as gazetted under Ugandan legislation, and the IUCN's Red List (IUCN 2014a); culturally important species; and invasive species.

The assessment of ecosystem services, often seen as a third component of biodiversity, is covered in.

3.2.3.1 *Ecosystems and Habitats of Concern*

The intrinsic values of ecosystem functions and processes, and habitats, supported in the CHAA were assessed on two levels: ecosystem integrity and priority habitat (including critical habitat). The methods used for each of these are discussed below.

The assessment of ecosystem integrity broadly followed the guidance provided by the CBD's *Voluntary Guidelines on Biodiversity-Inclusive Impact Assessment* (Secretariat of the CBD 2006) and Treweek (1999). For the identification and assessment of priority habitats, natural and modified habitats were identified initially based on remote imagery, then verified with field data. For critical habitat, the IFC's approach was followed (refer to IFC PS6 (IFC 2012a, b)).

These guidance documents are complementary, and are recognised as a leading-practice approach for the assessment of impacts to biodiversity through a focus on the protection and conservation of biodiversity values of key conservation concern.

3.2.3.1.1 Ecosystem Integrity

Ecological integrity refers to the abundance and distribution of species and the ecological patterns and processes that maintain biological diversity and ensure ecosystem resilience (Woodley et al. 1993). The major ecosystems and habitat types within the CHAA were initially identified at the desktop level based on the works by: RPS (2006); AWE (2008a, b, c, 2013a, b, 2014a, b); AECOM (2012); EACL (2013, 2014); as well as a land cover assessment undertaken based on SPOT6 data (Appendix E). Thereafter, those ecosystems and habitats were confirmed by field verification undertaken during the terrestrial and aquatic field studies (see Section 3.3.1 and 3.3.2 respectively).

The area of each ecosystem and habitat was determined based on the land cover assessment data built on the SPOT6 and aerial imagery data analysis, and the mapping of communities done during the terrestrial ecology field surveys. A quantitative and qualitative assessment of the integrity of each of the identified ecosystems and habitats was determined from field data (see Appendix C and D). For the purposes of this impact assessment, the integrity of the ecosystems was determined based on the following criteria (after: Kent and Coker 1992, Treweek 1999, Tucker 2005, Secretariat of the CBD 2006):

■ Composition

   Diversity and complexity - what is there and how abundant (in a particular time frame) it is.

■ Structure (or pattern)

   How biological units are organised in time and space. Ecosystem 'scale' refers to the space it occupies and the way it changes over time. The structure and interactions that shape the flow of energy and the distribution of biomass.

■ Linkages and corridors

   To habitat of the same or different ecosystems, which provide an important 'playing field' for ecological processes and enable the goal of their persistence. These linkages are in contrast to a highly-fragmented landscape where patches of natural habitat are effectively isolated.

■ Key processes (including ecosystem function)

   Which natural (that is, physical and/or biological) and/or human-induced processes are of key importance for the creation and/or maintenance of ecosystems. These are termed drivers of change, and include direct and indirect drivers. Examples of direct drivers include: changes in land use and land cover; fragmentation and isolation; extraction, harvest, or removal of species; external inputs such as emissions, effluents, chemicals; disturbance; introduction of invasive, alien and/or genetically modified species; and restoration. Examples of indirect drivers of change include: demographic; economic; socio-political; cultural; and technological processes or interventions.

■ Representativeness in the landscape.

The uniqueness of the ecosystems within the CHAA and the wider landscape; this rarity factor is related to the concepts of irreplaceability and vulnerability. The concept of irreplaceability relates to rarity or uniqueness in the landscape, while vulnerability refers to degree of threat (for more detailed definitions, see Section 3.3.3.1.2).

■ Resilience and stability

The ability of the ecosystem to absorb change and persist, and maintain the same form.

Based on the assessment of these criteria, the condition of the ecosystems and habitats was estimated and assigned a subjective class, that is, pristine, near-pristine, slightly-degraded, moderately-degraded, heavily-degraded.

Two key drivers for this condition designation were: to aid in the identification of modified and natural habitat (see below), and the IFC's requirement of no net loss of natural habitats within the LSA (IFC 2012a); and the philosophy of net positive impact (NPI) in areas of critical habitat (IFC 2012a, see below). Where NPI is primarily measured in terms of quality hectares, which can be determined as a derivative of the area of an ecosystem multiplied by the condition of different habitat types.

3.2.3.2   Species of Concern

Although all species occurring in an area of interest are a component of overall biodiversity and ecological value, it is neither practicable, nor necessary, to assess potential effects of a project on every species that might be affected. This is particularly the case for most invertebrates and lower plants (that is, bryophytes and pteridophytes) where the taxonomy and ecology is often poorly established. As such, and in line with global conservation priority setting, terrestrial and aquatic vertebrates and selected invertebrates were used as a surrogate for all animal species, and vascular plants as a surrogate for all plants (Secretariat of the CBD, 2006). The selection was based upon a higher level of knowledge (that is, ecology and conservation status) of these surrogates, and adopts the hypothesis that conditions that support restricted-range vertebrates and selected invertebrates, and/or vascular plants, are also likely to support species of other taxonomic groups, including rare and threatened species. Although this is an approximation of the likely situation, it provides manageable and meaningful conclusions.

For the intents of this biodiversity impact assessment, a species of concern was defined as a plant or animal species that requires special conservation consideration based on certain characteristics, or one which may be particularly sensitive to Project effects. Those characteristics were then used to gauge the sensitivity of the particular species to the development, and how best to manage those sensitivities as part of the development.

The following selection criteria were used to screen and identify terrestrial and aquatic species of concern for the assessment, which are in line with the criteria for critical habitat designations (IFC 2012a):

a)   Threatened and restricted-range/endemic species (Criteria 1 and 2).

b)   Statutory species (national/international legislation, agreements, conventions) (Criteria 1, 2 and 3).

c)   Species of economic and/or cultural importance (Criteria 5 and 13).

d)   Convention on the International Trade in Endangered Species (CITES)-listed species (Criterion 1, 2 and 3).

e)   Evolutionarily distinct species (Criterion 5)

f)   Species that play a critical ecological role, represent guilds of species, or capture effects to other species with similar habitat requirements and sensitivities (Criterion 10).

g)   Invasive or potentially invasive species.

The determination of which level the species of concern was placed at, was used for determining the level of sensitivity of the particular species. A similar approach was used for assessing the sensitivity of the valued components. As an example,

■ A species of concern with a <u>moderate</u> sensitivity could be one that is a regional endemic, a species whose distribution is significantly reduced from former extent but currently stable.

■ A species of concern with a <u>very high</u> sensitivity may have an IUCN status of critically endangered or endangered, a local endemic, or its range is restricted to the CHAA. Or local temporal concentrations of individuals significant to global population, or much reduced and/or highly fragmented species distribution compared to its former extent, or ecosystem representation whose presence or processes support critically endangered or endangered species' habitat, or buffers it, keystone species, and/or species new to science.

The identification of a list of potential species of concern for the CHAA was determined from the species lists and known distribution records contained in: AECOM (2012, 2013); AWE (2008a, b, 2013a, b, 2014a, b); Emerton and Muramira (1999); GBIF (2017); Lamprey (2009); NEMA (2010); Plumptre et al. (2003, 2007, 2010, 2011); and the findings of the field surveys (see Appendix C and D). For those species where actual records of occurrence did not exist, yet were identified as potentially occurring in the area (based on habitat preferences and knowledge of the species), inferred distributions were derived from: Kalema and Beentje (2012) (plants); Mandahl-Barth (1954) (freshwater molluscs); Greenwood (1966) (fish); Carder and Tindimubona (2002), Davenport (2003) (butterflies); Miller and Miller (2003) (Odonata); Channing and Howell (2006) (amphibians); Spawls et al. (2004) (reptiles); Stevenson and Fanshawe (2002) (birds); and Butynski et al. (2013), Happold (2013), Happold and Happold (2013), Kingdon and Hoffman (2013a, b), Kingdon et al. (2013) (mammals).

It is recognised that some species of concern would not actually occur in the CHAA for various reasons, such as unsuitable habitat. Therefore, a screening of the probability of the various species of concern actually occurring in the CHAA was determined through a probability analysis based on:

■ Knowledge and experience of the CHAA, and the wider area, as determined based on observations made during the Scoping Study (Golder Associates 2014c).

■ Findings of previous studies and published scientific literature.

■ Species records stored in the GBIF (2017).

■ Knowledge of the life histories of the species, habitat preferences, and known ecological requirements as determined through published information and information presented in the species profiles on the IUCN's Red List (IUCN 2017).

■ Consultation with experts and professional judgement and experience of the assessors.

Three levels of probability were used: possible, probable and unlikely. These were defined as:

e) Possible: the species may occur in the CHAA, or move through the CHAA (in the case of migratory and highly mobile species) due to potential habitat and/or resources.

f) Probable: the species is likely to occur in the CHAA due to suitable habitat and resources being present, and/or known records from the CHAA.

g) Unlikely: the species will not likely occur in the CHAA due to lack of suitable habitat and resources.

The probability assessment was used as the starting point for the screening of species of concern to occur in the CHAA as per the criteria set out above. Only those species with a possible and probable likelihood of occurrence within the CHAA were considered for inclusion in the valued component assessment. Nevertheless, the other species were not ignored; rather, it was assumed that the species chosen could act as proxies for many of the other species, should they occur, however remote the possibility. As such, a precautionary approach was adopted where there was an uncertainty that a species could potentially occur in the CHAA.

3.2.3.3 *IFC Priority Habitat*

Under the IFC's approach (see IFC 2012b), three classes of habitat are used to assign value to biodiversity: modified habitat; natural habitat; and critical habitat. Modified habitats are found in areas that have been altered by human activity and may contain large portions of non-native plants and animals. Examples include agricultural landscapes and reclaimed areas (IFC 2012b). Modified habitats may or may not retain ecological functions that support significant biodiversity value. Natural habitats are those where the species composition and primary ecological functions of the area have not been fundamentally altered by human activity (IFC 2012b). The definition of "fundamentally altered" is undertaken on a case-by-case basis; however, for the intents of this biodiversity impact assessment, natural habitats were defined as those habitats where the key processes, composition, and structure were largely intact. Critical habitats are a subset of either modified or natural habitats that constitute areas of significant importance for biodiversity conservation. The identification of natural, modified and critical habitat is discussed below.

Different mitigation standards are recognised for development occurring in each of the three habitat classes. Consequently, identifying the types of habitat that might be affected by a development project is a central aspect of understanding baseline conditions.

3.2.3.3.1 Natural and Modified Habitat

As mentioned in Section 3.3.1, the identification of modified and natural habitats was initially based on secondary data sources using SPOT6 imagery as a basis. Although it is recognised that the modified and natural components of particular ecosystems and habitats within land cover classes cannot be accurately determined directly from spectral classes, using SPOT6 data does provide a very good indication of modified and natural habitats. For more information on the approach and methods for the determination of land cover, see Appendix E. Following that initial land cover assessment, each land cover class was assigned to the natural or modified categories, as per the IFC's criteria (see IFC 2012b), as relevant to the CHAA, and based on initial observations made during the scoping visit (Golder Associates 2014c). Areas within protected and managed areas (for example, Central Forest Reserves) were automatically assumed to be natural habitat, as were the near-shore (that is, within 1 km of the shore) environments of Lake Albert. These classes were then refined using the data collected as part of the terrestrial and aquatic ecology baseline studies (see Appendix C and D).

3.2.3.3.2 Critical Habitat

The identification and assessment of critical habitat followed the approach defined by the IFC (refer to IFC PS6 (IFC, 2012a, b)). The IFC's PS6 uses the concept of critical habitat as an important means to identify biodiversity values of key conservation concern. The purpose of defining critical habitat is to identify areas of a particularly sensitive nature that deserve special attention for avoidance and may require supplementary mitigations, including offsetting.

The IFC's critical habitat concept considers and expands on a variety of pre-existing ideas and definitions of priority sites for biodiversity conservation; for example: Key Biodiversity Areas (IUCN 2010); Endemic Bird Areas and Important Bird Areas (BirdLife International 1998); Alliance for Zero Extinction sites (AZE 2010); World Heritage Sites (UNESCO 2014); and Ramsar Convention on wetlands of international importance (Ramsar 2014). This approach is also supported by a broad array of conservation organisations, and is increasingly accepted and applied by a variety of private companies (as developers) and financial institutions (the Equator Principles Banks as lenders).

As mentioned, critical habitats are a subset of either modified or natural habitats that constitute areas of significant importance for biodiversity conservation. For a development to occur in a critical habitat, the IFC requires that the following criteria are met:

■ No other viable alternatives within the region exist for development of the project on modified or natural habitats that are not critical.

■ The project does not lead to measurable, irreversible and adverse impacts on those biodiversity values for which the critical habitat was designated, and on the ecological process supporting those biodiversity values.

- The project does not lead to a net reduction in the global and/or national/regional population of any species of concern, for which critical habitat was identified in the CHAA, over a reasonable period of time.

- A robust, appropriately-designed, and long-term biodiversity monitoring and evaluation programme is integrated into the project's management programme to achieve net gain or net positive impact (NPI).

If these conditions can be met, it is reasonable that a mitigation strategy can be designed to achieve net gains, over a reasonable period of time, for the biodiversity values for which the critical habitat has been designated; that is, a no net loss in natural habitat and NPI philosophy in critical habitat. Consequently, projects proposed in areas containing critical habitat face challenges not faced by projects in natural or modified habitats that are not classified as critical.

Critical habitat was identified by delineating spatial units of analysis (DMUs), screening biodiversity features (that is, at the species, ecosystem and landscape scales), and evaluating the distribution of critical habitat in the CHAA. For a detailed discussion of the methods and approach used, see Appendix B.

3.3   Impact Assessment

The impact assessment process identifies the magnitude of a particular impact from the project and then compares that magnitude with the sensitivity of the receiving environment to derive an overall significance for the impact. This method relies on a detailed description of both the impact and the biodiversity valued component that is the receptor. The magnitude of an impact depends on its characteristics, which may include such factors as its duration, reversibility, area of extent, and nature in terms of whether positive, negative, direct, indirect or cumulative.

3.3.1   Key Questions and Indicators

One of the main purposes of an impact assessment is to provide answers to questions that people have about how a project could affect something that matters to them, such as a valued component. To focus this assessment and ensure that the impact assessment clearly addressed the key issues raised by the stakeholders (see Section 3.1), and the objectives set for this impact assessment (see Section 2.1), questions were formulated that captured the concerns relative to a particular issue. In this report, those concerns are expressed as 'key questions', and they form the basis of the investigations of potential effects and impacts of the Project.

Two key questions were established:

3)   **What effect could the Project have on habitats and ecosystem integrity?**

4)   **What effect could the Project have on species of concern?**

Under each of these key questions, sub-questions were developed that focused on the specific phases of the Project, in particular, the construction, operation and decommissioning phase.

Indicators for the impact assessment were selected to assess the level of potential impact. Changes to the indicators were analysed to determine the effectiveness of the mitigation hierarchy, and identify Project constraints and opportunities for additional avoidance and mitigation. Indicators and context for impact assessment are outlined for the key questions and associated valued components in Table 1.

Table 1: Key questions and indicators

Key Question	Valued Component	Indicator	Indicator Description	Context
What effect could the Project have on habitats and ecosystem integrity?	Ecosystem integrity Priority habitat	■ regional representative-ness	The uniqueness of an ecosystem or habitat in the CHAA and wider landscape. This rarity factor is related to the concepts of irreplaceability and vulnerability.	The persistence of species of concern in the CHAA and wider area. Maintain the distribution and

Key Question	Valued Component	Indicator	Indicator Description	Context
		■ changes in soil, water flows and quality, and vegetation	Drivers of change affecting key processes	abundance of species of concern such that self-sustaining and ecologically effective populations can be maintained.

Achieve net gains for species of concern for which critical habitat is affected by the proposed Project, and at least no net loss for all other valued components.

Maintenance of ecosystem processes and functions and connectivity. |
		■ ecosystem composition	The diversity and complexity of an ecosystem or habitat – what is there and how abundant. Relates to species composition and abundance – keystone species are of particular relevance; changes in populations of these species have greater impacts on ecosystems than would be expected from its relative abundance or total biomass	
		■ ecosystem configuration	The structure or pattern of an ecosystem: the spatial structure and scale of the ecosystem in relation to the scale of the human intervention; food-web structure and interactions that shape the flow of energy and the distribution of biomass (relates to changes in food-web, e.g. those caused by introduction of invasive species); linkages and corridors to habitat of the same or different ecosystems	
What effect could the Project have on species of concern?	All species of concern	■ habitat quantity and quality	The extent and integrity of preferred foraging and breeding habitat	
		■ habitat connectivity	Connectivity to adjacent areas of suitable habitat and potential for dispersal	
		■ abundance and distribution	Expected vs actual population numbers and distribution	
		■ survival and reproduction	Likelihood of continued survival/reproduction compared to baseline	

Valued components were assessed in the context of maintaining self-sustaining and ecologically effective populations (or sub-populations) (in the case of species of concern), or a functioning and resilient ecosystem, at the scale of the CHAA. A self-sustaining population is one that will be maintained into the future with a low risk of loss (that is, extirpation). Long-term population persistence is the outcome of maintaining self-sustaining, ecologically effective populations, and population persistence is frequently applied as a conservation target by conservation biologists and resource managers (Ruggiero et al. 1994, With and Crist 1995, Fahrig 2001, Nicholson et al. 2006).

Maintaining self-sustaining and ecologically effective populations often will result in the protection of the ecological services humans benefit from when ecosystems are functional. Such benefits include the continued opportunity for consumptive and non-consumptive use of non-timber forest products by people that value those resources as part of their culture and livelihood (Hooper et al. 2005). For more information on the assessment of impacts to ecosystem services, see the Ecosystem Services Review, Volume 4, Study 9.

3.3.2   Impact Assessment

Key questions were answered using a two-step process. Firstly, an overall written analysis, also known as a reasoned narrative, identified the indicators used for the assessment, and walks the reader through the logic of the assessment and the conclusions reached. Secondly, a formal impact classification was applied.

For a detailed explanation of the approach and method used for the reasoned narrative and the impact classifications, see APPENDIX E.

3.4   Limitations

This biodiversity impact assessment has been undertaken based on historical data and field surveys focusing on the current extent of the proposed Project. Any subsequent design changes and or alterations may require new surveys to be conducted (for example, if infrastructure layout is changed and extended beyond the current CHAA). Additionally, this biodiversity impact assessment should be read with the following limitations in mind:

- In a few instances, access limited the areas that could be sampled during the terrestrial ecology field campaigns. The escarpment area, for example, was extremely steep in many places and it was not practical to access some of the natural habitats.

- Comprehensive field trapping and sampling programmes were limited in many instances due to theft and/or vandalism of traps. Therefore, multiple-trap-night surveys were not always able to be employed, nor were trapping regimes for reptiles and small mammals.

- A dedicated assessment of the migratory species of bird in the CHAA has not yet been completed. A survey needs to be completed in late September or October to assess the importance of the area for migrants.

- The selection of species of interest for the impact assessment was based on the level of knowledge (that is, ecology and conservation status) of the species to act as surrogates for all species in the area, and adopts the hypothesis that conditions which support restricted range vertebrates and/or vascular plants are likely to also support rare species of other taxonomic groups.

Despite these limitations to baseline data, the conclusions contained within this report are based upon a robust and transparent procedure, and represent an accurate evaluation and assessment of likely impacts.

4.0   RELEVANT LEGISLATION

This chapter presents a summary of Ugandan national legislation, associated regulations and policies that are pertinent to biodiversity, to assist and guide the ESIA. It describes international conventions and regional frameworks to which Uganda is a signatory; and also includes a summary of the international standards and guidelines that represent good industry practise, to which CNOOC wishes to adhere. Publicly available documents, and reports supplied by CNOOC were used to compile this review.

4.1 Uganda's Policy, Legal and Institutional Framework on Biodiversity

4.1.1 The Constitution of the Republic of Uganda (1995)

The over-arching government policy on natural resource conservation in Uganda is provided for in the Constitution of the Republic of Uganda. The relevant constitutional provisions in the National Objectives and Directive Principles of State Policy include the following:

■ **Principles of State Policy XXVII (iv)**: mandates the State (both central and local government) to create and develop parks, reserves and recreational areas, and to ensure conservation and promote the rational use of natural resources so as to safeguard and protect the bio diversity of Uganda.

■ **Article 237 (2) (b)**: the Government or local government, as determined by Parliament by law, shall hold in trust for the people and protect, natural lakes, rivers, wetlands, forest reserves, game reserves, national parks and any land, to be reserved for ecological and touristic purposes for the common good of all citizens.

■ **Article 245**: the utilisation of natural resources of Uganda shall be undertaken in such a way as to meet the development and environmental needs of present and future generations of Ugandans and, in particular, the State shall take all possible measures to prevent or minimise damage and destruction to land, air and water resources resulting from pollution and other causes.

4.1.2 Uganda Wildlife Bill (2017)

The primary objectives of the Uganda Wildlife Bill are to provide for the conservation and sustainable management of wildlife, to strengthen wildlife conservation and management; to continue the Uganda Wildlife Authority; and to streamlines roles and responsibilities for institutions involved in wildlife conservation and management.

The Bill re-aligns the Uganda Wildlife Act Cap. 200 with the 2014 Uganda Wildlife Policy, the Oil and Gas policy and laws, the Land use policy and law, the National Environment Act, the Uganda Wildlife Education Centre Act, the Uganda Wildlife Research and Training Institute Act and all other laws of Uganda and developments which came into force after the enactment of the Uganda Wildlife Act in 1996.

For the first time, nationally-protected species were declared in the 2017 Uganda Wildlife Bill. Wildlife species listed in the Third Schedule of Act V are protected species in Uganda, in addition Act V states that wildlife species protected under any international convention or treaty to which Uganda is a part (and to which the regulations set out in section 86 applies), are protected species.

4.1.2.1 Uganda Wildlife Act (1996)

The Uganda Wildlife Act defines two types of conservation areas: "wildlife protected" and "wildlife managed" areas. Although the Act *made provision for* the declaration of protected species, no protected species were declared in the Act.

Wildlife Protected Areas

■ **National Park**: these are protected areas of international and national importance because of their biological diversity, landscape or national heritage, and in which biodiversity conservation, recreation, scenic viewing, scientific research and other economic activity may be permitted.

■ **Wildlife Reserve**: these are protected areas of importance for wildlife conservation and management and in which conservation of biological diversity, scenic viewing, recreation, scientific research, and regulated extractive utilisation of natural resources are permitted.

Wildlife Management Areas

■ **Community Wildlife Areas**: these are wildlife management areas where wildlife is protected, whilst taking into account the continued use of the land and the sustainable exploitation of wildlife in the area by people and communities ordinarily residing there. Sustainable exploitation of the natural resources of

the area, including by mining and other methods, is permitted - providing that it is in a manner compatible with the continued presence of wildlife in the area.

4.1.2.2   Uganda Wildlife Act Cap 200 of 2000

The Uganda Wildlife Act cap 200 of 2000 was enacted by an Act of Parliament to provide for sustainable management of wildlife (UWA 2014). The Act consolidated wildlife management law in Uganda and established the Uganda Wildlife Authority (UWA) as the responsible authority for wildlife management and conservation, and enforcement of wildlife laws and regulations. The Act covers all wildlife protected areas (PAs) and wildlife outside PAs, and specifically mandates UWA to control and monitor industrial and mining developments in wildlife protected areas.

4.1.2.3   Uganda Wildlife Policy (1999, 2014)

The Uganda Wildlife Policy generally promotes long-term conservation of wildlife and biodiversity in a cost-effective manner, which maximises the benefits to the people of Uganda in terms of ecology, economy, aesthetics, science and education. The policy aims at achieving this through promoting conservation and sustainable utilisation of wildlife throughout Uganda. The policy seeks to exclude industrial development, including mineral exploration and extraction, from wildlife protected areas (that is, national parks and wildlife reserves).

The Ugandan Government resolved to review Uganda's Wildlife Policy, to harmonise it with related instruments like the National Environment Policy, the Wetland Policy and the Constitution, in the form of the 2014 Uganda Wildlife Policy. New aspects incorporated in the policy included:

■   To provide for incentives that supports the private sector to invest more in wildlife development in Uganda.

■   To guarantee safety for tourists by enhancing security in in national parks and game reserves, under the expanded anti-terror surveillance in Uganda.

■   To increase resource allocation to the tourism sector, specifically for extending and improving infrastructure to, within and around tourism sites.

■   To reconcile the needs for wildlife conservation and human beings, particularly in areas that have been affected by insurgency and civil strife.

■   To ensure that any infrastructural development within and around wildlife conservation areas does not compromise the support eco-systems for flora and fauna in the respective areas.

■   Demands for land in national parks will not be entertained, except in very exceptional circumstances where survival of communities is involved.

4.1.2.4   Uganda Forestry Policy (2001) and the National Forestry and Tree Planting Act (2003)

The Forestry Policy is implemented through the National Forestry and Tree Planting Act (2003). The Act provides for:

■   The conservation, sustainable management and development of forests.

■   The declaration of forest reserves for the purposes of protection and production of forests and forest produce.

■   The sustainable use of forest resources and enhancement of productive capacity of the forests.

■   The promotion of tree planning.

■   Consolidation of the law relating to the forestry sector and trade in forest produce.

Parts of Uganda's permanent forest estate carry dual status as National Parks, Wildlife Reserves and Animal Sanctuaries; such areas are subject to additional regulations under the Uganda Wildlife Act (1996).

Declared forest reserve categories include Central Forest Reserves (CFRs), Local Forest Reserves, Community Forests, private forests, and forests forming part of a wildlife conservation area (declared under the Uganda Wildlife Act, Cap 200).

CFRs fall in two main categories, namely those designated for production and those for protection. Such forest reserves are subsequently managed in a manner consistent with the purpose for which they were declared:

■ **Production forests**: includes savanna bushland and grassland areas - reserved for supply of forest products and future development of industrial plantations.

■ **Protection forests:** includes all the tropical high forests, savanna woodlands and/or grasslands – reserved forests include those that protect watersheds and water catchments, biodiversity, ecosystems and landscapes that are prone to degradation under uncontrolled human use.

CFRs are held in trust for the people of Uganda and managed by the National Forestry Authority (NFA) and are classified according to the following categories:

■ Site of special scientific interest;

■ Strict nature reserve;

■ Joint management forest reserve;

■ Recreation forest for purposes of eco-tourism; and

■ Any other area, for a purpose prescribed in the order.

In a forest reserve, it is prohibited to cut, disturb, damage, burn or destroy any forest produce, remove or receive any forest produce, or undertake activities not consistent with the specific management plan except under conditions set out in the Act or in accordance with a licence granted under the Act. The Act also makes provision for classification of trees as reserved/protected and therefore subject to specific controls. In addition, Section 38 of the Act requires that an environmental impact assessment be undertaken for any project or any activity which may, or is likely to have a significant impact on a forest.

4.1.2.5   *The Land Act (1995)*

Section 43 of the Land Act provides for management and utilisation of land in accordance with the Uganda Wildlife Act, and other laws. Section 44 (i) mandates the government or local governments to protect national parks, wetlands and forest reserves (amongst others) for ecological and tourism purposes, and hold these in trust for the people of Uganda.

4.1.2.6   *Uganda National Land Policy (2013)*

The Uganda National Land Policy makes provisions in relation to natural resource management and biodiversity. These include Government resolutions to ensure that land use practises conform to land use plans, and that the principles of sound environmental management including biodiversity preservation, soil and water protection, conservation and sustainable land management are applied. The policy commits the Government to take measures including to

■ Provision of special protection for 'fragile' ecosystems (that is, unique and sensitive biodiversity features).

■ Development of harmonised criteria for gazetting and de-gazetting conservation areas.

■ Establishment and implementation of effective mechanisms for management of wildlife outside protected areas.

■ Incentivise community participation in conservation on privately-owned land and co-management of conservation on public land.

■ Regulate the use of hilltops and other sensitive ecosystems.

■ Develop mechanisms to resolve human-wildlife conflict.

4.1.3   Uganda National Biodiversity Strategy and Action Plan (2015-2025)

Published by the Ugandan National Environmental Management Authority (NEMA) in October 2016, the National Biodiversity Strategy and Action Plan (NBSAP) provides a framework to guide the setting of conservation priorities, channelling of investments and building of the necessary capacity for the conservation and sustainable use of biodiversity in the country.

The overarching principles of the NBSAP are:

a)   Sustainable development and environmental sustainability

b)   Mainstreaming of biodiversity conservation, sustainable use of biological resources and equitable sharing of benefits from biological resources into existing policy, legislative, institutional and development frameworks as appropriate;

c)   Stakeholder participation in the development and implementation of biodiversity strategy and action plans;

d)   Awareness creation, education, training and capacity building at local, national and institutional levels to enhance effective participation and implementation of biodiversity measures;

e)   Recognition, promotion and upholding of traditional and indigenous knowledge of biological resources and sustainable resource management and where benefits arise from the use of this knowledge;

f)   Engagement and collaboration with international partners to enhance conservation and sustainable use of Uganda's biological diversity;

g)   Integrated implementation of Multi-Lateral Environmental Agreements;

h)   Equal consideration of the three objectives of the Convention on Biological Diversity – conservation; sustainable use; and benefit sharing arising from the use of biological resources

The Uganda NPSAP is a useful policy guide for addressing Uganda's concerns in biodiversity conservation and the utilisation of its components, as well as for implementation of the requirements of the Convention on Biological Diversity.

4.2   Conventions and International Agreements

Uganda is a signatory to the following international conventions and agreements:

■   Convention on Biological Diversity: Under the convention, each contracting party is expected to develop national strategies, plans or programs for the conservation and sustainable use of Biological diversity.

■   Convention on International Trade in Endangered Species (CITES).

■   Convention on the Conservation of Migratory Species of Wild Animals, (the Bonn Convention).

▪   African-Eurasian Water-bird Agreement (AEWA).

▪   International Gorilla Agreement (Uganda is in the process of acceding to this agreement – it has been signed but is not yet ratified).

■   Convention on Wetlands of International Importance (the Ramsar Convention).

■   UNESCO World Heritage Commission.

■   Lusaka Agreement on the Cooperative Enforcement Operations Directed against Illegal trade in Fauna.

4.3   International Guidance

4.3.1   International Finance Corporation's Performance Standards

At the project financing level, the management of biodiversity is addressed by PS6: *Biodiversity Conservation and Sustainable Management of Living Natural Resources.* PS6, and the associated GN6 relates to:

- The protection and conservation of biodiversity.

- Maintenance of ecosystem services.

- Sustainable management of living natural resources.

The requirements set out in PS6 have been guided by the Convention on Biological Diversity. PS6's main priority is that the Project should seek to avoid impacts on biodiversity and ecosystem services. When avoidance of impacts is not possible, measures to minimise impacts and restore biodiversity and ecosystem services should be implemented.

However, when a project occurs in critical habitat supporting exceptional biodiversity value, a net gain in biodiversity value is required.

PS6 sets specific biodiversity protection and conservation standards relating to potential project impact. The specific requirements are separated according to the following categories:

- **Modified Habitat**: areas that may contain a large proportion of plant and/or animal species of non-native origin, and/or where human activity has substantially modified an area's primary ecological functions and species composition. PS6 relates to areas of modified habitat that have significant biodiversity value, and requires that impacts on such biodiversity must be *minimised, and mitigation measures implemented* as appropriate.

- **Natural Habitat**: viable assemblages of plant and/or animal species of largely native origin, and/or where human activity has not essentially modified an area's primary ecological functions and species composition. In such areas, the conservation outcome required by PS6 is *no-net-loss of biodiversity* **value** achieved using the "like-for-like" or better principle of biodiversity offsets, where feasible.

- **Critical Habitat**: areas with high biodiversity value, including (i) habitat of significant importance to Critically Endangered and/or Endangered species; (ii) habitat of significant importance to endemic and/or restricted-range species; (iii) habitat supporting globally significant concentrations of migratory species and/or congregatory species; (iv) highly threatened and/or unique ecosystems; and/or (v) areas associated with key evolutionary processes. When a project occurs in critical habitat supporting exceptional biodiversity value, a *net gain in biodiversity value* is required by PS6. This is achievable through appropriate biodiversity offsets.

- **Legally Protected and Internationally Recognised Areas**: such areas often have high biodiversity value; when this is the case these areas are likely to qualify as critical habitat and, as such, the conservation outcome required by PS6 is also a *net gain in biodiversity value*, as well as obtaining the relevant legal permits, following standard governmental regulatory procedures, and engagement of affected communities and other stakeholders.

- **Invasive Alien Species**: the development project should not intentionally introduce any new alien species (unless carried out within the appropriate regulatory permits) and should not deliberate any alien species with a high risk of invasive behaviour under any circumstance. PS6 requires that any introduction of alien species be the subject of a *risk assessment* for potential invasive behaviour, and that the project should *implement measures to avoid* the potential for accidental or unintended introductions.

- **Management of Ecosystem Services**: where a project is likely to adversely impact ecosystem services, an *ecosystem service review to identify priority ecosystem services* is required. Priority ecosystem services are (i) those services on which project operations are most likely to have an impact and, therefore, which result in adverse impacts to Affected Communities; and/or (ii) those services on which the project is directly dependent for its operations (for example, water). If adverse impacts on Priority

ecosystem services are unavoidable, these must be *minimised and mitigation measures* that aim to maintain the value and functionality of priority services implemented. With respect to impacts on priority ecosystem services on which the project depends, *impacts on ecosystem services should be minimised and measures that increase resource efficiency* of their operations implemented. For a full assessment of ecosystem services, see Golder Associates (2014i).

4.3.2   Regional Frameworks

At the regional level, Uganda is a member of the **African Union** and one of its objectives is to promote sustainable development at the economic, social and cultural level.

In the East African region, Uganda is obliged to implement the articles of the Treaty for the establishment of the **East African Community**, which it ratified together with other member states in 2000. In article 119, Partner States agreed to promote close cooperation in culture and sports.

Uganda is signatory to the **Nile Basin Initiative** (NBI). The NBI was established in 1999 by the Nile basin countries, to oversee the implementation of the Nile River Basin Action Plan. This process is still ongoing; once concluded, the resulting agreement will supersede all the existing Nile water agreements, pending establishment of a permanent legal and institutional framework for the Nile Basin.

Uganda is also a member of the **Lake Victoria Basin Commission** (LVBC). Releases from Lake Victoria have a controlling role on the water balance and level of Lake Albert, and hence on the flows within the Victoria and Albert Niles. The LBVC was established by the East African Community as a mechanism for coordinating the various interventions on the Lake and its Basin. The LBVC also serves as a centre for promotion of investments and information sharing among the various stakeholders.

5.0   KEY ISSUES RELATING TO BIODIVERSITY

As identified through stakeholder consultation, review of background biodiversity and environmental reports, published ecological literature, and consideration of the IFC's Environmental, Health, and Safety Guidelines for Onshore Oil and Gas Development (IFC 2007b) and the performance standards (that is, IFC 2012a, b and c), broadly, the key issues pertaining to the CHAA's biodiversity include:

- Habitats and ecosystems

    - Construction and operation of the pipeline and the potential effects that the construction and operation could have on wetlands, streams, woodlands, bushland and grasslands (including potential critical habitat), agricultural areas, and soils.

    - Construction and operation of the wells and CPF on the environment of the Buhuka Flats and Lake Albert.

    - The potential effects the construction and operation of the Project could have on Lake Albert, wetlands and environment of the Buhuka Flats. These include: vibration; pollution (oil, erosion and sedimentation, other run-off, effects to groundwater); increased fishing pressure from in-migration; long-term damage to the lake ecosystem.

    - Potential induced effects to the Bugoma Central Forest Reserve due to upgrade of the existing road, including the possible need for offsets.

    - Potential effects the construction and operation of the Project could have on the escarpment vegetation corridors connecting the wild areas along Lake Albert from Semliki to Murchison Falls National Park.

- Species of concern

    - Concern for the loss of animal species from the Buhuka Flats. Potential effects to the populations of Hippopotamus (*Hippopotamus amphibius*), Nile Crocodile (*Crocodylus niloticus*), and Grey Crowned Crane (*Balearica regulorum*), amongst others.

- The identification of migratory and threatened species inhabiting the CHAA.

- Potential effects to the populations of Chimpanzees (*Pan troglodytes*), Nahan's Francolin (*Ptilopachus nahani*) and African Elephant (*Loxodonta africana*) in Bugoma Central Forest Reserve.

In summary, the main issues related to potential effects to the biodiversity of the CHAA from the construction and operation of the Project relate to the to changes in ecosystem composition (for example, species composition), configuration (for example, patch size and connectivity) and function of the wider CHAA through the direct loss, disturbance or change in condition of natural and modified habitats, including critical habitat.

6.0 BASELINE ENVIRONMENT

This section describes the baseline biodiversity environment of the LSA and CHAA. It draws upon existing, published information, local knowledge and comprehensive, multi-season field surveys. The detailed baseline study reports for the terrestrial and aquatic ecology are presented in APPENDIX B and APPENDIX C respectively.

6.1 Terrestrial Biodiversity

This section focuses on describing the baseline terrestrial biodiversity of the LSA. It summarises the findings reported in the terrestrial ecology baseline report, as presented in APPENDIX B.

6.1.1 Vegetation Communities and Flora Species

A summary of the baseline of the vegetation communities and flora species of the CHAA are presented based on the findings of the desktop study and the field investigations of the LSA.

6.1.1.1 Vegetation Communities

According to Langdale-Brown et al. (1964), the CHAA is mapped as supporting the following vegetation communities:

a) Dry *Hyparrhenia* Grass Savanna, with undifferentiated deciduous Thicket (Q3/V1) on the Buhuka Flats.

b) *Themeda-Chloris* Grass Savanna (Q4) on the Buhuka Flats.

c) Dry *Combretum-Hyparrhenia* Savanna (N2) on the escarpment.

d) Moist *Combretum-Terminalia-Albizia-Hyparrhenia rufa* Savanna/Medium Altitude Forest/Savanna Mosaic (K/F2) beyond the escarpment, towards Bugoma Central Forest Reserve along the pipeline route.

e) Moist *Combretum-Terminalia-Albizia-Hyparrhenia rufa* Savanna (K) beyond the escarpment, towards Bugoma Central Forest Reserve along the pipeline route.

f) *Cynometra-Celtis* Medium Altitude Moist Semi-deciduous Forest (D2) beyond the escarpment, towards Bugoma Central Forest Reserve along the pipeline route.

It is noted that the delineation of these communities is 50 years old. Since that time, large tracts of vegetation have been altered in the CHAA, in particular, along the pipeline route, and, therefore, strict alignment with Langdale-Brown et al.'s (1964) classification was not possible. These areas have been subjected to high-intensity, subsistence agriculture, which has altered much of the original natural landscape (Forest Department 2002). These drivers of change, together with widespread cattle grazing and charcoal manufacture, have put pressure on the natural vegetation communities in the CHAA as compared to Langdale-Brown et al.'s (1964) original work. This is particularly noticeable in the areas on the escarpment, between the escarpment proper and the Bugoma Central Forest Reserve (see Figure 4). These areas have, for the most part, been converted to subsistence agricultural fields.

Nevertheless, significant natural vegetation still exists long the escarpment (Figure 5). This corridor extends from the areas south of the CHAA, northwards toward the Kabwoya Wildlife Reserve and the Kaiso-Tonya Community Wildlife Area. Indeed, Plumptre et al. (2007) identified these corridors to be part of an important

linkage from the Semliki/Toro Wildlife Reserve in the south, the Budongo–Bugoma–Kagombe–Itwara Forest Reserves, right through to the Murchison Falls National Park in the north.

The field surveys (APPENDIX B) identified seven broad vegetation communities within the LSA (as depicted in Figure 5 and

Figure 6):

a)   Wooded Grassland;

b)   Woodland;

c)   Thicket-Grassland Mosaic;

d)   Open Grassland;

e)   Bushed Grassland;

f)   Bushland and Shrubland; and

g)   Wetlands (including permanent wetlands of *Phragmites, Typha,* and *Cyperus*, and seasonally flooded grassland (floodplains) of *Sporobolus pyramidalis* and *Cynodon dactylon*).

These communities broadly align with those described by Langdale-Brown et al. (1964); however, their current distributions are different to those originally described, primarily due to the increased pressures from agriculture and human disturbance over the last 50 years. The characteristics and condition of each of these communities is summarised below.
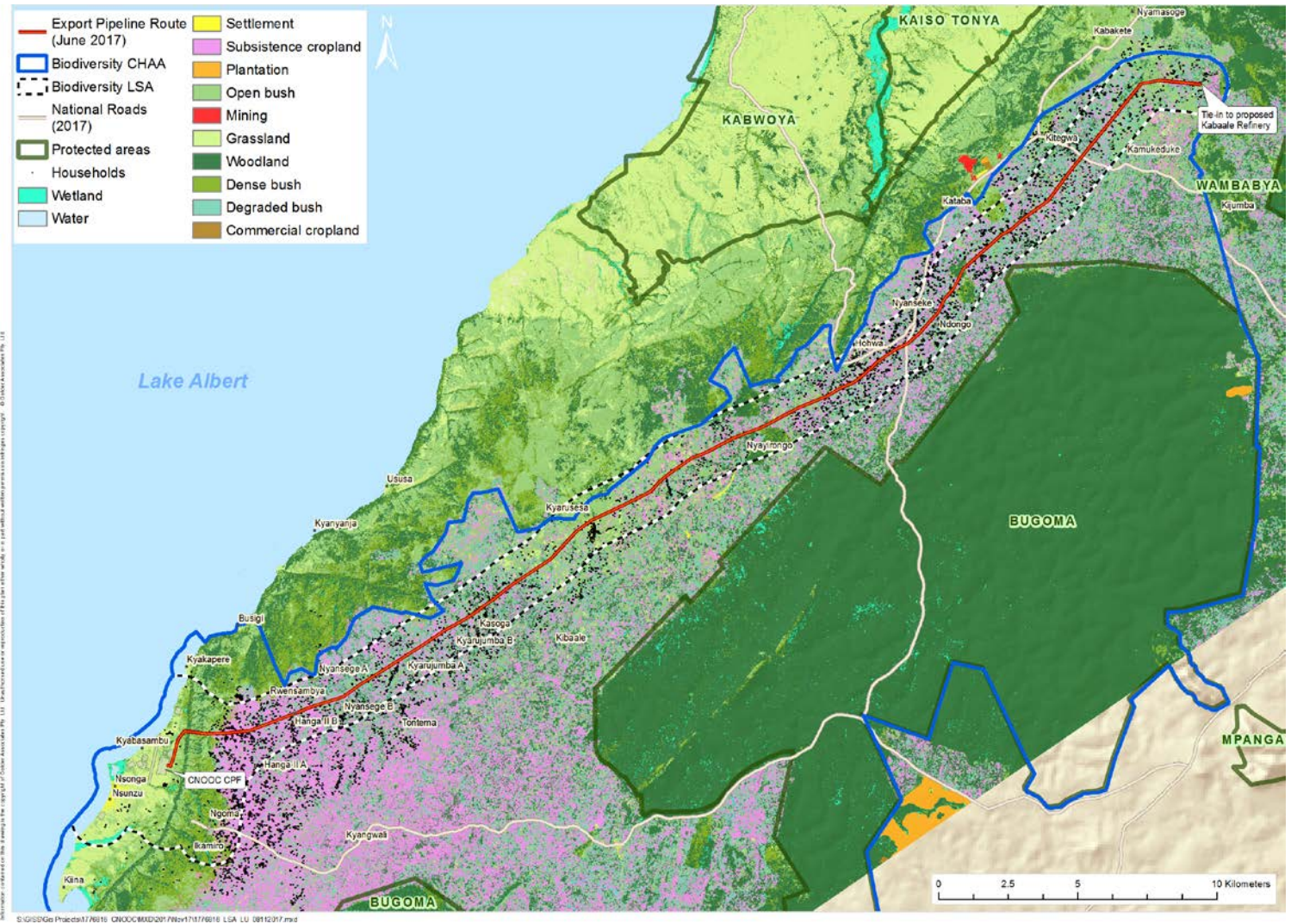
Figure 4: Land cover and land use in the CHAA
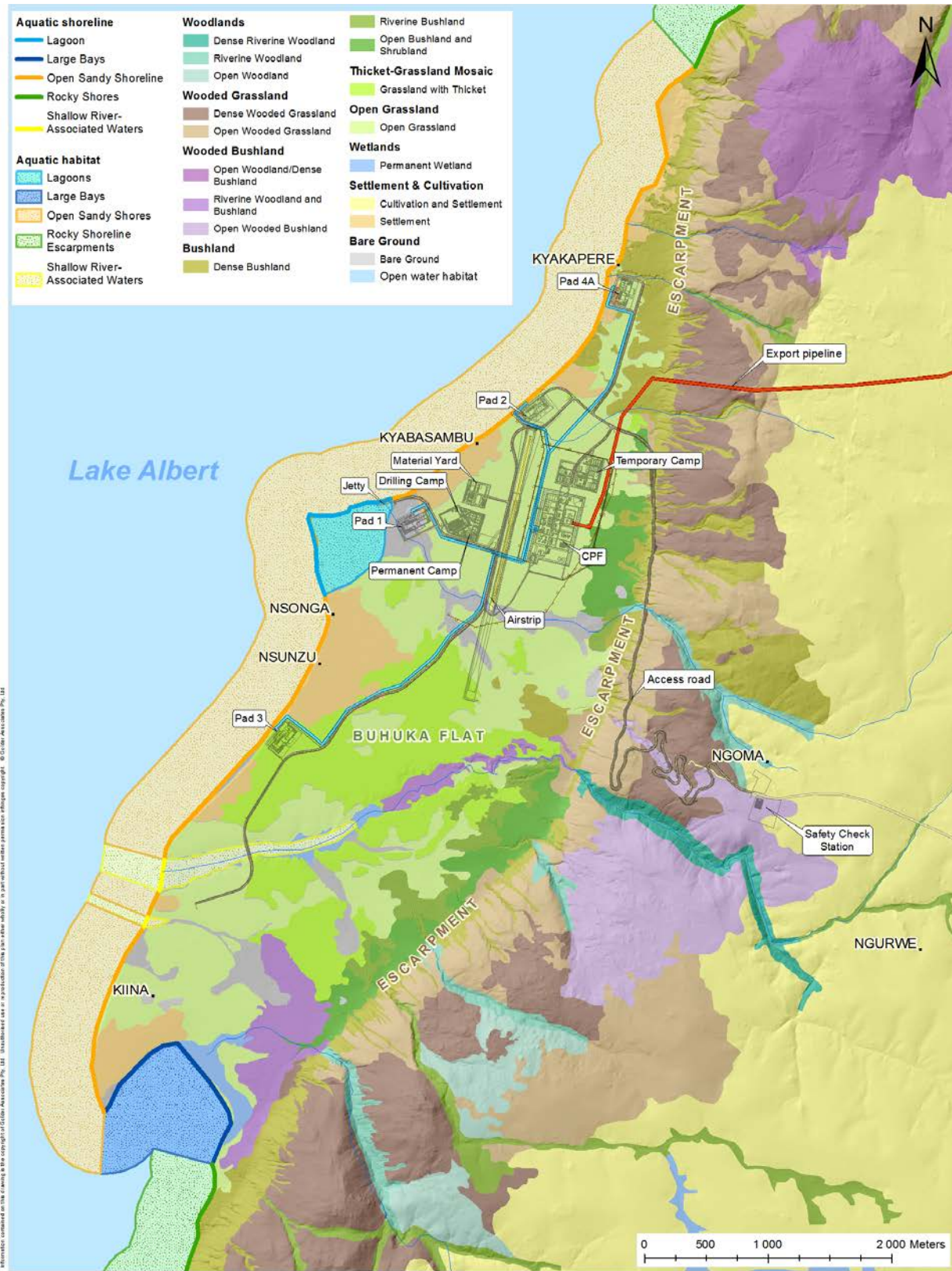
Figure 5: Vegetation communities of the CHAA (focus on Buhuka Flats)
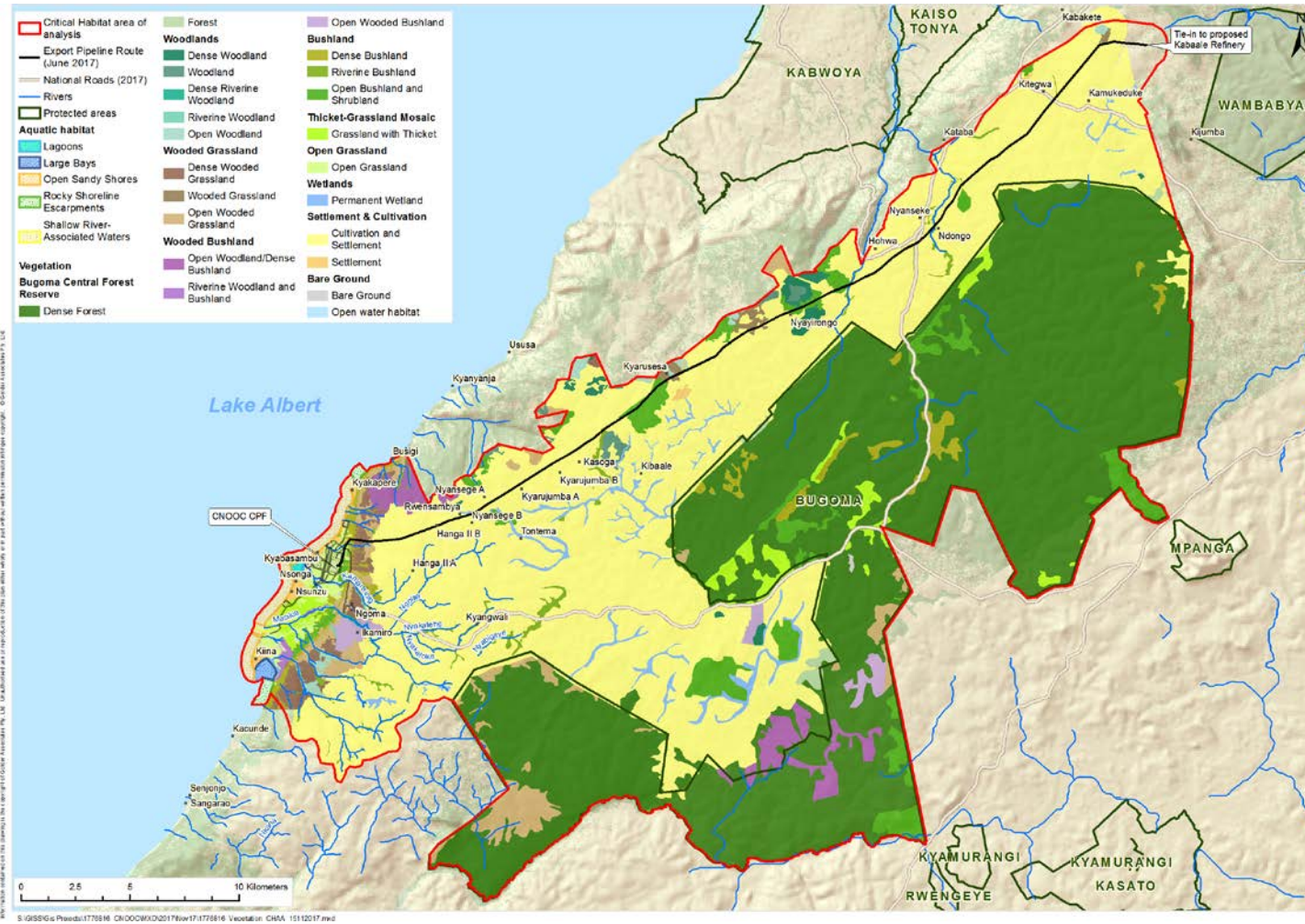
Figure 6: Vegetation communities of the CHAA

6.1.1.1.1 Wooded Grassland

Figure 7: Typical wooded grassland in the CHAA

Aligns with the Dry *Combretum-Hyparrhenia* Savanna (N2) of Langdale-Brown et al. (1964); the ground layer in these communities is dominated by grasses, while woody plants comprise 10% to 50% of the upper storey structure (Langdale-Brown et al. 1964). In the LSA, the ground layer is dominated by *Hyparrhenia rufa* and *Sporobolus pyramidalis* (Figure 7). The woody plant fraction was dominated by *Rhus natalensis*, *Combretum collinum*, *Acacia hockii* and *Annona senegalensis*.

These communities comprise about 3.35% of the CHAA, and included the sub-communities of: wooded grassland (WGl): open wooded grassland (OWGl); and dense wooded grassland (DWGl) (Figure 4a). These communities are largely restricted to the escarpment and beyond. The original extent of these communities on the plateau above the escarpment appears to have been significantly reduced in the last 50 years due to subsistence agricultural practices. On the escarpment, clearing for agricultural fields, and grazing by cattle are the primary drivers of change, together with frequent fires.

6.1.1.1.2   Woodland

Figure 8: Typical woodland along a watercourse in the CHAA

Aligns with the *Cynometra-Celtis* Medium Altitude Moist Semi-deciduous Forest (D2) of Langdale-Brown et al. (1964); these communities are characterised by an upper storey canopy layer that does not interlock and remains open, which allows for the growth of herbaceous vegetation; however, the herbaceous layer lacks a multi-layered structure (Langdale-Brown et al. 1964).

Within the CHAA, these communities were mostly dominated by *Acacia* species, while some were mixed with *Crateva* sp. and *Acalypha* sp. (Figure 7). The most abundant species in these communities were typically *Tamarindus indica*, *Rhus natalensis* and *Acacia sieberiana*, while the understorey was typically dominated by *Grewia trichocarpa* and *Azima tetracantha*. *Hypoestes forskaolii*, *Panicum deustum* and *Sporobolus pyramidalis* were common herbaceous layer species.

These communities comprise about 0.70% of the CHAA, and included the sub-communities of: open woodland (OWo); and riverine woodland (RiWo) (Figure 8), and they tend to be restricted to the riverine areas along the mainly seasonal watercourses. Harvesting of large trees for the manufacture of charcoal is a noticeable driver in these communities, as well as trampling and grazing by cattle.

6.1.1.1.3 Thicket-Grassland Mosaic

Figure 9: Typical Thicket-grassland mosaic community in the LSA

Aligns with the Dry *Hyparrhenia* Grass Savanna, with undifferentiated deciduous Thicket (Q3/V1) of Langdale-Brown et al. (1964); these communities are characterised by thickets of 2 to 4 m height, with a dominance of much-branched, thorny, woody species that form dense clumps or continuous thickets sometimes approaching 100% cover (Langdale-Brown et al. 1964).

Within the CHAA, particularly on the Buhuka Flats, these thickets are interspersed with grassland, forming a mosaic (Figure 9). The most abundant species were *Acacia brevispica*, *Acalypha fruticosa*, *Azima tetracantha*, *Euphorbia candelabrum*, *Cadaba farinosa* and *Dichrostachys cinerea*. Common species in the herbaceous and ground layer include *Sansevieria* spp., *Sporobolus pyramidalis*, *Cynodon dactylon*, *Aloe* sp. and *Cissus oliveri*.

These communities comprise about 1.37% of the CHAA, and included the sub-communities of: grassland with thicket (GIWT), which is largely restricted to the Buhuka Flats (Figure 5). Within this area, noticeable effects of heavy cattle grazing were observed, which appears to be the primary driver for maintaining the mosaic nature of this community, which also limits bush encroachment.

6.1.1.1.4 Open Grassland

Figure 10: Typical grassland community of the LSA

Aligns with the *Themeda-Chloris* Grass Savanna (Q4) of Langdale-Brown et al. (1964); these communities are dominated by a grass layer, with woody species typically constituting less than 5% (Langdale-Brown et al. 1964).

Within the CHAA, the dominant grass species in these communities included *Sporobolus pyramidalis*, *Pennisetum purpureum*, *Imperata cylindrica*, *Cynodon dactylon* and *Panicum maximum* (Figure 10). Occasional woody species included *Acacia polyacantha* subsp. *campylacantha* and *Vernonia amygdalina*. Often, these grasslands supported some thicket communities.

These communities comprise about 0.71% of the CHAA, and included the sub-communities of: open grassland (OGl) (Figure 5) and were largely restricted to the Buhuka Flats. Livestock grazing is by far the most dominant driver affecting the structure of the community, keeping it at very low stature.

6.1.1.1.5 Modified Habitats

Most areas of modified habitat occur along the proposed feeder line route. These areas are modified from their original, natural habitat - having been converted to cultivation. Patches of natural vegetation occur within these modified areas, although most have been largely altered from their original state. These remnants show affinities to the various vegetation communities identified in the wider area, including woodland, bushland, wooded grassland and wetland.

6.1.1.2   Flora Species

Few studies have focused specifically on the flora of the CHAA. Those studies that do exist tend to focus on protected areas and forest reserves. For example: Plumptre et al. (2009), in a study of Kabwoya Wildlife Reserve, which is about 30 km north of Buhuka Flats and the same ecoregion as the CHAA, identified 167 flora species in that reserve; NEMA (2010) identifies the Bugoma Central Forest Reserve as a particularly species rich area; while Kalema (2005) compiled a list of species for the Semliki Wildlife Reserve, which is about 40 km south of the CHAA. These studies do provide useful references for species assemblages of the wider area, and formed a good basis upon which to develop a list of potential species for the CHAA. These lists, together with those provided by the IUCN (2017), formed the basis of the identification of threatened species occurring in the CHAA.

Species Richness, Diversity and Abundance

In the area of the Buhuka Flats, the most abundant species were *Cynodon dactylon*, *Sporobolus pyramidalis*, *Acalypha fruticosa*, *Phragmites kirkii*, *Capparis erythrocarpos*, *Senna* sp., *Asparagus africanus*, *Cissus oliveri*, *Typha capensis*, *Cyperus articulatus* and *Dichrostachys cinerea*.

On the escarpment, where the soil conditions are more marginal and fragile, the most abundant species were *Acalypha fruticosa*, *Rhus natalensis*, *Hypoestes forskaolii*, *Terminalia brownii*, *Acacia brevispica*, *Cissus oliveri*, *Sporobolus pyramidalis* and *Enteropogon macrostachyus*.

Beyond the escarpment, on the plateau, soil conditions (including drainage) were better, with only localised areas of water-logging. Within these areas, however, there is a strong element of human influence in the form of agricultural activities. Here, *Pennisetum purpureum*, *Acacia polyacantha*, *Imperata cylindrica*, *Vernonia amygdalina*, *Panicum maximum*, *Combretum collinum*, *Acanthus polystachius* were the most abundant species.

Sporobolus pyramidalis had the highest relative abundance across all the LSA and all communities sampled. This was followed by *Acalypha fruticosa*, *Cynodon dactylon*, *Panicum maximum*, *Vernonia amygdalina* and *Rhus natalensis*. This indicates that grasses form a substantial proportion of all the vegetation communities within the LSA.

Ninety-four species were uncommon in the LSA. These include *Cordia africana*, *C. millennii*, *Cynometra alexandrii*, *Pterygota mildbraedii*, and *Markhamia lutea*. These are all good timber tree species, which are under intense pressure from logging. *Cordia millenii* is listed under Uganda's National Forestry Authority as a Reserved Species (Kalema and Bleentje 2012), and is, therefore, flagged for protection owing to excessive felling for its high-grade timber. None of the other species are listed under Ugandan legislation, or the IUCN's Red List (IUCN 2017). These species are widespread in the region and Africa (Kalema and Beentje 2012).

Overall, 96 families and 635 species were recorded in the LSA (APPENDIX B). Although the highest species richness was recorded in bushland (369 species), woodland (318 species) and wetland communities (301 species), with thicket-grassland and bushed grassland communities recording 91 and 202 species respectively, the number of species recorded was strongly correlated with sampling effort. In particular, the latter two communities had less sampling effort applied than the aforementioned communities (see APPENDIX B). A better measure was the mean number of species per survey plot, which identified bushed grassland (13.47 spp./plot), wooded grassland (8.89 spp./plot) and woodland (6.91 spp./plot) to have the highest species richness, while the lowest was wetland (5.02 spp./plot) and open grassland (5.79 spp./plot).

The general observation from these findings is that the more wooded vegetation communities recorded higher species richness per sampling unit. Accordingly, the least wooded communities of wetland and open grassland had the lowest species richness per sampling unit.

Across the LSA, woody species contributed 38.6% of species richness as compared to 61.4% for the non-woody species (APPENDIX B). On the Buhuka Flats, herbs and shrubs dominated; while on the escarpment, shrubs dominated; beyond the escarpment, herbs and trees dominated.

Species of Concern

Four species of conservation interest were recorded in the LSA. These were the: *Milicia excelsa* (Mvule Tree) (listed as Lower Risk/Near Threatened by the IUCN, and a restricted species on the Ugandan list of Reserved Tree Species, as promulgated under Uganda's *National Forestry and Tree Planting Act 2003*); *Tamarindus indica* (Tamarind Tree) (Not Evaluated by the IUCN, yet a restricted species on the Ugandan list of Reserved Tree Species, as promulgated under Uganda's *National Forestry and Tree Planting Act 2003*); *Cordia millenii* (Drum Tree) (listed as Lower Risk/Least Concern by the IUCN); and the CITES Appendix II-listed *Euphorbia candelabra* (Candelabra Tree) and *Aloe* sp. (Aloe) (both Not Evaluated by the IUCN).

Five invasive species were recorded in the LSA, although they were uncommon. *Mimosa pigra* (Giant Sensitive Tree), *Lantana camara* (Lantana), and *Eichhornia crassipes* (Water Hyacinth) were the commonest species recorded, predominantly on the Buhuka Flats and the shore of Lake Albert (APPENDIX B). These species are recognised as some of most noxious weeds in the world (Lowe et al. 2000).

Other invasive species recorded included: *Pistia stratiotes* (Water Lettuce) (in a wetland community on the Buhuka Flats, where it was locally abundant); *Parkinsonia aculeata* (Parkinsonia) (recorded on the Buhuka Flats in open grassland); and *Ricinus communis* (Castor Oil Plant) (recorded from Wetland and Woodland communities).

For further discussion and assessment of these species, see Section 7.2.

6.1.2 Invertebrates

As mentioned, the sampling of terrestrial invertebrates was limited to butterflies, dragonflies and damselflies for the reasons discussed. Summarised below are the findings of the baseline surveys presented in APPENDIX B.

6.1.2.1 Butterflies

A summary of the baseline of the butterfly species of the LSA is presented, based on the findings of the desktop study and the field investigations. The detailed baseline studies are presented in APPENDIX B.

Species Richness, Diversity and Abundance

One-hundred-and-fifty-five species of butterfly were recorded in the LSA. Of these: 38 are forest-dependent species, including one forest highland species; 27 forest edge/woodland species; 25 migrant species; 20 open habitat species; 42 widespread species; and two wetland-dependent species (APPENDIX B). Based on their ecological preferences, 27.3% of the butterfly species recorded were those that are typically widespread; 13% were typical of open habitats; 16.2% were migrants; 17.5 % were forest edge/woodland species; 24.7% were characteristic of forest habitats; and 1.3% were wetland dependent.

The habitat mosaic of the escarpment area was the most species rich, along with the Kamansinig River, and the Hohwa River along the pipeline route, as well as the Kibale-Butoole area.

Species of Concern

No Albertine Rift endemic species were recorded in the LSA. Only four of the species recorded have been evaluated by the IUCN, and are all listed as Least Concern; these were:

■ Jeffry's Bush-brown (*Bicyclus jefferyi*)

This widespread species favours forest clearings and edges of relatively wet forests, and although it is common, its population trend is unknown (Larsen 2011a).

■ Small Grass Yellow (*Eurema brigitta*)

This species is one of the most common butterflies of Africa and the Oriental region, thus having a vast EOO (Larsen 2011b). It is believed to have a stable population trend and favours a wide variety of savanna and grassland habitats.

- Dark Blue Pansy (*Junonia oenone*)

  This species occurs across the entire African continent, and, although its population trend is currently unknown, there are no present threats to its global population (Larsen 2011c).

- Dark Grass Blue (*Zizina antanossa*)

  This species is one of the most widely distributed butterflies in Africa. It inhabits grassy, open areas in savannah, and disturbed areas of forest. Its population trend is unknown, but it is not known to be affected by any major threats at present (Larsen 2011d).

For further discussion and assessment of other species that may potentially occur in the CHAA, see Section 7.2.

Habitats

Although no IUCN-listed, or Uganda-listed threatened species were recorded in the LSA, it does support a rich diversity of species. Habitats of importance for butterflies within the LSA, based on species richness and diversity, were the watercourses draining off the escarpment and along the pipeline route, the vegetation communities of the escarpment, and forest. It is noted that the forest patches may represent relicts of the original habitat in the wider area. However, it is noted too that the majority of species recorded are habitat generalists or ecotone species, and are not dependent upon intact habitat for their survival. Nevertheless, forest dependent species did constitute ~25% of the species recorded, and ~1.5% were wetland dependent. Therefore, certainly for butterflies, the array of habitats supported in the LSA is important to maintain species diversity.

For further discussion and assessment of habitats, please refer to Section 7.1.

6.1.2.2   Dragonflies and Damselflies

A summary of the baseline of the dragonfly and damselfly species of the LSA is presented based on the findings of the desktop study and the field investigations. The detailed baseline studies are presented in APPENDIX B.

Species Richness, Diversity and Abundance

Forty-six species of dragonflies and damselflies were recorded from the LSA. The seasonally flooded wetlands along the Kamansinig River and the permanent wetlands of Masika River were the most species rich.

Species of Concern

All the species recorded have been assessed by the IUCN, and all are categorized as being of Least Concern, with stable or unknown population trends. One species, the Common Riverjack (*Mesocnemis singularis*), although listed as Least Concern, is recommended by the IUCN for further monitoring due to possible declining population trends (Clausnitzer et al. 2010).

For further discussion and assessment of other species that may potentially occur in the CHAA, see Section 6.3.2.

Habitats

Although no IUCN-listed, or Uganda-listed threatened species were recorded in the LSA, it does support a rich diversity of species. Habitats of importance for dragonflies and damselflies within the LSA, based on species richness and diversity, were the seasonally flooded and permanent wetlands on the Buhuka Flats and along the pipeline route.

For further discussion and assessment of habitats, please refer to Section 7.1.

6.1.3   Reptiles and Amphibians

A summary of the baseline of the reptile and amphibian species of the LSA is presented based on the findings of the desktop study and the field investigations. The detailed baseline studies are presented in APPENDIX B.

6.1.3.1   Amphibians

Species Richness, Diversity and Abundance

Twenty-three amphibian species were recorded from the LSA; this is between 76% and 100% of the expected species in the CHAA (APPENDIX B). These represent seven families and ten genera. The most species rich sites for amphibians were along the pipeline route: Kabakete, near the proposed Kabaale refinery site, had 12 species; and Zorobe had eight species. On the Buhuka Flats, the wetland on the lower reaches of the Masika River had eight species, with the wetlands of the Kamansinig River having up to seven species.

The most common species was a Ridged Frog (*Ptychadena* sp.1[3]), which was recorded at 42% of the sampling sites. This was followed by the Cinnamon-bellied Reed Frog (*Hyperolius cinnamomeoventris*) at 37% of the sites, the Kivu Reed Frog (*H. kivuensis*), and the Crowned Bullfrog (*Hoplobatrachus occipitalis*) at 32% of sites, while the Banded Banana Frog (*Afrixalus fulvovitattus*), Common Toad (*Amietophrynus regularis*) and Anchieta's Ridged Frog (*Ptychadena anchietae*) were found at 26% of the sites.

Species of Concern

All the species recorded are listed as Least Concern by the IUCN, with the majority believed to have stable population trends, or unknown trends, except one. The Lake Victoria Toad (*Amietophrynus vittatus*) is listed as Data Deficient by the IUCN, with an unknown population trend (IUCN SSC Amphibian Specialist Group 2014a). This species was recorded on the Buhuka Flats in the seasonally flooded wetlands associated with the Kamansinig River (APPENDIX B, AWE 2008a, 2008b, 2013a). DeSaeger's River Frog (*Amietia desaegeri*), although listed as Least Concern by the IUCN, is a range restricted species (IUCN SSC Amphibian Specialist Group 2014b).

For further discussion and assessment of this species, see Section 7.2.

Habitats

Habitats of importance for amphibians within the LSA, based on species richness and diversity, were the seasonally flooded and permanent wetlands on the Buhuka Flats and along the pipeline route, and watercourses draining off the escarpment.

For further discussion and assessment of habitats, please refer to Section 7.1.

6.1.3.2   Reptiles

Species Richness, Diversity and Abundance

Twenty-one reptilian species, belonging to eight families and 11 genera, were recorded in the LSA (APPENDIX B), which could account for ~70% of the species in the CHAA. Generally, however, the reptilian diversity for each sampling site was poor, which may be an artefact of the sampling effort (see Section 3.5). The most diverse site was the area where the CPF will be located with five species, followed by Kasoga/Buhumurro-

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[3] This species is noted to not be new to science; however, it is difficult to separate from other species. Therefore, a specimen was sent to the museum for determination, the results of which were not available at the time of writing this report (M. Behangana, pers. comm.)

Nsanga on the pipeline route (four species), Masika River and wetlands associated with the Kamansinig River, each with three species. The rest of the sites had one, two or no reptiles recorded at them.

The most common species were the Speckle-Lipped Skink (*Trachylepis maculilabris*), recorded at 56% of the sites, followed by the Ground Agama (*Agama agama*) at 44% of the sites, and the Tree Agama (*Acanthocercus atricolis*) and the Striped Skink (*Trachylepis striata*) at 33% of the sites.

Species of Concern

The majority of species recorded were of Least Concern or Not Evaluated by the IUCN, and tended to be common species in the area. Four species, the Nile Crocodile (*Crocodylus niloticus*), Nile Monitor (*Varanus niloticus*), Smooth Chameleon (*Chamaeleo laevigatus*), and Graceful Chameleon (*C. gracilis*) are listed under CITES Appendix II (UNEP-WCMC 2018).

The Nile Soft-shelled Turtle (*Trionyx triunguis*) is known from Lake Albert, however it was not recorded from the LSA during baseline data gathering surveys. Although the species has been assessed as Vulnerable by the IUCN (2017), and populations in central and north-eastern Africa are understood to be stable (van Dijk et. al., 2017), it is facing pressures from human exploitation within Lake Albert, where adults and eggs are hunted for food and medicinal purposes; the carapace can fetch a high price in the markets of Kampala (APPENDIX B).

For further discussion and assessment of these and other species that may potentially occur in the CHAA, see Section 7.2.

Habitats

Habitats of importance for reptiles within the LSA, based on species richness and diversity, were the seasonally flooded and permanent wetlands on the Buhuka Flats and along the pipeline route, and wooded grasslands. The wetlands associated with Lake Albert's shoreline (in particular, the lagoon, and the lower reaches of the Masika River) are important breeding and nursery areas for the Nile Soft-shelled Turtle and the Nile Crocodile. The ravines associated with the watercourses draining off the escarpment are important habitats for a variety of reptiles. Importantly, the heterogeneity of habitats in the wider LSA is important for maintaining reptile diversity.

For further discussion and assessment of habitats, please refer to Section 7.1.

6.1.4   Birds

A summary of the baseline of the bird species of the LSA is presented based on the findings of the desktop study and the field investigations. The detailed baseline studies are presented in APPENDIX B.

Species Richness, Diversity and Abundance

Two-hundred-and-eighty-three species were recorded in the LSA; mostly composed of species typical of the area. However, no forest specialists were recorded, and only a few forest generalists, reflecting the almost total loss of the original forest cover of the escarpment and the land above it. The seasonally flooded and permanent wetlands of the Buhuka Flats supported a wide variety of waterbirds, while grassland species were well-represented in the open areas. Interestingly, the diversity of aerial feeder species (like martins, swifts and their kin) was low, but the number of individuals was high.

The richness of species along the pipeline route was less than the flats; however, the diversity was still quite high, with 29 species recorded that were unique to that area.

Fifty-five species of waders and waterbirds were recorded in the LSA, primarily from the shore of Lake Albert and the wetlands on the Buhuka Flats. Notable species include: the first record of the Terek Sandpiper (Xenus cinereus) from Lake Albert; the second record of the Lesser Sandplover (*Charadrius mongolus*) for Uganda.

The species richness and abundance of individuals increased as expected during the peak migratory period of September/October. Some Palearctic migratory stragglers were still present in February-March in some numbers. Although very large numbers of migratory species were not recorded, it is conceivable that Lake

Albert as a whole could support significant numbers. For example, a 1 km count along the shores of the lake, south from the jetty, produced over 400 birds of 27 species. Given this, and the fact that the lake is ~180 km long, it is conceivable that the shores of Lake Albert could support as many as 100,000 birds, just on the Ugandan side. The number of these species and individuals had significantly dropped during the May-June survey indicating that the majority of individuals had migrated away from the lake. Therefore, it can be expected that during the peak migratory period, the numbers of birds in the area will be substantial.

Interestingly, 16 raptor species were recorded. The Albertine Rift is a known migratory route for raptors, yet all the species recorded were residents.

Species of Concern

The majority of species recorded in the LSA were of Least Concern status, and tended to be common species in the area. Two species listed as Endangered by the IUCN were recorded; these were Grey Crowned Crane (*Balearica regulorum*) and White-backed Vulture (*Gyps africanus*).

Grey Crowned Crane was recorded on the Buhuka Flats, where up to 14 individuals were regularly seen. (APPENDIX B). Indications were that breeding pairs were beginning to form at the end of May. Twenty White-backed Vultures were seen overflying the LSA in February.

Twelve regionally listed species were recorded in the LSA. These included: the vulnerable Martial Eagle (*Polemaetus bellicosus*), African Skimmer (*Rynchops flavirostris*), Grosbeak Weaver (*Amblyospiza albifrons*), Saddle-billed Stork (*Ephippiorhynchus senegalensis*), Great White Egret (*Ardea alba*); and the near threatened Purple Heron (*Ardea purpurea*), Grey Heron (*Ardea cinerea*), Goliath Heron (*Ardea goliath*), Brown Snake-eagle (*Brown Snake-eagle*), African Marsh Harrier (*Circus ranivorus*), Black-bellied Firefinch (*Lagonosticta rara*), and Vieillot's Black Weaver (*Ploceus nigerrimus*). Interestingly, individuals of most of these species were encountered throughout the entire LSA; that is, the Buhuka Flats, the escarpment and the pipeline route.

Other species of interest included the east African endemics: Spotted-flanked Barbet (*Tricholaema lacrymosa*), White-headed Saw-wing (*Psalidoprocne albiceps*), Black-lored Babbler (*Turdoides sharpie*), Red-chested Sunbird (*Cinnyris erythrocercus*), Baglafecht's Weaver (*Ploceus baglafechtii*), Red-headed Quelea (*Quelea erythrops*), and Grey-headed Oliveback (*Nesocharis capistrata*).

Palearctic migratory species were more abundant during the dry season and the second wet season (corresponding to the peak migratory period of September/October), when 39 species were recorded. These included: Black-winged Stilt (*Himantopus himantopus*); Common Ringed Plover (*Charadrius hiaticula*); Lesser Sandplover (*Charadrius mongolus*); Little Stint (*Calidris minuta*); Ruff (*Philomachus pugnax*); Common Snipe (*Gallinago gallinago*), Common Greenshank (*Tringa nebularia*), Green Sandpiper (*T. ochropus*); Wood Sandpiper (*T. glareola*); Terek Sandpiper (*Xenus cinereus*); Common Sandpiper (*Actitis hypoleucos*); White-winged Tern (*Chlidonias leucopterus*); Eurasian Reed Warbler (*Acrocephalus scirpaceus*); Great Reed Warbler (*A. arundinaceus*); Willow Warbler (*Phylloscopus trochilus*); Garden Warbler (*Sylvia borin*); Black Stork (*Ciconia nigra*); Black Kite (*Milvus migrans*); Eurasian Marsh Harrier (*Circus aeruginosus*); European Honey Buzzard (*Pernis apivorus*); Lesser Spotted Eagle (*Aquila pomarina*); Tawny Eagle (*Aq. rapax*); Booted Eagle (*Hieraaetus pennatus*); Great Spotted Cuckoo (*Clamator glandarius*); Blue-cheeked Bee-eater (*Merops persicus*); Eurasian Bee-eater (*M. apiaster*); African Hoopoe (*Upupa epops*); Sand Martin (*Riparia riparia*); Eurasian Swallow (*Hirundo rustica*); Yellow Wagtail (*Motacilla flava*); Red-throated Pipit (*Anthus cervinus*); Whichat (*Saxicola rubetra*); Northern Wheatear (*Oenanthe oenanthe*); Isabelline Wheatear (*O. isabellina*); Pied Wheatear (*O. pleschanka*); Woodchat Shrike (*Lanius senator*); Spotted Flycatcher (*Muscicapa striata*); Semi-collared Flycatcher (*Ficedula semitorquata*); and Nightingale (*Luscinia megarhynchos*). Overall, numbers of both Palearctic and Afrotropical species were quite high; however, the majority of waterbirds are resident in Uganda, making only local movements in response to rainfall.

For further discussion and assessment of these and other species that may potentially occur in the CHAA, see Section 7.2.

Habitats

The bird recorded in the LSA represent guilds that are closely tied to the various habitats of the area, as well as many generalist species. For example, woody vegetation associated with wooded grassland and woodland communities was important for a variety of tree-dependent species; while the more open areas are important for species such as Temminck's Courser (*Cursorius temminckii*), Grey Crowned Crane (*Balearica regulorum*) and a variety of plovers and lapwings, whilst the seasonally flooded and permanent swamps, support a wide variety of bird species.

Nevertheless, habitats of importance for birds within the LSA, based on species richness and diversity, included: the ecotonal habitat at the foot of the escarpment and the escarpment face; the permanent wetlands associated with the Masika and Kamansinig Rivers; and the shore of Lake Albert. The proposed pipeline route passes through predominantly agricultural country. Although largely disturbed and modified, these habitats are, nevertheless, species rich.

For further discussion and assessment of habitats, please refer to 7.1.

6.1.5   Mammals

A summary of the baseline of the mammal species of the LSA is presented based on the findings of the desktop study and the field investigations. The detailed baseline studies are presented in APPENDIX B.

Species Richness, Diversity and Abundance

Generally, the LSA supports a depauperate community and populations of medium to large-sized mammals, presumably due to the strong influence of human disturbance and associated pressures (*viz.*, AWE 2008a, b, 2013a, 2014a, EAC 2013, 2014). The mammal fauna assemblage is dominated by small to medium-sized species such as rodents, shrews, bats, mongoose, rabbits, duiker, bushbuck and primates.

Thirteen species of non-volent small mammals (that is, rodents and shrews) were recorded on the Buhuka Flats and escarpment area, which comprised 11 species of rodent and two shrews. Those areas surveyed along the pipeline route only recorded two species of rodent. These low figures for species richness and diversity may be an artefact of the sampling effort (see Section 3.4). The Pygmy Mouse (*Mus minutoides*) was the most abundant and common, followed by the Multimammate Mouse (*Mastomys natalensis*).

Two species of fruit bat (Sub-order: Megachiroptera), the Ethiopian Epauletted Fruit Bat (*Epomophorus labiatus*) and Peter's Dwarf Epauletted Fruit Bat (*Micropteropus pusillus*) were recorded from Buhuka Flats. Sixteen confirmed species of insectivorous bats (Sub-order: Mircochiroptera) were recorded from the Buhuka Flats, with possibly another two unconfirmed species. These represent the majority of species expected to occur in the CHAA.

The most common and abundant species were the Yellow House Bat (*Scotophilus dingani*), the Dark-winged Lesser House Bat (*Scotoecus hirundo*) and the Banana Pipistrelle Bat (*Neoromicia nanus*) appeared to occur in survey areas at higher levels of activity.

Thirteen medium-sized mammals were recorded in the LSA. These species tended to be habitat generalists, and included four primates: Vervet Monkey (*Cercopithecus aethiops*), Red-tailed Monkey (*C. ascanius*), Colobus Monkey (*Colobus guereza*) and Olive Baboon (*Papio anubis*); three viverrids: African Civet (*Civetta civetictis*), African Palm Civet (*Nandinia binotata*) and Small-spotted Genet (*Geneta tigrina*); a herpestid: the Marsh Mongoose (*Atilax paludinosus*); three rodents: Lesser Cane-rat (*Thryonomys gregorianus*), Bunyoro Rabbit (*Poelagus marjorita*) and Stripped Ground Squirrel (*Xerus erythropus*); and two bovids: Bush Duiker (*Sylivicapra grimmia*), and Bushbuck (*Tragelaphus scriptus*). These species appear to be sparsely distributed throughout the LSA. Of interest though is the relatively high diversity of carnivores and omnivores. The populations of all the species recorded within the LSA are unknown.

A small population of Hippopotamus occurs on the Buhuka Flats. No accurate counts of the number of individuals occur, however, it is doubtful that more than five animals exist in this isolated population (pers. obs.).

Species of Concern

As discussed, the majority of species recorded were cosmopolitan, generalist species with a Least Concern status and stable populations, as assessed by the IUCN. The notable exception being the small population of Hippopotamus on the Buhuka Flats; this species is listed as Vulnerable by the IUCN, with a decreasing population (Lewinson and Oliver 2008). Within Uganda, this species is recognised as having a restricted distribution, although it is locally abundant; as such, it is fully protected under the law (Lewinson and Oliver 2008).

Five species of bats recorded in the LSA are potentially cave or cavity roosting species. These include the Little Free-tailed Bat (*Chaerephon pumila*), Angolan Free-tailed Bat (*Mops condylura*), a Bent-wing Bat (*Miniopterus* sp.), the Dark-winged Lesser House Bat and Yellow House Bat. Although no caves were identified within the LSA that could house colonies of these species, there is a possibility that such features could exist, particularly on the escarpment. Of most interest is the Bent-Wing Bat. This species is listed in CITES Appendix II (UNEP-WCMC 2018), and is known to roost in caves housing hundreds or even thousands of individuals (Monadjem et al. 2010).

For further discussion and assessment of these and other species that may potentially occur in the CHAA, see Section 6.3.2.

Habitats

As mentioned, the majority of the species recorded in the LSA are habitat generalists and quite wide ranging. There are obvious exceptions. The Bugoma Lagoon area and swamps of the lower reaches of the Masika River are important daytime refuges for the local Hippopotamuses, along with many other small and medium-sized mammals. Similarly, the seasonally flooded wetlands of the upper reaches of the Masika River and its tributaries, and the ones associated with the Kamansinig River, as well as those along the pipeline route, are important habitats for the small mammal assemblages in the LSA.

The escarpment is an important habitat for all the mammal species recorded in the LSA. It not only forms a continuous corridor along the length of Lake Albert, but it also offers important refugial sites for many of the small mammal species; notably the cavity and cave roosting bat species. The escarpment is dissected by numerous watercourses draining off the plateau; these watercourses form incised ravines in the escarpment that have the potential to support significant roosting sites for bats.

The thicket communities on the Buhuka Flats, and remnant vegetation patches along the pipeline route form important refuges and resource areas for small mammals.

For further discussion and assessment of habitats, please refer to Section 7.2.

6.2 Aquatic Biodiversity

This section focuses on describing the baseline aquatic biodiversity of the LSA and CHAA. It summarises the findings reported in the aquatic ecology baseline reports, as presented in APPENDIX C.

6.2.1 Water Quality

The water quality characteristics, as relevant to aquatic ecology, of the near-shore environment of Lake Albert, the Masika River, the Kamansinig River and the Well Pad 2 Stream are summarised below.

General Parameters – Lake Albert

Generally, the water quality parameters assessed for Lake Albert fell within the accepted limits of Uganda's national drinking water standards (the Ugandan standards), as published by the National Water and Sewerage Cooperation (NEMA 1996). Generally, the water quality at all sites sampled in Lake Albert was suitable for fisheries productivity and maintenance of other aquatic biodiversity (APPENDIX C).

Dissolved oxygen ranged between 7.03 and 7.95 mgL^{-1}, levels conducive to an environment supporting a high fish biomass (Romaire 1985), and tended to be higher in the wet season.

The pH had a narrow range between 9.45 and 9.66, which, although above the Ugandan standards, is considered normal for Lake Albert. Interestingly, this pH is higher than the values for the rivers draining off the escarpment, which ranged between 8.8 and 9.2. These findings are similar to the findings from 50 years ago, when the pH ranged from 8.9 to 9.1 (Talling 1963). Typically, a pH above 9.5 can lead to ammonia toxicity to fisheries (Beveridge, 1996); however, this high level apparently has little effect on the biodiversity of the lake.

Conductivity had a narrow range of 632 to 634 µS.cm^{-1}; these values were less than those recorded by Talling (1963), which ranged from 720 to 780 µS.cm^{-1}.

Interestingly, this pH is higher than the values for the rivers draining off the escarpment, which ranged between 8.8 and 9.2.

General Parameters – Rivers and Wetlands

Generally, the water quality parameters assessed for the rivers and wetlands fell within the accepted limits of Uganda's national drinking water standards (the Ugandan standards), as published by the National Water and Sewerage Cooperation (NEMA 1996). Dissolved oxygen varied at all sites sampled, ranging from 1.3 mg.L^{-1}, near the mouth of the Masika River, to 9.2 mg.L^{-1} in the Well Pad 2 River mid-stream. The pH also varied, ranging from 7.1 at the mouth of the Masika River, to 9.6 at the mid-stream of Well Pad 2 stream. Similarly, the conductivity ranged 278 µS.cm^{-1} at the mouth of the Masika River, to 966 µS.cm^{-1} in the middle of the Bugoma Lagoon.

Phosphorous Compound – Lake Albert

The total phosphorus concentration ranged from 21.1 to 43.9 µg.L^{-1} between the dry and wet season; these concentrations supply soluble reactive phosphorus (SRP) in the range of 0.0 to 3.4 µg.L^{-1}, a range which would typically lead to the lake waters off the Buhuka Flats being classed as nutrient poor and not very productive (that is, oligotrophic) (OECD 1982). However, other nutrient sources within the water column, such as soluble reactive silica (SRSi) (see below), which drives diatom biomass, counter the oligotrophic conditions. Furthermore, green and blue-green algae readily absorb the SRP, thereby increasing the biomass in the otherwise nutrient poor (that is, oligotrophic) environment.

Within such a system, as represented by Lake Albert, aquatic biodiversity can be unique, with endemic and range-restricted species encountered that are adapted to the nutrient poor conditions. Such a system is sensitive to phosphorous loading, such as that occurring from agricultural run-off and pollution, which, in turn, can adversely affect fish production.

Phosphorous Compound – Rivers and Wetlands

The overall total phosphorus concentration ranged from 79.4 to 350.3 µg.L^{-1}, supplying SRP in the range of 0.2 in the middle of the lagoon, to 34.5 µg.L^{-1} at the mouth of the Masika River. The influence of soap products, from local people doing their washing in the rivers, may have resulted in the high concentrations observed.

Silica Compound – Lake Albert

The SRSi levels were relatively high in all samples from Lake Albert, and ranged from 410 to 1096 µg.L^{-1} in the wet and dry season. As mentioned above, SRSi is readily absorbed by diatoms; in particular, the diatom genera *Cyclostephanodiscus* and *Nitzschia* are abundant in the lake, and form an important food source for fish.

Silica Compound – Rivers and Wetlands

At the time of the first wet season sampling, sufficient rainfall had not yet fallen; hence, there was no water connectivity between the lake and the rivers and wetlands draining off the escarpment and the Buhuka Flats. As such, the concentration of SRSi was similar in these systems compared to the lake. The SRSi ranged from 456.7 to 929.7 µg.L^{-1} in all the nine sites sampled. It is expected that, following sufficient rainfall, these systems will be flushed and the concentrations of SRSi may drop.

Nitrogen Compound – Lake Albert

Total Nitrogen concentration decreased in the wet season, ranging from 149 to 872 $\mu g.L^{-1}$, compared to the dry season, which ranged from 407.8 to 729.2 $\mu g.L^{-1}$. These concentrations support high levels of phytoplankton, which is the major carbon producer, and food source for fish in Lake Albert. As expected, the total nitrogen concentrations in the vicinity of the confluence of the Masika River and Lake Albert were the highest, at 872 $\mu g.L^{-1}$.

Ammonia concentrations within the water column were similar in the wet and dry seasons, ranging from 3.1 to 28.7 $\mu g.L^{-1}$. The higher concentrations of 22.3 and 28.7$\mu g.L^{-1}$ were recorded from the sampling locations associated with Pad 2 and the confluence of the Masika River and Lake Albert. The reason as to why the concentration at the Pad 2 sampling locations is unclear; however, the high concentrations recorded at the Masika River's confluence were not unexpected. Although ammonia becomes detrimental to fish health at concentrations greater than 20 $\mu g.L^{-1}$, typically, within a healthy aquatic ecosystem, it is converted immediately into nitrate in the presence of oxygen (via the intermediate product nitrite) (Delince 1992). Within the samples from Lake Albert, nitrate concentrations ranged from 15.3 to 95.3 $\mu g.L^{-1}$ indicating efficient conversion of toxic ammonia, driven by good dissolved oxygen concentrations, which were greater than 7.0 $mg.L^{-1}$ at all sites (see above). Consequently, ammonia concentrations were observed to drop below 5 $\mu g.L^{-1}$ further into the lake. As such, the aquatic ecosystem offshore from the Buhuka Flats is healthy, as indicated by the efficient conversion of ammonia and good concentrations of dissolved oxygen.

Nitrogen Compound – Rivers and Wetlands

The total nitrogen concentration ranged from 104.2 to 863. $\mu g.L^{-1}$ at all sites sampled, which presented an ammonia concentration ranging from 4.4 to 33.9 $\mu g.L^{-1}$. Nitrate concentrations ranged from 18.6 to 179.7 $\mu g.L^{-1}$. The higher concentrations were observed at the mouth of the Masika River and could be the result of an oxygen deprived environment.

Chlorophyll a – Lake Albert

Chlorophyll a, an indirect determinant of algal biomass (Heckey 1993), ranged from 1.0 to 3.1 $\mu g.L^{-1}$ in the wet season, and 1.7 to 8.7 $\mu g.L^{-1}$ in the dry season. Similar to the observed concentrations of phosphorous, the concentrations of chlorophyll a qualifies the lake waters offshore from the Buhuka Flats as nutrient poor (that is, oligotrophic – being in the range of 0 to 8.5 $\mu g.L^{-1}$ according to OECD 1982). Within Lake Albert, this range indicates a stable food supply for the fish without visible algal blooms.

Chlorophyll a – Rivers and Wetlands

Chlorophyll a, ranged from 0.0 to 18.3 $\mu g.L^{-1}$, which could be expected to decrease during the wet season as the algal growth is suppressed by the growth of emergent wetland plants and the shade they produce.

Faecal Coliform – Lake Albert

The National Water and Sewerage Cooperation (NEMA 1996) identifies that zero colony forming units (CFU) per 100 mL is the recommended concentration of faecal coliform for drinking water, it is also the recommended level for the maintenance of healthy aquatic biodiversity.

Faecal coliform concentrations within Lake Albert, at the locations sampled, ranged from 2 to 8 CFU per 100 ml in the dry season, jumping to 2 to 100 CFU per 100 ml in the wet season. As expected, concentrations were higher at the inshore sampling sites, and decreased further out into the lake.

The marked difference between the wet and dry season concentrations can be attributed to the increased run-off experienced during the wet season into the lake.

Faecal Coliform – Rivers and Wetlands

All sites within the rivers and wetlands assessed on the Buhuka Flats had faecal coliform ranging from four to 504 CFU per 100 ml. These values are well above the National Water and Sewerage Cooperation standard.

6.2.2   Phytoplankton

The phytoplankton communities of the near-shore environment of Lake Albert, the Masika River, the Kamansinig River and the Well Pad 2 stream are summarised below.

Species Richness, Diversity and Abundance – Lake Albert

Thirty-five genera were identified in the phytoplankton communities of Lake Albert, offshore from the Buhuka Flats, over the wet season compared to the 26 genera identified during the dry season. These comprised: blue-green algae – 20 species comprised of eight genera; simple algae (that is, Cryptomonads, Dinoflagellates, Euglenoids) – two species each (interestingly, the Euglenoids were not recorded in the dry season); diatoms – eight species comprised of six genera; filamentous green algae – 18 species comprised of 12 genera. Generally, the species diversity increased across all groups from the dry season to the wet season.

Among the blue-green algae, six species (*Anabaenopsis tanganikae*, *Aphanocapsa incerta*, *Ap. nubilium*, *Chroococcus limneticus*, *Planktolyngbya circumcreta* and *P. limnetica*) were present at all sites sampled. Other taxa, such as *Cylindrospermopsis, Merismopedia* and *Coelosphaerium,* were rare. One species, *Microcystis aeruginosa*, recently identified as the only toxin-producing blue-green algae in Ugandan freshwater habitats (Okello et al. 2010), was conspicuously absent at all sites sampled. This is a notable observation given that this species prefers polluted environments, and its absence suggests that the waters of Lake Albert are a relatively pristine environment (Okello et al. 2010).

Of the five genera of Diatoms identified, three taxa: *Cyclostephanodiscus* species; *Nitzschia acicularis* and *N. fonticola*, were represented at all sites sampled, while *Navicula* species were found at fewer sites. The genus *Aulacoseira* was conspicuously absent in the dry season, yet was encountered during the wet season. This difference between the seasons could be attributed to this taxon being selectively fed upon by zooplankton and fish. Interestingly, this taxon has almost disappeared from Lake Victoria, which has apparently led to the virtual total decline of some native fish species which feed almost exclusively upon it (Ogutu-Ohwayo et al, 2002).

The majority of the 18 filamentous green algae species identified were widespread across all the sampling sites. Some taxa increased during the wet season compared to the dry season, although seven genera (*viz., Closterium*, *Dictyosphaerium*, *Didymocystis*, *Gonatozygon*, *Kirchneriella*, *Oocystis* and *Pediastrum* were rare during the dry and wet seasons.

In general, there was an increase in the species composition per site from the dry season to the wet season; ranging from 15 to 23 species in the dry, to 18 to 26 species in the wet.

The composition of the phytoplankton community within Lake Albert differed between the dry and wet seasons. During the dry season, the phytoplankton communities were dominated (>50%) by diatoms (ranging from 15.46 to 85.35 $mm^3.L^{-1}$), with blue-green algae comprising between 13.92 and 70.34 $mm^3.L^{-1}$ of the biomass volume. In the wet season, blue-green algae dominated (ranging from 0.84 to 3.53 $mm^3.L^{-1}$), while the diatom communities decreased markedly to between 0.91 and 3.09 $mm^3.L^{-1}$. Both diatom and blue-green algae biomass tended to be higher in the offshore areas (~1 km) compared to the inshore areas.

It is interesting to note that the diatom biomass recorded in Lake Albert during the dry season was lower than that recorded in Lake Edward and Lake George, which ranged from 45 to 230 $mm^3.L^{-1}$ and 90 to 420 $mm^3.L^{-1}$, respectively (Okello and Kurmayer, 2011).

Single-celled algae (that is, Cryptomonads) populations increased from the dry season (~0.94 $mm^3.L^{-1}$) to the wet season (from 0.09 to 0.14 $mm^3.L^{-1}$), although they only constituted a minor proportion of the phytoplankton communities. Multi-celled algae (in particular, Dinoflagellates) were not recorded during the dry season, yet, during the wet season, their populations increased to around 0.12 $mm^3.L^{-1}$. Green algae biomass ranged between 1.38 and 37.19 $mm^3.L^{-1}$ in the dry season, and dropped to between 0.05 and 8.46 $mm^3.L^{-1}$ in the wet season.

The observed difference between the seasons could be attributed to the increase in grazing pressure from the larger zooplankton population, which increased during the wet season (see below).

Species Richness, Diversity and Abundance – Rivers and Wetlands

Thirty-one genera, belonging to five families were identified in the phytoplankton communities of the rivers and wetlands of the LSA. These included: blue-green algae – ten species in nine genera; simple algae – one species in a single genus (which was only recorded in the lagoon); diatoms – eight species in eight genera; filamentous green algae – 13 species in 11 genera.

Among the blue-green algae, five species (*Anabaena circinalis*, *Aphanocapsa nubilium*, *Chroococcus limneticus*, *Merismopedia tenuissima* and *Planktolyngbya limnetica*) were present at all sites sampled. Like the blue-green algal community of Lake Albert, *Microcystis aeruginosa*, was conspicuously absent at all sites sampled. This is a notable observation given that this species prefers polluted environments, and its absence suggests that the waters of the rivers and wetlands of the LSA are a relatively pristine environment (Okello et al. 2010).

Ten of the identified species of diatom were recorded in the Masika River and the lagoon. Only four species were recorded in the Kamansinig River, these were: *Navicula gastrum*; *Nitzschia acicularis*; *Ni. onticola* and *Surirella* sp.). The rare *Aulacoseira* was present in the lagoon.

The 13 species of filamentous green algae were mainly present in the Bugoma Lagoon sites, being absent from the Kamansinig River, and only represented by one genus, *Actinastrum*, in the Masika River.

The Bugoma Lagoon wetland had the highest total phytoplankton biomass of ~190 mm^3. L^{-1}. Of this, more than 50% was contributed by the blue-green algae, while diatoms and filamentous green algae shared similar proportions. Simple algae appeared in minor quantities.

Species of Concern

Of all the taxa of phytoplankton identified during the dry and wet season, only the genus *Aulacoseira* is a group of special interest. As mentioned above, this has almost disappeared from Lake Victoria, which has apparently led to the virtual total decline of some native fish species which feed almost exclusively upon it (Ogutu-Ohwayo et al. 2002). Its existence in Lake Albert suggests that this lake is still relatively undisturbed and unpolluted.

For further discussion and assessment of these and other species that may potentially occur in the CHAA, see Section 6.3.2.

Habitats

The near-shore environment of Lake Albert, the watercourses and wetlands of the Buhuka Flats support a diverse assemblage of phytoplankton. These areas are naturally higher in nutrients that support higher biomasses of phytoplankton, which, in turn, drive the food web of the south-eastern shores of Lake Albert, and, potentially, contribute to the food web of the wider lake.

For further discussion and assessment of habitats, please refer to Section 6.3.1.

6.2.3   Zooplankton

The zooplankton communities of the near-shore environment of Lake Albert, the Masika River, the Kamansinig River and the Well Pad 2 stream are summarised below.

Species Richness, Diversity and Abundance – Lake Albert

The zooplankton communities within Lake Albert and the Bugoma Lagoon wetland of the Buhuka Flats are dominated by three taxa: Copepod crustaceans (Order: Copepoda) (comprising three species); water fleas (Order: Cladocera) (comprising seven species), and rotifers, or wheel animals (Phylum: Rotifera) (comprising nine species). Depending on the location: Copepods comprised, on average, 56% (range: 0% to 100%) of the zooplankton biomass in the dry season samples, and 69% (range 8% to 100%) in the wet season samples; water fleas comprised, on average, 49% (range: 10% to 90%) of the biomass in the dry season samples, and 38% (range 0% to 92%) in the wet season samples; rotifers comprised, on average, 26% (range: 0% to 80%) of the biomass in the dry season samples, and 33% (range 0% to 100%) in the wet season samples.

In Lake Albert, zooplankton abundance was dominated by the Copepods *Thermocyclops neglectus* and *Mesocyclops* sp., the water fleas *Diaphanosoma excisum* and *Moina micrura*, and the rotifer *Keratella tropica*. The relative abundance was higher in the offshore environments compared to the inshore environments. In contrast, the zooplankton abundance of the Bugoma Lagoon was dominated by the rotifers *Brachionus angularis*, *B. calciflorus*, and *B. falcatus*, with the Copepod *T. neglectus* and water fleas *M. micrura* and *D. excisum* also strongly represented.

The Bugoma Lagoon supported the highest number of rotifer species, yet also exhibited the highest decline in species richness from the dry season to the wet season. There was a marked difference in species diversity, compositions and abundance between the dry season and the wet season at all sites sampled. In the lagoon, total abundance of zooplankton decreased from an average of ~1,000,000 individuals per square metre in the dry season, to an average of ~180,000 individuals per square metre in the wet season. The dominant taxa comprising these abundances also shifted between the dry and wet seasons; as mentioned above, Copepods were more abundant in the wet season than the dry, while rotifers dominated in the dry season. The opposite trend was observed in Lake Albert. Here the zooplankton abundance increased from an average of ~350,000 individuals per square metre in the dry season, to an average of ~1,400,000 individuals per square metre in the wet season. Certainly, in Lake Albert, there was a tremendous increase in abundance of all taxa in the wet season compared to dry season.

In comparison with other lakes in the Victoria basin (for example, see Vincent et al. 2012, Mwebaza-Ndawula et al. 2003), the diversity of zooplankton in this particular part of Lake Albert is generally low. Nonetheless, key species reported to characterize zooplankton assemblages of Ugandan lakes, and which are important food species for fish (Mwebaza-Ndawula et al. 2004), occurred in relatively high abundance.

Species of Concern

No species of concern were identified in the zooplankton communities in the LSA.

For further discussion and assessment of other species that may potentially occur in the CHAA, see Section 6.3.2.

Habitats

The zooplankton communities of near-shore and off-shore environments of Lake Albert reflect a healthy water habitat dominated by Cyclopoid Copepods. A similar healthy environment was reported in Lake Albert over a decade ago by Lehman et al. (1998). The exception is the Bugoma Lagoon, where high numbers of rotifers were observed. Typically, a high abundance of rotifers, notably species of *Brachionus*, as observed in the lagoon, reflect elevated levels of pollution, or eutrophication, of waterbodies (Radwan and Popiolek 1989, Tasevska et al. 2010). This is possibly the current situation in the Bugoma Lagoon where *B. angularis* and *B. calciflorus* were abundant. Another notable observation was the absence of the predatory Cyclopoid copepod, *Mesocyclops* sp., in the lagoon, yet it was recorded in >75% of the other sites sampled. The changes in the zooplankton assemblages in the Bugoma Lagoon, and the dominance of rotifers, could also be due to the lack of connectivity with the lake and the consequent stagnation of the water coupled with the increase in nutrient loads in-flowing from the Kamansinig River and the hinterland, as well as the presence of Hippopotamus adding to the nutrient loading.

Nevertheless, the dominance of Copepods in the aquatic habitats of Lake Albert is important. These taxa are keystone species in sustaining fish communities in most water bodies (Mwebaza-Ndawula et al. 2001, Mwebaza-Ndawula et al. 2003, Mwebaza-Ndawula et al. 2004). As such, the near-shore habitats, wetlands of the lower Masika River and Kamansinig River, and the large bays of the Buhuka Flats are important habitats for zooplankton.

For further discussion and assessment of habitats, please refer to Section 6.3.1.

6.2.4   Macro-invertebrates

The macro-invertebrate communities of the near-shore environment of Lake Albert, the Masika River, the Kamansinig River and the Well Pad 2 stream are summarised below.

Species Richness, Diversity and Abundance – Lake Albert

Species richness of mayflies (Order: Ephemeroptera), stoneflies (Order: Plecoptera) and caddis flies (Order: Trichoptera) (EPT) in Lake Albert was low, yet similar in the dry season and both wet season samples, ranging from zero to 15.

The species diversity was equally low during the dry and both wet seasons, being dominated by a few taxa; the mayfly *Povilla adusta*, the molluscs *Melanoides tuberculata*, *Gabbia humerosa*, and *Bellamya unicolor*, and the freshwater clam *Corbicula africana*. In terms of abundance of individuals, mayflies comprised the largest number (0 to 1707 larvae per square metre), yet only included three species (dominated by *Povilla adusta,* with *Caenis* sp. and *Baetis* sp. also occurring); while no stoneflies were recorded during any of the seasonal surveys. Among the caddis flies, only members of the family Psychomidae were recorded in the dry season, only *Dipseudopsis* spp. (Family: Dipseudopsidae) was recorded in the first wet season, and both were recorded during the second wet season survey.

The larvae of phantom midges (Family: Chaoboridae) were common and abundant (up to 294 larvae per square metre) in the inshore and offshore sediments of Lake Albert across all sampling periods. Larvae of non-biting midges (Family: Chironomidae) and biting midges (Family: Ceratopogonidae) were also relatively abundant.

Snails (Phylum: Gastropoda), freshwater mussels (bivalves in the Order: Unionoidea), freshwater clams (*Corbicula africana*) and aquatic worms (Phylum: Annelida, Class: Oligochaeta) were the most common and abundant macro-invertebrates recovered from bottom sediments in the dry and wet seasons.

During the dry season, five snail taxa (*Melanoides tuberculata*, *Cleopatra* sp., *Gabbia* (*Gabbiella*) *humerosa*, *G. walleri* and *Bellamya unicolor*) were the most abundant and widely distributed. In contrast, during the first wet season two species (*viz*., *M. tuberculata* and *B. unicolor*) were the most abundant and widely distributed taxa. Their densities ranged from zero to 1064 individuals per square metre in the dry season, and zero to 896 in the wet season. In the second wet season, *Gabbia humerosa* was most abundant with densities of 1401 - 1078 individuals per square metre recorded at two locations (Pad 2 and Pad 3 inshore); this species was not recorded at any other location on that occasion.

Two species of freshwater mussel (*viz*., *Byssanodonta parasitica* and *Corbicula africana*) were common and abundant. Their densities in the dry season were markedly less than the first wet season survey (that is, zero to 294 individuals per square metre in the dry, compared to zero to 672 individuals per square metre in the first wet). In the second wet season survey, significantly higher number of individuals were recorded at the Pad 1 offshore site only (zero to 518 individuals of *B. parasitica* and zero to 140 individuals of *C. africana*) with the other sites supporting relatively low numbers.

The densities of aquatic worms (Oligochaetes) ranged from zero to 98 individuals per square metre in the dry season, up to 168 per square metre in the first wet season, and up to 42 per square metre in the second wet season; the highest densities being recorded in inshore habitats adjacent to the lagoon.

Total taxa richness scores in Lake Albert were similar in both of the wet and dry season samples, with an average of seven species (range: three to 15 species) recorded in the inshore habitats, and eight species (range: two to 15 species) recorded in the offshore habitats. Importantly, the densities of the various groups varied, sometimes significantly, between the dry and wet seasons, with higher densities observed for all groups during the first wet season.

Based on EPT and total taxa richness scores for the dry and wet season surveys, the sampling sites in Lake Albert and the wetlands of the Buhuka Flats showed varying environmental conditions. Only the inshore sampling sites in the vicinity of Pad 1 and Pad 4-2 reflected a moderate to good environmental condition. Those sampling locations in the vicinity of Pad 2 (offshore), Pad 3, Pad 4-2 (offshore), Pad 5 (offshore), and in the Bugoma Lagoon reflected fair environmental conditions. Interestingly, the remainder of the sites, namely Pad 1 (offshore), Pad 2 (inshore) and Pad 5 (inshore) reflected poor environmental conditions.

Typically, densities of benthic macro-invertebrates, especially the insect group (that is, mayflies, stoneflies, caddis flies and midges), tend to increase from the dry to wet season (Wetzel 2001). The numbers of the mayfly *Povilla adusta* and phantom midges (*Chaoboridae*) recorded across the three sampling periods reflected this trend, however, the same trend was not observed in any of the other macro-invertebrate samples from the LSA. The reasons for this are not clear based on the current data and sampling regime.

It should be noted that a dedicated search conducted in November 2014 as part of the second wet season survey did not find *Bellamya rubicunda* or *Gabiella candida* at either the Lake Albert inshore stations or the wetland streams of the Buhuka Flats (see APPENDIX C).

Species Richness, Diversity and Abundance – Rivers and Wetlands

The most common macro-invertebrates in the rivers and wetlands were: mayflies (*Baetis* spp., Order: Ephemeroptera) and caddis flies (*Cheumatopsyche* spp., Order: Trichoptera), with densities ranging from 0 to 6,723 individuals/m^2 and 2801 individuals/m^2 respectively; dragonflies (Brachymesia spp., Order: Libellulidae; and) with mean density of 0 to 126 individuals/m^2 recorded in the River Masika at the base of the escarpment; water bugs (*Macrocoris* spp., Order: Hemiptera), with mean density of 0 to 98 individuals/m^2; non-biting midges (Order: Diptera, Chironomidae), with 0 to 98 individuals/m^2; and aquatic worms, with 0 to 385 individuals/m^2. Other notable groups included black flies (Order: Diptera, Simuliidae), with densities ranging from 0 to 210 individuals/m^2, recorded from the mouth of Well Pad 2 stream. Importantly, the densities and species composition of the various groups varied, sometimes significantly, between the dry and wet seasons, with higher densities observed for all groups during the wet seasons; particularly the dragonflies which were present in much greater densities during the second wet season survey than the previous sampling events.

Freshwater snails (*Biomphalaria* spp.) were recorded in the Kamansinig River, Masika River and Well Pad 2 stream.

Based on the EPT scores, the Kamansinig River at the foot of the escarpment reflected a moderate to good environmental condition, the remainder of the river and wetland habitats were fair to poor. Total taxa richness scores for the Kamansinig River and Well Pad 2 stream reflected a moderate to good environmental condition compared to the other sites sampled.

It is important to note that the watercourses draining off the escarpment are seasonal (Golder Associates 2014b). Therefore, low counts of macro-invertebrates would be expected in some of these sites during the dry season. This was reflected in the observed EPT diversity recorded during the second wet season; *Baetis* spp. (Ephemeroptera) and *Cheumatopsyche* spp. (Trichoptera) were abundant during this time, yet absent from the dry season surveys. Similarly, the Bugoma Lagoon appears to be isolated from the lake during the dry season. This could account for the low dissolved oxygen in the bottom sediments resulting from inadequate mixing and decomposition of plant material. These conditions in the Bugoma Lagoon support the fact that intolerant species of mayflies, stoneflies and caddis flies were absent, yet more tolerant species like non-biting midges and aquatic worms were common.

Species of Concern

All the species recorded in the LSA were Least Concern, or not yet evaluated by the IUCN. The Critically Endangered freshwater Mud Snail (*Gabbiella candida*) has, to date, only been recorded from Butiaba, about 90 km north of the LSA (Kyambadde 2010a, GBIF 2017).

It should be noted that a dedicated search conducted in November 2014 as part of the second wet season survey did not find *Bellamya rubicunda* or *Gabiella candida* at either the Lake Albert inshore stations or the wetland streams of the Buhuka Flats (see APPENDIX C). Nevertheless, taking a precautionary approach, there remains a potential that these species could be found within suitable habitat in the LSA (see Section 6.3.2).

No other known macro-invertebrate species of concern were identified as occurring, or have a potential to occur, in the LSA.

Habitats

The near-shore and inshore habitats of Lake Albert in the vicinity of the Buhuka Flats offer a diverse array of substrates (that is, clay/snail shells, sand/plant materials, soft mud, and rock/shells) that support a rich diversity of the benthic macro-invertebrates. Similarly, the wetlands associated with the Masika River, Kamansinig River, Well Pad 2 stream, and the watercourses along the pipeline route, all provide important habitat for macro-invertebrates. The Bugoma Lagoon offers a unique habitat for fish and other organisms including macro-invertebrates.

For further discussion and assessment of habitats, please refer to Section 6.3.1.

6.2.5 Fish

The freshwater fish communities of Lake Albert, the Masika River, the Kamansinig River and the Well Pad 2 stream are summarised below.

Species Richness, Diversity and Abundance

Twenty-four fish species comprising 19 genera and nine families were recorded from Lake Albert in the LSA. This represents ~45% of the 53 fish species reported to occur in Lake Albert (Greenwood 1966).

Four species contributed the most biomass (% weight of catch as a surrogate for abundance – although the limitations of this are recognised) in the first wet season survey from all sampling locations in the LSA; these included: the Nile Perch (*Lates niloticus*) (42%), *Ragoge* (*Brycinus nurse*) (17%), *Ngassa* (*Hydrocynus forskahlii*) (12%) and *Angara* (*A. baremoze*) (3%). These are also some of the most commercially important species in Lake Albert (Taabu-Manyahu et al. 2012). In comparison, five species contributed the most biomass by catch in the dry season samples: Nile Perch (40%), *Ngassa* (18%), *Angara* (9%), Shield-head Catfish (*Synodontis schall*) (9%) and Black Nile Catfish (*Bagrus bajad*) (8%).

During the second wet season, *Ragoge* (*B. nurse)* dominated the catch (73%) with similar numbers being caught at Pad 1, Pad2, Pad 3 and Pad 5 sampling sites. The remainder of the catch was largely made up of Nile Perch (L. niloticus) (8%), *Ngassa* (*H. forskahlii*) (4%), Haplochromines (3%), Angara (*A. baremoze)* (1%) and *Bagrus bayad* (1%).

Other important species, in terms of abundance, included: Silver Butter Catfish (*Schilbe intermedius*) (6%), which was only recorded at two sampling locations (that is, Pad 2 and Pad 4-2) during the first wet season; a Cichlid (*Thoracochromis* (*Haplochromis*) *wingati*) (~5%) at Pad 5 during the first wet season; and another Cichlid (*T. loati*) (3%), which was recorded in sizable numbers in the vicinity of Pad 1.

Five species (*Imberi* (*Alestes macrolepidotus*), *Muziri* (*Neobola bredoi*), *Mpoi* (*Barilius* (*Distichodus*) *niloticus*, *Citharinus citharus*, *C. latus*), *Kisinja* (*Barbus* (*Labeobarbus*) *bynni*), Lake Albert Cichlid (*Thoracochromis* (*Haplochromis*) *avium*)), were not recorded during the dry season, yet were recorded in the first wet season. Conversely, the Shield-head Catfish, a Barb (*Barbus* (*Labeobarbus*) *perience*) and Mango Tilapia (*Sarotherodon galilaeus*) were recorded in the dry season, yet not in the wet season. Similarly, Senegal Bichir (*Polypterus senegalis*), *Imberi*, Barbel (*Clarius gariepinus*), *Mpoi*, *Muziri*, and Lake Albert Cichlid that were recorded in the first wet season, were not recorded in the during the second wet season. One catfish species, Sudan Squeaker (*S. frontosus*), and the African Carp (*Labeo horrie*), were recorded for the first time during the second wet season surveys. These seasonal differences seen in the community composition may be due to migratory responses to inflow of run-off into the lake.

Species composition within the Bugoma Lagoon was noticeably different compared to Lake Albert. Five species dominated the biomass of each catch; these included: Nile Tilapia (*Oreochromis niloticus*) (36%); Singidia Tilapia (*O. leucostictus*) (18%); *Imberi* (18%); Senegal Bichir (*Polypterus senegalis*) (16%); and *Angara* (8%).

In general, the fish community in the near-shore zone of the LSA is composed of a fairly uniform, multi-species mix of various ages in good condition. The diversity, age classes and condition of the species assessed is a

reflection of adequate food and a healthy environment. Species distribution within the lake environment reflects that habitat requirements of each species.

The near-shore artisanal fishery is dominated by gillnets, and is mostly focused on Nile Perch, *Ragoge*, *Ngassa*, and *Angara*. *Muziri* features strongly in the seine net fishery. For more information and discussion on the fisheries, see Ecosystem Services Review.

Species of Concern

One locally threatened species, the African Electric Catfish (*Malapterurus electricus*) may occur in the LSA. Although this species has not been recorded from LSA, it is known from the wider Lake Albert (Azeroual et al., 2010).

Eight commercially important species are known to occur within the LSA. These include the *Imberi*, *Angara*, Catfish (*Clarias lazera*), *Mpoi*, *Ngassa* (*Hydrocynus vittatus*), Nile Tilapia, Mango Tilapia, and Zill's Tilapia (*T. zillii*). The three species of *Mpoi*, the *Angara*, *Ngassa*, Butter Catfish, and Shield-head Catfish are of particular importance because these species have become very rare in Lake Albert (Wandera and Balirwa 2010). Lake Albert supports at least ten endemic, range-restricted fish species, notably the commercially important *Angara*, *Ngassa* and *Imberi* (Wandera 2000, Campbell et al. 2005, Wandera and Balirwa 2010), all of which have been recorded in the LSA.

Lake Albert has previously experienced increases in populations of *Ragoge* and *Muziri* (Wandera and Balirwa 2010). In 2012, these two species constituted 51% and 34% of commercial fish catches, and indications then were that their populations were increasing in the lake (Taabu-Manyahu et al. 2012). An increase in the populations of these species, which feed exclusively on zooplankton, could have implications for the zooplankton community structure due to increased pressure on these micro-organisms. However, recent baseline work conducted in November 2017 as part of the social baseline update indicated that fisheries are now under significant pressure in Lake Albert since the construction of the escarpment road. This new easy access to the Lake Albert shore has facilitated a large increase in fishing demand, with trucks arriving from Kampala on a near-daily basis to collect the catch. The size of fish being caught by local communities on the Flats appears to have decreased significantly, with only white bait being observed drying during 2017, compared to much larger Nile Perch observed during fieldwork conducted prior to the escarpment road being in place (see Social Impact Assessment, Ecosystem Services Review).

For further discussion and assessment of other species of concern that may potentially occur in the CHAA, see Section 6.3.2.

Habitats

The near-shore habitats of Lake Albert and the wetlands of the lower Masika River and Kamansinig River, and the large bays of the Buhuka Flats are important habitats for zooplankton. In particular, the dominance of Copepod zooplankton is important because these taxa are keystone species in sustaining fish communities in the lake (Mwebaza-Ndawula et al. 2001, Mwebaza-Ndawula et al. 2003, Mwebaza-Ndawula et al. 2004). This is supported by the high biomass, high catch rates, and strong multispecies fishery in the near-shore waters of Lake Albert in the LSA.

For further discussion and assessment of habitats of concern, please refer to Section 6.3.1.

7.0   OVERALL BIODIVERSITY VALUE

Presented below are the findings of the baseline biodiversity value of the CHAA, as described based on a description of the two identified components of overall biodiversity defined in Section 3.3.3, that is, ecosystems and habitats, and species of concern. Within each of these, valued components are described.

7.1　Ecosystems and Habitats of Concern

Uganda falls at the confluence of a number of regional centres of endemism (White 1983): the Guinea-Congo Forest; Lake Victoria Basin; Afro-Tropical Highlands; Somali-Masai; and Sudan and Guinea Savannah. This has resulted in the region having a unique suite of biodiversity. Indeed, the Albertine Graben is an area of high endemism and threatened species (Critical, Endangered and Vulnerable); with over 50% of birds, 39% of mammals, 19% of amphibians and 14% of reptiles and plants of mainland Africa occurring in this region (Plumptre et al. 2003). Furthermore, the Albertine Graben and Lake Albert, within which the CHAA is located, is recognised as: part of the Eastern Afromontane Biodiversity Hotspot (CI 2014); an Endemic Bird Area (Stattersfield et al. 1998); a Key Biodiversity Area (IUCN 2010); and within three globally important ecoregions, notably, the Albertine Rift Montane Forests, the East Sudanian Savanna, and the Rift Valley Lakes Freshwater Ecoregion (Olson and Dinerstein 1998). As such, the Graben is recognised as an area of global importance for conservation. For further discussion and analysis of the biodiversity importance of the wider Albertine Graben and Lake Albert, see, for example, Emerton and Muramira (1999), Wandera (2000), Plumptre et al. (2003, 2005, 2007, 2010, 2011), NEMA (2010), Taabu-Munyaho et al. (2012), AECOM (2012, 2013), CI (2014). The near-shore environment of Lake Albert, and the wetlands associated with the rivers draining off the escarpment, support important populations of commercially important fish species (including important breeding areas), freshwater turtles, crocodiles, invertebrates, algae and aquatic plants, staging grounds for migratory birds, as well as biogeochemical processes that drive the ecosystem.

The Project is located within the Albertine Graben, and adjacent to Lake Albert. As such, it can be expected that the CHAA includes ecosystems and habitats that are important components of the biodiversity and biogeographical significance of the Albertine Graben and Lake Albert.

Nevertheless, the CHAA is located in an area that is heavily influenced by human activities, and currently does not support a high species richness and diversity. Historically, the Buhuka Flats was part of the Buhuka Community Wildlife Area (CWA) (UWA, pers. comm.); however, it was not maintained as a CWA, and, subsequently, the large animal populations declined (UWA, pers. comm.), and, apart from a few Hippopotamus, all the large mammals have disappeared from the area. As such, it is no longer recognised as a CWA and was degazetted in 2002 (RPS 2006). Nevertheless, as identified in Section 6.1.1.1, significant natural vegetation still on the Buhuka Flats and along the escarpment (Figure 4a), 84% of which is considered natural habitat under the IFC's definitions (Figure 15). These vegetation communities and habitats support populations of smaller mammals, mammals, reptiles, amphibians, and invertebrates, including species of concern (see Section 6.3.2).

The Buhuka Flats and the adjacent escarpment area are currently primarily used for livestock grazing, subsistence agricultural purposes, firewood collection, charcoal manufacture, and harvesting of non-timber forest products, while the near-shore environment of Lake Albert supports a strong artisanal fishing industry. These activities exert pressures on the ecosystems, and, undoubtedly have affected the ecological integrity of the ecosystems of the LSA (for example, see NEMA 2010, Wandera and Balirwa 2010). In addition, the ease of access to the Buhuka Flats has been altered with the construction of the escarpment road; this increased ease of access may facilitate increased anthropogenic demand for services such as livestock grazing and firewood harvest, exacerbating pressure on nearby ecosystems.

Similarly, the ecosystems along the pipeline route have experienced severe pressure from subsistence agricultural practices that have resulted in the transformation of a large proportion of the natural habitats in recent history (see Figure 15) (for a review, see AECOM 2012).

Regardless of the intense agricultural, fishing and subsistence pressures within the CHAA, the entire area supports ecosystems and habitats of greater or lesser value. For the intents of this impact assessment, these have been grouped into the following broad ecosystems: the near-shore environment of Lake Albert; the vegetation communities and corridors along the rift valley escarpment; wetlands of the Buhuka Flats and pipeline route; and the ecosystem services they offer (see Ecosystem Services Review) for a more detailed discussion of these ecosystems as they relate to the supply of ecosystem services); and the Bugoma Central Forest Reserve.

Information on the ecology, ecosystem functioning and processes of some of these systems are available, either in published literature (for example: Lake Albert (see, Green 1971, Wandera 2000, Campbell et al. 2005, Wandera and Balirwa 2010, Taabu-Munyaho et al. 2012); the importance of the vegetation along the escarpment as a corridor (see Plumptre et al. 2003, 2007, Ayebare et al. 2013); the Bugoma Central Forest Reserve (see Plumptre et al. 2010, 2011)), or in previous studies undertaken in the area (for example, AWE 2008a, b, 2013a, 2014a, EAC 2013, 2014). As mentioned in Section 3.3.3.1.1, these available studies were supplemented by seasonal surveys of the LSA to gauge an understanding of the current integrity of the ecosystems in the CHAA (see Section 6.1, 6.2, and APPENDIX B and APPENDIX C).

As relevant to this impact assessment, a summary of those studies, and other relevant scientific literature, is provided below to provide a description of the ecological integrity of each of these ecosystems (based upon: composition and structure; linkages and corridors; key processes, including drivers of change; representativeness; resilience and stability). Therefore, as relevant to the Project, and the potential effects the Project may have on those biodiversity values, presented below is a description of the baseline of ecosystems and habitats of concern that comprise the receptors/valued components for impact assessment.

7.1.1 Near-Shore Habitats of Lake Albert

For the intents of this impact assessment, the near-shore environment of Lake Albert is defined as the area within 500 m of the shore of the lake, with water depths typically between 0 m to 12 m; beyond this distance the depth of the lake increases to 18 m and more (NEMA 2010). This area supports a diversity of habitats, water depths, temperature regimes and concomitant flora and fauna communities. These near-shore habitats are also recognised as sensitive ecological areas by NEMA (2010).

Lake Albert supports the most diverse commercial fisheries in Uganda, with at least 55 species (Wandera and Balirwa 2010). This diverse fish fauna supports an array of multi-species fisheries along the lake's length, and, in terms of fisheries production, Lake Albert is second only to Lake Victoria (Taabu-Munyaho et al. 2012). Although this is currently the case, Lake Albert is facing multiple environmental changes, including declining fish species diversity, over fishing and reduced catches, hyper-eutrophication in places and hypoxia (Campbell et al. 2005). Furthermore, the ecology of the lake, and the processes driving the ecosystem, remains poorly understood (for example, Lehman et al. 1998, Wandera 2000, Wandera and Balirwa 2010).

Composition and Structure

The south-central part of the lake, in the vicinity of the LSA, is dominated by the steep sided escarpment, and predominantly deep waters close to the shore (Taabu-Munyaho et al. 2012). In the immediate vicinity of the LSA, that is, the Buhuka Flats, the ecosystem of the lake is composed of a diversity of habitats. Indeed, all the six main habitat types in Lake Albert identified for fishes by Wandera and Balirwa (2010) (*viz.*, shallow river-associated waters, open sandy shores, lagoons, large bays, rocky escarpments, and, open-water habitats), occur within the near-shore areas of the LSA (Figure 5). Of these habitats, those workers identified river mouths, lagoons, near-shore waters of large bays, and rocky areas as priority habitats for fish breeding. All these habitats are well represented in the CHAA (Figure 5), and constitute approximately 5.7 km (river mouths 0.3 km; lagoons 1.4 km; large bays 2 km; rocky shores 1.9 km).

Wandera and Balirwa (2010) reported that, together, throughout the lake, these habitats support 40 species of fish. River mouths contributed the highest number of species, while lagoons supported the highest number of individuals and biomass (Wandera and Balirwa 2010). Indeed, these workers specifically recognise the Bugoma Lagoon of the Buhuka Flats as one of these important habitats in the lake. The importance of the near-shore habitats within the CHAA is reflected in the diversity and abundance of fish species recorded during the aquatic ecology surveys (see Section 6.2.5, and APPENDIX C). Approximately 36% of the species known to inhabit Lake Albert were recorded from the LSA, and these were represented by a range of age and size classes, all in good condition. This suggests that the diversity in composition and structure of the habitats in the LSA is important for the life cycle of a range of species, including many commercial species.

Not only are the shoreline waters, and their concomitant structural diversity, important habitats for juvenile fishes (Wandera and Balirwa 2010), they are also important areas for invertebrate and algae communities that form an important food source for juvenile and adult fish. The submerged and emergent aquatic plants that

are common in the shallow waters off the Buhuka Flats and the wetlands associated with the Masika River and Kamansinig River provide a diversity of structural refuge and breeding sites not only for fish, but also for many invertebrate prey species (such as, Copepod crustaceans, water fleas, rotifers, midges, mayflies, stoneflies, caddis flies). Importantly, the dominance of Copepod crustaceans in the aquatic habitats of Lake Albert is important. These taxa are keystone species in sustaining fish communities in most water bodies (Mwebaza-Ndawula et al. 2001, Mwebaza-Ndawula et al. 2003, Mwebaza-Ndawula et al. 2004). As such, the near-shore habitats, wetlands of the lower Masika River and Kamansinig River, and the large bays of the Buhuka Flats are important habitats for these components of the zooplankton community.

Linkages and Corridors

The near-shore aquatic habitats within Lake Albert are all part of the wider lake ecosystem. In terms of size, the lake, as a contained ecosystem, is not large, being approximately 5300 km^2 (~150 km long by ~35 km wide) (Wandera and Balirwa 2010). And, although it is primarily fed by the Victoria Nile (which drains Lake Kyoga and Lake Victoria) and the Semliki River system, which account for 83% of inflow (Golder Associates 2014b), the biodiversity of the lake is unique. Lake Albert supports at least ten endemic fish species, notably the commercially important *Angara*, *Ngassa* and *Imberi* (Wandera 2000, Campbell et al. 2005, Wandera and Balirwa 2010), as well as numerous mollusks, crabs and seed shrimp (Crustacea: Ostracoda) (Plumptre et al. 2003).

The movement of fish and other animals within Lake Albert is currently not understood, nor is the movement of fish and other animals into and out of the lake (for example, see Campell et al. 2005, Wandera and Balirwa 2010). Nevertheless, certain species, notably *Angara*, *Ngassa*, African Butter Catfish (*Schilbe niloticus*), and African Catfish (*Clarias lazera*) do make lateral movements within the lake to shallow waters in bays and up river systems to breed (Akinyi et al. 2010a, Azeroual et al. 2010c, e, Lalèyè et al. 2010), and these breeding movements tend to be seasonally based (Kusnierz et al. 2014). How far these species travel within the lake to reach their preferred breeding areas is not known. However, given that there are only a few major river systems entering the lake that would be suitable for breeding, and the afore-mentioned species are caught throughout the lake (see Taabu-Munyaho et al. 2012), it is conceivable that individuals would travel large distances within the lake to breed. Likewise, juveniles would disperse widely within the lake.

Based on the above, and the fact the CHAA supports important breeding habitat for fish (that is, river mouths, lagoons, near-shore waters of large bays, and rocky areas (after Wandera and Balirwa 2010)), it is possible that the near-shore habitats within the vicinity of the Buhuka Flats are an important end point, or starting point, for fish.

Key Processes and Drivers of Change

As mentioned, Lake Albert is primarily fed by the Victoria Nile and the Semliki Rivers. Certainly, in the case of the Victoria Nile, and many of the other rivers and streams feeding the lake, these flow through areas of high agricultural activity. Consequently, it can be expected that these rivers carry with them high levels of nutrients and other contaminants. Certainly, Wandera (2000) and Wandera and Balirwa (2010) identified that agricultural run-off was having real effects on increasing the nutrient levels of the lake, a process known as eutrophication.

Intense fishing pressure from commercial and artisanal fisheries has led to the decrease in populations of many of the commercially important species of the lake. Available data suggest that the overall shape of Lake Albert's food web is triangular, dominated by predatory species like the Nile Perch and *Ngassa* at the top, and the various tilapia species, *Ragoge* and *Muziri* forming the broader base (Campbell et al. 2005). As noted by Campbell et al. (2005), the Nile Perch has undergone dietary shifts suggesting that recent overfishing of it and its prey species may be changing the nature of the entire food web within the lake, and ultimately the ecosystem integrity. Another observation by Wandera and Balirwa (2010) was the shift towards increased catches of *Ragoge* and *Muziri* in recent times. These workers suspected that this shift was due to the decreased populations of larger species, and the consequent reduced catches of those species. With the increased pressure on *Ragoge* and *Muziri* populations (which are food species for the larger species, and the main predators of zooplankton, especially Cyclopoid copepods (Green 1971)), it is not unreasonable to assume that the fish community within the wider lake may change in the long-term.

The fishing activities based out of the 11 fishing villages in the CHAA and vicinity (that is, five on the Buhuka Flats, with six located to the north and south of the Buhuka Flats), undoubtedly put pressure on the local fish populations. Indeed, apart from the published accounts of the decrease in commercial fish stocks (Wandera 2000, Wandera and Balirwa 2010, Taabu-Munyahu et al. 2012), anecdotal accounts from the local fisher-folk also identify noticeable decreases in catches of fish per unit effort (Social Impact Assessment).

Likewise, the presence of approximately 22,000 people on the Buhuka Flats and other nearby villages (Golder Associates 2014e) who do not have access to running water and sanitation, will put large pressures on the nutrient loading of the inflowing lake waters of the LSA.

Despite the current human population of the Buhuka Flats and LSA, the near-shore aquatic environment was generally healthy (as reflected by the water quality, and the phytoplankton and zooplankton communities, in particular the Copepod crustacean communities – see Section 6.2). The notable exception was the Bugoma Lagoon. Here the water quality parameters and zooplankton communities reflected an environment with a high nutrient load and stagnant water. However, this was expected given that this wetland was isolated from the lake, possibly due to the lack of significant surface water inflow (at the time of sampling) and the resident Hippopotamus population. It is expected that the water quality, and the associated zooplankton diversity, in the Bugoma Lagoon will improve as inflow increases during the rainy season (Surface Water). As such, it is plausible that the health status of this system will fluctuate between the seasons, driven by increased water flows in the rainy season, and the subsequent drying in the dry season. These seasonal effects will be observed for all the wetlands in the CHAA (see Section 6.3.1.2.3).

Current climate change models predict that Uganda is likely to experience more extreme periods of intense rainfall, an erratic onset and cessation of the rainy seasons and more frequent episodes of drought (GCCA 2012). An overall increase of approximately 180 mm per annum is predicted, which will result in a mean annual rainfall for the CHAA of 880 mm to 1580 mm for the period 2020 to 2039 (Golder Associates 2014b). Current records of the lake's water level indicate that it varies by approximately 4 m every year, as influenced by rainfall (Surface Water). How this increased rainfall could influence that water level of the lake is unknown.

Within the CHAA, the main drivers of change influencing the near-shore aquatic habitats derive from the human population exerting pressure on fish stocks, including catching breeding individuals (Golder Associates 2014e), and polluted run-off from the 11 villages in the area. There has been a substantial increase in the local population over the past 10 years, driven by a multitude of factors such as regional instability, attractive livelihood opportunities to engage in fishing on Lake Albert, and more recently, interest in capitalising from opportunities related to oil and gas developments (Social Impact Assessment).

Representativeness

The majority of the aquatic habitats within the CHAA are represented widely around the lake. Within the southern section of the Ugandan side of the lake, from the northern end of Kaiso-Tonya Community Wildlife Area in the north, to the Uganda-Democratic Republic of Congo (DRC) border in the south (approximately 210 km of shoreline), shallow river-associated waters comprise ~14 km (7%) of shoreline, and include the mouths of, amongst others, the Wasi River, the Muzizi River, the Nkussi River, the Masika River, and a number of others. Open sandy shores account for ~68 km (32%), lagoons (including the wetland systems of the Wasi and Muzizi Rivers) account for ~54 km (26%), large bays account for ~13 km, and rocky escarpments account for ~25 km (12%).

Based on these figures, the CHAA supports 3% (0.4 km) of the shallow river-associated waters, 13% (8.5 km) of the open sandy shore habitat, 2% (1.2 km) of the lagoons, 14% (1.8 km) of large bays, and 7% (1.6 km) of rocky escarpment (Figure 14). Of particular significance is the lagoon, which, according to Wandera and Balirwa (2010), is only one of six such lagoons in the lake.

Resilience and Stability

Lake Albert is approximately ~5500 km^2. Given its size, the buffering effect of the large water body, it is expected to be reasonably resilient and stable.

Overall Condition

Based on the findings of the baseline studies, the condition of the near-shore habitats of Lake Albert in the CHAA are near pristine. Despite the pressures of local the local population and their associated fishing activities, these habitats are still in a natural state and support health populations of phytoplankton, zooplankton, macro-invertebrates and fish. Some localised areas, particularly around the fishing villages are slightly degraded due to polluted run-off and gross pollution.

7.1.2   Escarpment Vegetation Corridors

The escarpment supports natural vegetation bounded on the east by highly modified subsistence agricultural landscapes, and the Buhuka Flats and Lake Albert on the west. The vegetation communities form part of a continuous strip of vegetation to the south and to the north.

Composition

Within the CHAA, the vegetation communities on the escarpment are composed of a mix of the described vegetation communities of the area. Four communities dominate; comprising 66%, that is, open wooded grassland (28%), followed by dense wooded grassland (23%), dense bushland (14%), and riverine bushland (10%). The remaining communities make up the rest. These form a continuous corridor of vegetation of approximately 2443 ha within the CHAA, which is bounded on the east by agriculturally modified landscapes, and the Buhuka Flats on the west (Figure 11).

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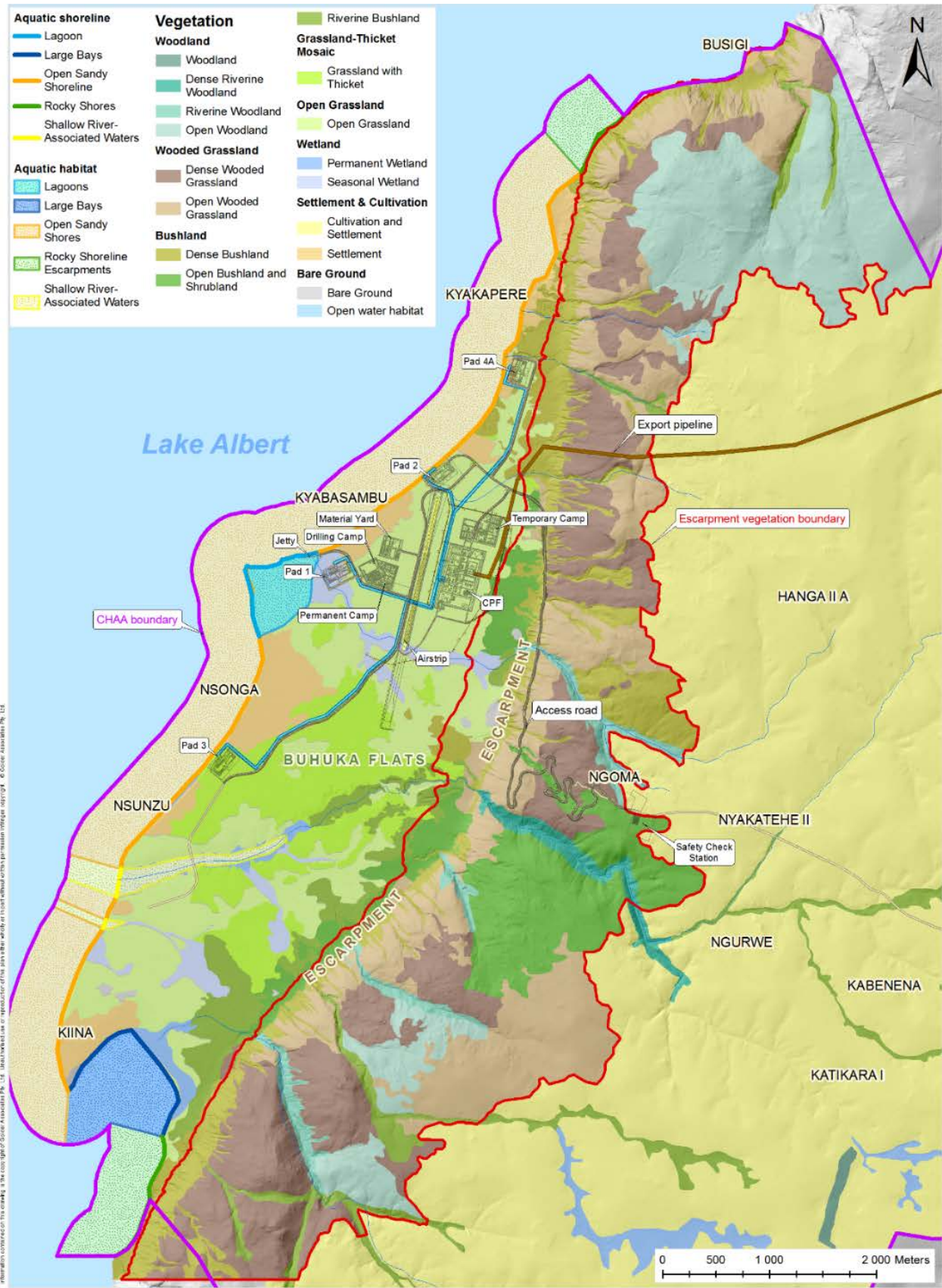
Figure 11: Escarpment vegetation communities

Structure

The vegetation communities form a diverse mosaic of habitats across the escarpment, with 15 different communities represented (Table 2).

Table 2: Extent of escarpment corridor vegetation communities within the CHAA

Escarpment corridor vegetation communities	Area (Ha)
Dense Bushland	337.7
Dense Riverine Woodland	28.3
Dense Wooded Grassland	589.0
Grassland with Thicket	5.2
Open Bushland and Shrubland	71.5
Open Grassland	31.5
Open Wooded Bushland	214.0
Open Wooded Grassland	552.2
Open Woodland	85.2
Open Woodland/Dense Bushland	353.2
Riverine Bushland	89.7
Riverine Woodland	69.8
Riverine Woodland and Bushland	2.9
Seasonal Wetland	5.1

The vegetation communities appear to be driven by landscape and geology. For example, open wooded grassland and dense wooded grassland tend to be restricted to the crest of the escarpment; dense bushland tends to be restricted to the steep slopes; with the watercourses support riverine communities.

Linkages and Corridors

In the regional context, these vegetation communities contribute to maintaining the continuity of the many high-priority conservation sites within the wider Albertine Graben. These corridors are also recognised as important for the maintenance of the evolutionary processes unique to the Albertine Graben (Ayebare et al. 2013).

On the local scale, within the CHAA, the escarpment is an important habitat for many species recorded in the LSA. It not only forms a continuous corridor along the length of Lake Albert, but it also offers important refugial sites for many of the small mammal species; notably the cavity and cave roosting bat species.

Key Processes and Drivers of Change

Within the CHAA, the main drivers of change influencing the vegetation communities along the escarpment are from livestock grazing, fuel wood harvesting, charcoal manufacture and the conversion of natural vegetation for subsistence agriculture. As mentioned, this is particularly noticeable between the current vegetation on the escarpment and the Bugoma Central Forest Reserve (see Figure 4).

The keeping of livestock forms a substantial component of the local socio-economic structures in the CHAA, particularly on the Buhuka Flats (Golder Associates 2014e). Livestock numbers are large and there is strong evidence for overgrazing on the Buhuka Flats extending up onto accessible regions of the escarpment corridor.

Large trees on the escarpment are becoming rarer as these individuals are selectively harvested for the manufacture of charcoal, which is typically on-sold. Smaller woody species are regularly harvested for fuel wood used directly in the fishing villages.

The harvest of fibre and other house construction materials is common on the escarpment. For example, thatching grass is regularly harvested on the escarpment and transported to the local fishing villages (Figure 12).

Figure 12: 'Chutes' used for transport of thatching grass harvested from the escarpment

The occurrence of frequent fires was also evident on the escarpment. Too-frequent fire is known to detrimentally affect the functioning and processes of savanna ecosystems (Smith et al. 2013).

The condition of the vegetation communities on the escarpment suggests that all these processes are contributing to changes in their composition and structure. In particular, encroachment of bushland into the grassland and woodland communities appears to be quite frequent. Bush encroachment is a typical consequence of changed land use practices like intense livestock grazing and removal of large, ecosystem engineer species like African Elephant (Wigley et al. 2009). Nevertheless, local communities often prefer these changes because they result in increased woody resources for building and firewood and increased browse availability for goats (Wigley et al. 2009). Consequently, in the long-term, a positive feedback loop could result in these communities becoming completely transformed.

Representativeness

The vegetation communities of the escarpment form part of a contiguous vegetation corridor, extending for approximately 70 km, from the Toro-Semliki Wildlife Reserve in the south, to the Kabwoya Wildlife Reserve in the north. This corridor is part of the wider Murchison Falls National Park-Budongo-Bugoma-Kagombe-Itwara Forest Reserves-Semliki/Toro Wildlife Reserve corridor (Plumptre et al. 2007). This corridor is recognised as being of regional importance for savanna species, and potential climate refugia in the future (Ayebare et al. 2013).

Resilience and Stability

The natural vegetation along the escarpment is under increasing pressure from surrounding land uses (that is, subsistence agriculture) and increased population pressure. The condition of the vegetation communities on the escarpment suggests that all the current divers of change are contributing to changes in their composition and structure. In particular, encroachment of bushland into the grassland and woodland communities appears to be quite frequent. Bush encroachment is a typical consequence of changed land use practices like intense livestock grazing and removal of large, ecosystem engineer and keystone species like African Elephant (Wigley et al. 2009). Nevertheless, as previously mentioned, local communities often prefer these changes because they result in increased woody resources for building and firewood and increased browse availability for goats. Consequently, in the long-term, a positive feedback loop could result in the frequency of open grassland and wooded communities becoming transformed to dense bushland and shrubland.

Overall Condition

Based on the findings of the baseline studies, and more up-to-date knowledge of the current pressures on the escarpment vegetation communities since the opening of the escarpment road, the overall condition of vegetation communities on the escarpment in the CHAA are slightly to moderately degraded. The combined pressures of livestock grazing, natural resource harvesting and frequent fire indicate that the composition of these communities are changing.

7.1.3 Wetlands and Riparian Habitats

The CHAA supports permanent wetlands and seasonally flooded grasslands, and riverine forest associated with riparian watercourses. These habitats form potentially important habitat for species of concern; in particular, Grey Crowned Crane, Madagascar Pond Heron and migratory birds.

Composition

The seasonal or permanent nature of the wetland communities of CHAA tended to determine the species composition. Seasonal wetlands were comprised largely of *Cyperus articulatus* and sparse *Typha* sp., while the permanent wetlands were largely composed of *Cyperus papyrus*, *Phragmites mauritianum* and *Typha capensis* (see Section 6.1.1.1).

In the pipeline region of the CHAA, the mainly seasonal watercourses support a riverine woodland vegetation community that is dominated by Acacia species, with *Crateva* sp. *Acalypha* sp. *Tamarindus indica*, and *Rhus natalensis* also occurring in the canopy layer, and an understorey dominated by *Grewia trichocarpa* and *Azima tetracantha*.

Structure

The seasonally flooded grassland communities had a very simple structure that, as mentioned, is largely determined by the water inundation frequency. The vegetation typically dies back during the dry season, and undergoes vigorous growth during the wet season. Consequently, the vegetation is dominated by short species that are quick growing. The underlying soils also form a determinant of these wetlands, with all the seasonally flooded areas being underlain by black cracking clays (Vertisols) (Golder Associates 2014d).

The permanent wetlands are dominated by tall growing species, such as *Phragmites* sp. and *Typha* sp. These species tend to be perennial and do not die back during the dry season. As such, the permanent wetlands maintain a dense, tall and emergent vegetation cover throughout the year.

The riverine forest associated with the riparian watercourses are characterised by an upper storey canopy layer that does not interlock and remains open, with a relatively structurally-homogenous herbaceous layer beneath.

Linkages and Corridors

The wetlands of the CHAA are typically part of larger watercourses that drain the area. For example, the Masika River forms permanent wetlands along it lower reaches on the Buhuka Flats, while the Kamansinig River forms seasonally flooded grasslands on some of its lower reaches.

Although these wetlands are restricted to the particular watercourses of the CHAA, they do form stepping-stone habitats for wetland species moving up and down the Albertine Graben. In particular, migratory bird species. The Albertine Rift is an important stopping point for migratory birds during their annual migration, between October and March, from Europe and Asia (Byaruhanga et al. 2001).

The larger permanent wetlands along the pipeline route form part of a more extensive network of wetlands on the plateau, many of which connect to those in the Bugoma Central Forest Reserve.

Key Processes and Drivers of Change

Currently, the wetlands of the CHAA appear to be functioning and stable. Water flows into, and through, the permanent wetlands of the CHAA appear to follow the natural wet-dry season cycles. This is reflected in the seasonal differences in the water quality data, and seasonality of particularly the insects and other animals of the wetlands (see Section 6.2.1 and 6.2.4, respectively). Seasonal water flows through these wetlands are important for flushing nutrients through the system and adding nutrients to the system. This is especially evident in the Bugoma Lagoon. The changes in the zooplankton in the lagoon, and the dominance of rotifers, could be due to the lack of flow and connectivity with the lake during the dry season.

An exception is the seasonally flooded grasslands associated with the Kamansinig River. The road leading from the foot of the escarpment and the borrow pit has noticeably influenced the flow regimes and drainage patterns of this wetland. The wetland on the western side of the road appears to have been altered and no longer fully functional (see Figure 19). This is a good example of how surface and sub-surface flows are important to maintaining a wetland's functionality and processes.

The permanent wetlands of the CHAA are important sources of fibre for house construction and container manufacture. This is especially evident in those wetlands close to human settlements, such as those along the pipeline route and the lower Masika River. Given their use as fibre sources, the frequency of human-induced fire in these wetland communities appears to be reduced.

Harvesting of large trees for the manufacture of charcoal is a noticeable driver in the riverine forest communities associated with the riparian watercourses within the CHAA, as well as trampling and grazing by cattle.

Representativeness

The CHAA supports approximately 1157.9 ha of wetlands, of which 85.3 ha are classified as seasonal. In addition, 840 ha of riparian vegetation communities are associated with drainage lines and riparian areas. 151 ha or 12% of all wetlands within the CHAA occur on the Buhuka Flats. The representativeness of these wetlands within the wider area is unknown; however, within the CHAA, wetlands constitute approximately 1.5% of habitats. This figure may under-represent the true extent of wetlands in the CHAA, particularly in the Bugoma Central Forest Reserve. Wetlands within that forest area were not confirmed through field investigations.

Resilience and Stability

Many factors contribute to the resilience and stability of wetlands, and those factors are dependent on the location and type of wetland (Carvalho et al. 2013). Typically, the overriding factor determining a wetland's resilience is the maintenance of the hydrological regime, and the amount of water entering and leaving the wetland. Other factors include nutrient loading, species diversity, trampling and grazing by livestock, and fire frequency (Carvalho et al. 2013).

The seasonal or permanent nature of the wetland communities of the CHAA tended to determine the species composition. Seasonal wetlands were comprised largely of *Cyperus articulatus* and sparse *Typha* sp., while

the permanent wetlands were largely composed of *Cyperus papyrus*, *Phragmites mauritianum* and *Typha capensis* (see Section 6.1.1.1).

As described, the altered flow of water to the seasonally flooded grasslands on the western side of the road leading from the escarpment has noticeably affected the functioning of the portion of the wetland downstream of the road crossing (Figure 19). It is unknown whether reinstatement of those flows would resurrect those wetlands. Consequently, this scenario suggests that these seasonally flooded grasslands are not very resilient, and highly susceptible to changes in water flow patterns. Additionally, these wetlands appear to be favoured by livestock for grazing. This is possibly because the conditions within the wetlands support lush vegetation growth during the wet season, which persists well into the dry season. Consequently, this grazing pressure and trampling may be adversely influencing the species composition of these habitats.

The permanent wetlands are associated with the larger watercourses in the CHAA. Therefore, these wetlands could be reasonably resilient provided the flow volumes of those watercourses are maintained. Livestock grazing in these wetlands has intensified since the opening of the escarpment road (Figure 13); hence, trampling and overgrazing are expected to affect the resilience and stability of these systems. These permanent wetlands are dominated by *Phragmites* sp. and *Typha* sp.; these plants are known to be very resilient to pollution and increased nutrient levels. Indeed, members of these taxa are very efficient at removing pollutants from water and are used to treat polluted water in constructed wetlands (Vymazal 2011).

Figure 13: Cattle watering at Kamansinig crossing, Buhuka Flats (Nov 2017)

The macro-invertebrate communities within the permanent wetlands are susceptible to changes in water quality, and the composition of these communities change with the seasons (see Section 6.2.3 and 6.2.4). However, these seasonal changes in these communities appear to be part of the natural cycle of these wetlands.

Overall Condition

Based on the findings of the baseline studies, and more up-to-date knowledge of the current pressures on wetlands in the Buhuka Flats, the overall condition of the wetlands in the CHAA are slightly to moderately degraded due to pressures of livestock grazing and natural resource harvesting.

7.1.4   Bugoma Central Forest Reserve

The Bugoma Central Forest Reserve is widely recognised for its biodiversity importance. For example, it is one of a handful of forests that constitute a network and corridor of critical biodiversity sites in Uganda, and supports populations of, amongst other species, Eastern Chimpanzee (*Pan troglodytes schweinfurthii*), African Elephant (*Loxodonta africana*), Nahan's Francolin (*Ptilopachus nahani*), as well as a variety of endemic birds and butterflies (NEMA 2010). It is also: the source of numerous rivers in the region, including the Nguse and Rutowa Rivers (NEMA 2010); and an Important Bird Area (BirdLife International 2014a). Of the 65 forested protected areas surveyed for biodiversity in Uganda, Bugoma Central Forest Reserve ranked 11 in overall biodiversity value, and 15 in terms of rarity value (BirdLife International 2014a). For a more detailed assessment and other studies on this forest's biodiversity and biogeographical importance, see, for example: Plumptre et al. (2010, 2011), and Ayebare et al. (2013). Hence, a very limited description is provided here, with only important features, as they relate to the potential effects of the Project, discussed.

Composition and Structure

This forest is a medium altitude, moist, semi-deciduous forest with a high biodiversity. About half of the forested portion of the Bugoma Central Forest is dominated by Iron Wood (*Crynometra alexandri*); a further 38% is mixed forest (BirdLife International 2014a). Two-hundred-and-fifty-seven species of trees and shrubs have been recorded in the forest, seven of which are Albertine Rift endemics, 12 are globally threatened and 14 are listed in IUCN red list (Plumptre et al. 2003, 2010, 2011).

Linkages and Corridors

The Bugoma Central Forest Reserve is recognised as being an important part of the wider Murchison Falls National Park-Budongo-Bugoma-Kagombe-Itwara Forest Reserves-Semliki/Toro Wildlife Reserve corridor (Plumptre et al. 2007). However, it is disconnected from other forest reserves, such as Budongo Central Forest Reserve, and is bordered by subsistence agricultural communities and settlements that are placing increased pressure on it (NEMA 2010, Plumptre et al. 2010, 2011).

Key Processes and Drivers of Change

While the Bugoma Central Forest Reserve is a reserve for timber resources, and harvesting of timber is reportedly undertaken on a sustainable basis (NEMA 2010); it is not a designated *wildlife* protected area. Given the increased human population around the forest, there have been increased incidents of illegal logging, fire wood collection and charcoal manufacture, and bush meat harvesting (NEMA 2010, Plumtptre et al. 2010). Between 2011 and 2012, increased immigration into the areas surrounding the forest resulted in increased deforestation, with an estimated 5,000 ha of the forest subject to encroachment by about 1,000 families and pit-sawyers (AECOM 2013). Recent reports of illegal logging of hardwood timber, and illegal land clearance in Bugoma CFR with the intention of transformation for sugarcane plantations (ACBF, 2016) suggest that pressure on the reserve has increased substantially.

Many of the tree species within the forest require elephants or large primates to disperse their seeds. With the declining populations of these species, particularly elephants, many tree species are declining (Plumptre et al. 2010).

Representativeness

This forest is one the last large tracts of remaining medium altitude, moist, semi-deciduous forest in western Uganda (Plumptre et al. 2010, 2011). The CHAA encompasses the entire Central Forest Reserve of approximately 401 km^2.

Resilience and Stability

Given the Bugoma Central Forest Reserve's size (approximately 401 km^2), it should be relatively resilient and stable from disturbance. However, the forest, and the populations of species it supports, is under intense pressure from the surrounding human population. What the long-term effects of the increase in the human population around the forest (see Golder Associates 2014e, h), including the illegal settlements within the forest (see Mugerwa 2013), could have on the forest are unknown, but are expected to be damaging to the resilience and stability of the forest. This forest is isolated from other forests in the region, and is being eroded on the outer edges (see Figure 4).

Overall Condition

Based on the findings of the studies and research conducted by others, the overall condition of the Bugoma Central Forest Reserve is slightly degraded to moderately degraded due to pressures of illegal logging, natural resource harvesting, and the current human pressures surrounding the forest.

7.2 Species of Concern

APPENDIX F provides the details of the critical habitat screening and appraisal of species of concern that could occur in the CHAA.

The information and data reviewed, together with the baseline field surveys, identified that the CHAA (Figure 2) supports a diverse and rich species assemblage, with numerous species of concern potentially occurring in the area. Based on those reports and surveys, the CHAA has the potential to support a possible 96 species of concern (excluding invasive species, which are discussed in Section 7.2.5), as per the definitions in Section 3.2.3. These include: six plant species; two macro-invertebrate species; 14 fish species; two butterfly species; one dragonfly and damselfly species; three amphibian species; nine reptile species; 44 bird species; and 14 mammal species (APPENDIX F). Forty-six of those species were recorded during the field surveys (APPENDIX B and APPENDIX C).

7.2.1 Threatened, Range-Restricted/Endemic and Statutory Species

Overall, the CHAA has a potential to support populations of seven globally recognised Critically Endangered and Endangered species (one Critically Endangered macro-invertebrate (the Mud Snail (*Gabbiella candida*), four Endangered birds (Madagascar Pond-Heron, Grey Crowned-Crane (*Balearica regulorum*), White-backed Vulture (*Gyps africanus*), Hooded Vulture (*Necrosyrtes monachus*)), one Endangered mammal (Eastern Chimpanzee (*Pan troglodytes schweinfurthii*)). The CHAA supports the range-restricted Nahan's Francolin (*Ptilopachus nahani*) which was down-listed from Endangered to Vulnerable in 2017 (IUCN 2017); and potentially supports five populations of other globally recognised Vulnerable birds and four populations of mammals; as well as one Near Threatened tree, one macro-invertebrate, 12 birds and four mammals (APPENDIX F).

Of these, 23 species (one Critically Endangered, three Endangered, five Vulnerable, 14 Near Threatened), could occur in the LSA, and hence potentially be affected by direct Project impacts. A further nine species (one Endangered, six Vulnerable, two Near Threatened) could occur in the CHAA, and hence potentially be affected by indirect, induced and cumulative impacts from the Project.

The CHAA also supports approximately 19 Palearctic migratory bird species that are listed under Appendix II of the Convention on Migratory Species (CMS 2014). For more details on those, and other locally important species, see APPENDIX F.

Of the above-mentioned species, those that have the potential to trigger critical habitat were carried forward for a more detailed and formal appraisal to determine if they could trigger critical habitat, as per the methods presented in APPENDIX A. That appraisal is presented in APPENDIX F, and the results are summarised in Section 6.3.2.2.

7.2.2 Species of Economic and/or Cultural Importance

Lake Albert supports a strong commercial fishing industry. As discussed in Section 6.3.1.2.1, this fishery is second in importance only to that of Lake Victoria. Within the CHAA, many of the species that form the mainstay of this fishery were recorded, or are probably present (as summarised in APPENDIX F, Table G1). These include: *Imberi*, *Angara*, *Mpoi*, African Catfish, *Ngassa*, Nile Tilapia, African Butter Catfish, Mango Tilapia, and Zill's Tilapia.

The off-shore habitats within Lake Albert form an important fishing ground for the 11 fishing villages in the CHAA and vicinity (that is, five on the Buhuka Flats, with six located to the north and south of the Buhuka Flats) (Golder Associates 2014e). As discussed in Section 6.3.1.1.1, the near-shore habitats supported in the CHAA are most likely important breeding habitats for many of the commercially important species supporting those 11 fishing villages.

Consequently, the near-shore environments of the CHAA also trigger critical habitat for Criterion 13 because these are seen to be important breeding areas for commercially important fish species, as well as important fishing grounds for those species. This near-shore habitat accounts for about 794 ha of the CHAA (Figure 5).

7.2.3   Species listed under CITES

CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) is an international agreement between governments (Uganda has been a signatory since 1991 – see Section 4.0), which has the aim to ensure that international trade in species does not threaten their survival (CITES Secretariat 2017).

The CHAA supports known populations of CITES-listed Appendix II plant and animal species. These include Aloes (*Aloe* spp.), Candelabra Tree (*Euphorbia candelabrum*), Graceful Chamaeleon, Smooth Chamaeleon, Serrated Hinge-back Tortoise, Leopard Tortoise, Nile Monitor, Nile Crocodile, Grey Parrot, and Hippopotamus (see APPENDIX F, Table G1). Other CITES-listed Appendix II species that may occur in the CHAA, yet have not been recorded, include the Secretarybird, White-bellied Pangolin, African Golden Cat, and Giant Ground Pangolin (APPENDIX F, Table G1; UNEP-WCMC 2018).

Importantly, within the CHAA, and Bugoma Central Forest Reserve in particular, CITES-listed Appendix I species have a high likelihood of occurring, or have been recorded (see Plumptre et al. 2010, 2011). These species include African Elephant, Eastern Chimpanzee and Leopard (APPENDIX F, Table G1).

CITES-listed species are grouped in the Appendices according to how threatened they are by international trade. Appendix I lists species that are the most endangered and are threatened with extinction; CITES prohibits international trade in specimens of these species, except when the purpose of the import is not commercial (CITES Secretariat 2017). Species listed in Appendix II are not necessarily threatened with extinction now, however, unless trade in these species is controlled, they could be seriously threatened (CITES Secretariat 2014). International trade in individuals of Appendix II species may be authorized by appropriate authorities when specific conditions are met, above all, that trade will not be detrimental to the survival of the species in the wild (CITES Secretariat 2017).

The populations of the CITES-listed species potentially and actually occurring in the CHAA are not precisely known. Indications are that the certain species are relatively common, for example Aloe and Candelabra Tree (Figure 4b), while others, such as African Elephant may be very uncommon (see Plumptre et al. 2010).

7.2.4   Evolutionarily Distinct Species

This section identifies those species of concern that could trigger critical habitat for Criteria 5 under the IFC's definitions (IFC 2012a). As discussed in Section 3.3.3.1.2, critical habitat for key evolutionary processes does not have quantitative thresholds (for example, see IFC, 2012a). Therefore, for the purposes of this impact assessment, expert opinion was used to identify critical habitat with respect to evolutionarily distinct species as indicators of the landscape-level features that can influence key evolutionary processes.

The Albertine Rift is known as a centre of endemism driven by unique evolutionary processes; indeed, it is the most species rich region in Africa for vertebrates (Plumptre et al. 2003, 2007). It is also a recognised Endemic Bird Area (Stattersfield et al. 1998), testament to a collection of unique species derived from a set of unique evolutionary processes. Lake Albert too is a recognised centre of endemism within the Albertine Rift, and is of biogeographical significance for a number of taxa and species, in particular snails (Plam et al. 2008) and fish (Wandera and Balirwa 2010).

At the species level, Criterion 5 applies for "distinct species", which include those termed Evolutionarily Distinct and Globally Endangered (EDGE) species (GN 95 IFC 2012b, Jetz et al. 2014, ZSL 2014). Jetz et al. (2014) define evolutionary distinctness as a measure of "a species's contribution to the total evolutionary history of its clade and is expected to capture uniquely divergent genomes and functions". Based on this definition, these workers identified bird species and particular regions where birds occur, that are of enormous value for protecting evolutionary diversity. Bird species with the greatest evolutionary distinctness are often located outside of areas traditionally identified as conservation priorities (Jetz et al. 2014).   Species representing the most evolutionary

Based on the works of Jetz et al. (2014), and a geographically-based search of the EDGE species database that covered the spatial extent of the CHAA (see ZSL 2017), two such EDGE species were identified as

potentially occurring in the CHAA. These were the Shoebill and Secretarybird, which are discussed and assessed in APPENDIX F.

7.2.5   Invasive and Potentially Invasive Species

The CHAA has been affected to a greater or lesser extent by human activities for a very long time. These activities have altered the landscape to a greater or lesser extent, the most noticeable being the conversion of the natural vegetation on the plateau above the escarpment to agricultural crop land (AECOM 2013). The influence of people on the Buhuka Flats is also very noticeable, the majority of the flats affected by livestock grazing, small-scale agriculture, fuel wood harvest, and building material collection.

As identified in Section 6.1.1, five invasive species were recorded in the LSA, they tended to be localised, and uncommon, although within certain areas, local populations were high (Figure 14). Three of these, the Giant Sensitive Tree (*Mimosa pigra*), Lantana (*Lantana camara*) and Water Hyacinth (*Eichhornia crassipes*) were the commonest species recorded, predominantly on the Buhuka Flats and the shore of Lake Albert (APPENDIX C). These species are recognised as some of most noxious weeds in the world (Lowe et al. 2000).

Other species recorded include: Water Lettuce (*Pistia stratiotes*) (in a wetland community on the Buhuka Flats, where it was locally abundant); and Castor Oil Plant (*Ricinus communis*) (recorded from wetland and woodland communities).

Other potentially invasive species to note were Neem (*Azadirachta indica*), Jatropha (*Jatropha curcas*) and Parkinsonia (*Parkinsonia* sp.). It is noted that many of these species have been planted by the local communities and offer important cultural and other ecosystem services.
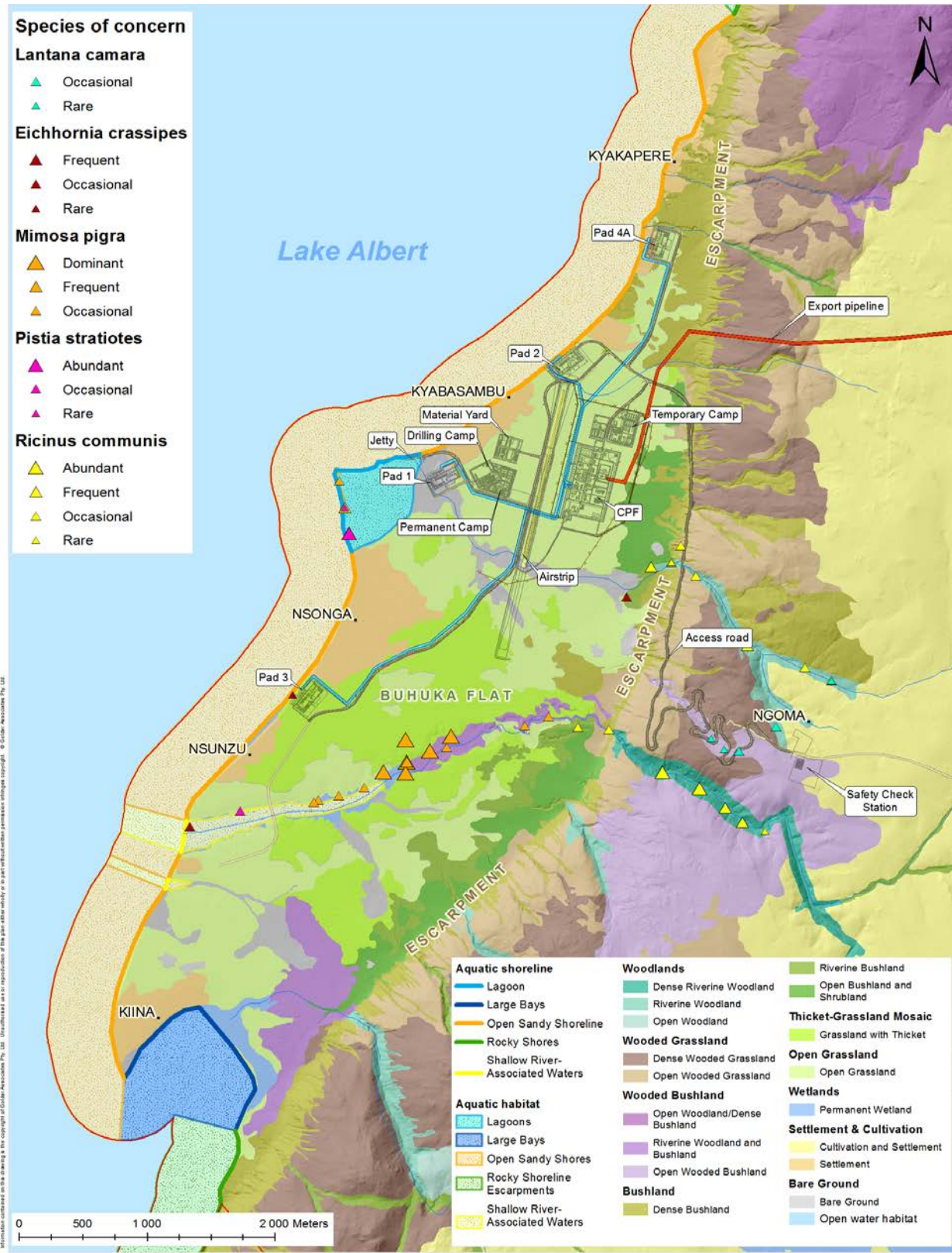
Figure 14: Invasive species recorded on the Buhuka Flats

8.0 NATURAL AND MODIFIED HABITAT WITHIN THE CHAA

An assessment and identification of the natural and modified habitats was restricted to the CHAA (Figure 2). The results of the assessment are summarised in Table 2.

Table 3: Natural and modified habitat in the CHAA

Habitat	Area (ha)	Area (km^2)	Proportion of CHAA
Modified	12,944	129.4	16%
Natural	68,303	683.0	84%

The majority of the Buhuka Flats and the escarpment is natural habitat, while the pipeline route is dominated by modified habitat (Figure 15). In the case of the Buhuka Flats, although this area is inhabited (including the villages of Kiina, Nsunzu, Nsonga Kyabasambu, Kyakapere) and under pressure from subsistence agriculture and livestock grazing, a large proportion of the flats is dominated by natural vegetation communities. These include, amongst others: thicket-grassland mosaic, open grassland, bushed grassland, and Wetlands (see Section 6.1.1.1, and Figure 4a and b). Of interest is the connectivity of the natural habitat that occurs on the Buhuka Flats and the escarpment. These habitats form part of the wider Murchison Falls National park-Budongo-Bugoma-Kagombe-Itwara Forest Reserves-Semliki/Toro Wildlife Reserve corridor (Plumptre et al. 2003) (see Section 6.3.1.2.1).

The plateau above the escarpment is markedly different. Here the area has been largely transformed into cropland and plantations, interspersed with settlements and patches of natural habitat, comprised largely of wetlands (see

Figure 6).
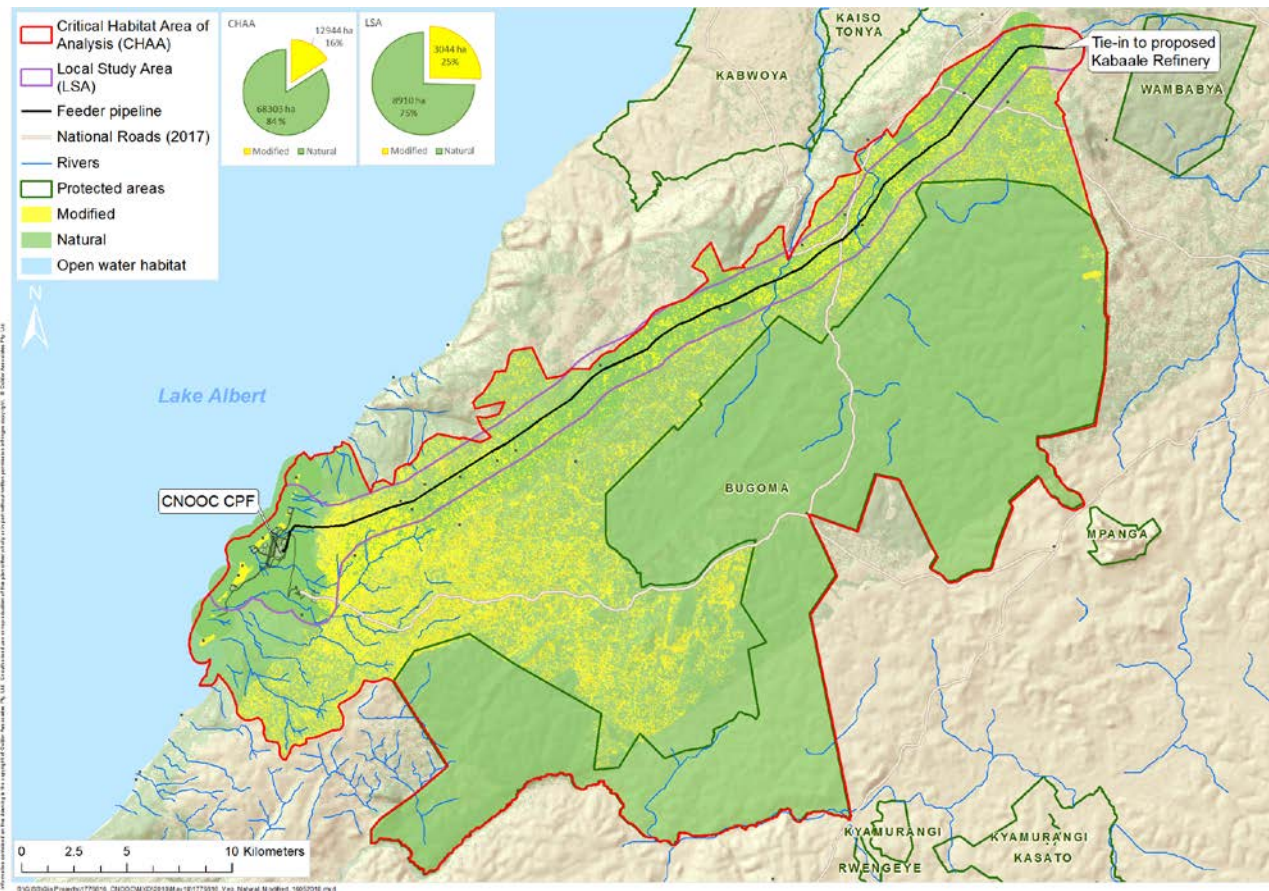
Figure 15: Natural and Modified habitat in the CHAA

9.0   CRITICAL HABITAT WITHIN THE CHAA

APPENDIX F presents the screening and assessment of all species of concern that could trigger Criterion 1, 2, 3 and 5 critical habitat within the CHAA, as per the methods presented in APPENDIX A. Ecosystems that could trigger Criterion 4 critical habitat are discussed in Section 9.1.2.

As discussed, quantitative thresholds for critical habitat are available for Criteria 1 to 3. No such thresholds exist for the other criteria. Therefore, a qualitative assessment of the remaining criteria for valued components of the CHAA was undertaken.

9.1   Assessment of Potential Triggers of Critical Habitat

The short-list of possible triggers of critical habitat that are likely to occur in the CHAA, derived from the critical habitat screening exercise (see APPENDIX F) are discussed in detail in the sections that follow.

9.1.1   Species Potentially Triggering Criterion 1, 2 and 3 Critical Habitat

As discussed in Section 3.2.3.3 and APPENDIX A, quantitative thresholds for distinguishing the tiers of critical habitat have been developed by the IFC for Criteria 1 to 3. Part of these thresholds require the need to have a reasonable understanding or knowledge of the global populations of species that could trigger those criteria, as well as knowledge of their global distributions (EOO) and occupancy (AOO).

Very few of the species assessed against the screening criteria (see Table G1) had detailed population-level information available or detailed distribution records. Nevertheless, some did have the required information. Where spatial data for EOO and AOO were available (as derived from the IUCN (2017) and other references), these were used as the species' distribution owing to a need to quantify the amount of overlap of these

distributions with the CHAA, and, in some instances, were used as a proxy for population level data to assess the values against the Tier 1 and Tier 2 triggers (APPENDIX A).

9.1.1.1 Mud Snail (Gabbiella candida)

■ Potential Critical Habitat triggered – Criterion 1 and 2

This Mud Snail is a globally listed Critically Endangered species (Table G2). It's known AOO is less than 10 km^2, around the port of Butiaba on Lake Albert, and is presumed to be endemic to this area (Kyambadde 2010a). Further surveys to understand this species's EOO have not been undertaken, yet it is possible that it could occur in a much wider area, within suitable habitat.

Two sister species (Bithyniidae: *G. humerosa* and *G. walleri*) were recorded in the LSA (see Section 3.3.2.4 of the main report, APPENDIX C). These two species have been recorded in the same locality and habitat that *G. candida* was recorded (GBIF 2017). Therefore, it is conceivable that it could occur within the CHAA within suitable habitat.

Major threats to this species include declining habitat quality due to erosion and silting from agriculture and water pollution (Kyambadde 2010a).

Although this species has not been recorded in the CHAA, and its known AOO (that is Butiaba, about 90 km north of the Buhuka Flats) is not within the CHAA, this species may occur in the near-shore habitats off the Buhuka Flats. Suitable, near-shore aquatic habitat within the CHAA (see Section 6.3.1.1.1) for this species includes the Bugoma Lagoon (33.2 ha), large bays (73.7 ha), open sandy shores (554.8 ha) and shallow river-associated water (37.2 ha), totalling approximately 699 ha (Figure 5).

Table G2: Population details for the Mud Snail

Global listing*	Critically Endangered
National listing	Not listed
Restricted range*	Yes
Migratory or congregatory	No
Discrete Management Unit	CHAA (814 km^2)
Global population*	Unknown
Global EOO*	10 km^2
Global AOO*	10 km^2
Regional/national population*	Unknown
Regional/national EOO*	10 km^2
Regional/national AOO**	10 km^2
Number of global discrete management units	1 (Butiaba Port)

* Kyambadde (2010a)

Although the Mud Snail has not been recorded in the CHAA, there is a potential that it could occur, due to the presence of potentially suitable habitat. Assuming it potentially could occur in the wider Lake Albert, within suitable habitat, and knowing that it is endemic to Lake Albert, its EOO and AOO could be less than 5000 km², based on the total area of Lake Albert (5,335 km²) and the availability of suitable habitat (that is, less than 18 m water depth) (after Kyambadde 2010b). Within the CHAA, suitable habitat for this species only occurs in the near-shore aquatic habitats, which total about 8.5 km^2. Using the EOO (that is, 5000 km^2) as a proxy for the global population for this species (see reasoning above), then the 8.5 km^2 of potential habitat within the CHAA equates to 0.2% of this species population potentially occurring in the CHAA.

Hence, applying the quantitative and qualitative triggers for Criterion 1 and 2 critical habitat (APPENDIX A, Table B1) to these derived population details for this species identifies that it does not trigger Criterion 2. However, there is a potential that it could occur in the CHAA, hence, because it is a Critically Endangered

species, and taking a precautionary approach, <u>this species has been assessed as triggering Criterion 1 Tier 2 critical habitat within the CHAA</u>.

9.1.1.2   Snail (Bellamya rubicunda)

Potential critical habitat – Criterion 2

This Snail is globally listed as Near Threatened (Table G3). It is an endemic, range restricted species, known only from Lake Albert (Kyambadde 2010b). Given that it is endemic to Lake Albert, its EOO and AOO is less than 5000 km² , based on the total area of Lake Albert (5,335 km²) and the fact the species only occurs down to a maximum of 18 m depth (Kyambadde 2010b). Accordingly, it is also close to meeting the IUCN's Endangered category (IUCN 2014); however, current known locations and threats appear to be localised and dispersed (Kyambadde 2010b).

A sister species (Viviparidae: *B. unicolor*) was recorded in the CHAA (see Section 3.3.2.4 of the main report, and APPENDIX C). This species has been recorded in the same locality and habitat that *B. rubicunda* was recorded (GBIF 2014). Therefore, it is conceivable that it could occur within the CHAA within suitable habitat.

Major threats to this species include declining habitat quality due to erosion and silting from agriculture and water pollution (Kyambadde 2010b).

Although this species has not been recorded in the CHAA, its EOO and AOO (that is Lake Albert) overlaps with the CHAA. Therefore, it is conceivable that this species may occur in the near-shore habitats off the Buhuka Flats. Suitable, near-shore aquatic habitat (see Section 5.3.1.1.1 of the main report) within the CHAA for this species includes: the Bugoma Lagoon (33.2 ha); large bays (73.7 ha); open sandy shores (554.8 ha); and shallow river-associated water (37.2 ha); totalling approximately 699 ha, or ~7 km^2 (Figure 12 of the main report).

Table G3: Population details for the Snail

Global listing*	Near Threatened
National listing	Not listed
Restricted range*	Yes
Migratory or congregatory	No
Discrete Management Unit	CHAA (814 km^2)
Global population*	Unknown
Global EOO*	5000 km^2
Global AOO*	Unknown
Regional/national population*	Unknown
Regional/national EOO*	5000 km^2 (Lake Albert) ~7 km^2 of 814 km^2 (CHAA)
Regional/national AOO**	Unknown
Number of global discrete management units	Unknown

* Kyambadde (2010b)

Although the Snail has not been recorded in the CHAA, there is a potential that it could occur, for the above reasons. Within the CHAA, suitable habitat for this species only occurs in the near-share aquatic habitats, which total about 7 km^2. Using the EOO (that is, 5000 km^2) as a proxy for the global population for this species (see reasoning above), then the 7 km^2 of potential habitat within the CHAA equates to 0.1% of this species population potentially occurring in the CHAA.

Hence, applying the quantitative and qualitative triggers for Criterion 2 critical habitat (APPENDIX A, Table B1) to these derived population details for this species identifies that it does not trigger Criterion 2. Therefore, <u>this species has been assessed as not triggering critical habitat within the CHAA</u>.

9.1.1.3   *Madagascar Pond Heron (Ardeola idae)*

■ Potential critical habitat – Criterion 1 and 3

The Madagascar Pond Heron is a globally listed Endangered species (Table G4), because of a very small breeding population limited to Madagascar that is undergoing continuing decline (BirdLife International 2017). It has a very large non-breeding range, which includes central and east Africa, including the Albertine Rift (BirdLife International 2017). Anecdotal evidence suggests that this species exhibits site fidelity and residence in suitable habitat throughout its non-breeding migratory habitat (Ndang'ang'a and Sande 2008).

Non-breeding habitat for this species includes shallow waterbodies fringed with vegetation and trees, the banks of small streams, including those inside forest (BirdLife International 2017). Its diet is broad and typical of a heron this size, that is, fish, insects, small invertebrates and vertebrates (Ndang'ang'a and Sande 2008).

Major threats to this species have primarily been noted in their breeding range, and include habitat loss from clearing, draining and converting wetland habitats to rice fields (BirdLife International, 2017).

Although this species has not been recorded in the CHAA, its non-breeding EOO overlaps the CHAA (IUCN 2017). Nevertheless, based on the presence of suitable, non-breeding habitat within the CHAA (see Table G1, Figure G1), this species may occur in the wetlands and riparian habitats of Buhuka Flats (primarily the Masika River), Bugoma Central Forest Reserve, and along the pipeline corridor.

Table G4: Population details for Madagascar Pond Heron

Global listing*	Endangered
National listing**	Vulnerable
Restricted range	No
Migratory or congregatory**	Yes - CMS Appendix II, Categories 1b and 1c of the AEWA
Discrete management unit	CHAA (814 km^2)
Global population**	2000 – 6000 (1,300-4,000 mature individuals)
Global EOO[#] (non-breeding)	3,322,293 km^2
Global AOO[#]	Unknown
Regional/national population**	Unknown
Regional/national EOO**	Unknown
Regional/national AOO**	Unknown
Number of global discrete management units	Unknown

* IUCN (2017)

** Ndang'ang'a and Sande (2008)

*** BirdLife International (2017)

[#] IUCN (2014)

Although the Madagascar Pond Heron has not been recorded in the CHAA, with the nearest records around Lake Edward (~180 km south-west of the CHAA, Ndang'ang'a and Sande 2008), there is a potential that it could occur in the CHAA. Suitable non-breeding habitat for this species occurs across the CHAA, and it may not necessarily be limited to those habitats mentioned above. As such, the whole CHAA was considered to be a DMU that could support a non-breeding sub-population of this species. Furthermore, the global population of this species is estimated to be between 2000 and 6000 individuals (Ndang'ang'a and Sande 2008). The precise distribution of these individuals across the non-breeding EOO is unknown; however, Kenya and Tanzania are believed to be the core areas for its non-breeding EOO (Martínez-Vilalta et al. 2014). Therefore, a disproportionate distribution of this species across its non-breeding EOO can reasonably be assumed, with concentrations in Kenya and Tanzania (after Ndang'ang'a and Sande 2008, Martínez-Vilalta et al. 2014).

Given these uncertainties, and the lack of data, regardless of the apparent disproportionate distribution of this species across its non-breeding EOO, a conservative approach to the application of the critical habitat triggers was used. It was assumed that individuals were evenly distributed across the global (non-breeding) EOO (that is, 3,322,293 km^2), which was then used as a proxy for the global non-breeding population of this species. Hence, the 814 km^2 of the CHAA equates to <0.01% of this species' non-breeding population.

Hence, applying the quantitative and qualitative triggers for Criterion 1 and 3 critical habitat (APPENDIX A, Table B1) to the derived population details for this species, identifies that it does not trigger Criterion 1 or 3. Therefore, this species has been assessed as not triggering critical habitat within the CHAA.

9.1.1.4 *Grey Crowned Crane (Balearica regulorum)*

■   Potential critical habitat – Criterion 1

The Grey Crowned-crane is a globally listed Endangered species (Table G5) (IUCN, 2017). It has a very large range that includes central, east and southern Africa, including the Albertine Rift (BirdLife International 2017).

The largest remaining populations of this species are concentrated in the northern part of their range, where approximately 30,000 to 55,000 individuals remain; with between 4000 and 5000 birds in the southern part (BirdLife International, 2017).

In East Africa, the populations tend to have peak breeding during the dry season (BirdLife International 2017). Typically, this species nests in solitary, territorial pairs at the edges of wetlands and in marshes with water at least 1 m deep and tall, emergent vegetation (Morrison and Bothma 1998, BirdLife International 2017).

The Grey Crowned-crane's diet is broad, consisting of seed heads, growing tips of grasses, pulses, nuts and grain, and small invertebrates and vertebrates (BirdLife International, 2017).

Major threats to this species are mainly from the loss of suitable breeding wetlands, pesticide use, frequent fires, changes to hydrological regimes, egg collecting and live trade/domestication of chicks (BirdLife International 2017). In Uganda, for example, indications are that that the illegal captive trade is particularly significant (Morrison 2008, 2009 in BirdLife International 2017). Additionally, electrocution and collision with overhead power lines has been identified as a serious threat in Uganda (K. Morrison in litt. 2011, J. Harris in litt. 2012).

This species' EOO substantially overlaps with the CHAA, and it has been recorded in the CHAA, on the Buhuka Flats and along the proposed pipeline route, with 14 individuals seen during the wet season surveys (see Section 6.3.2, APPENDIX B). Suitable breeding habitat for this species (that is, permanent wetlands (Morrison and Bothma 1998, Archibald et al. 2013)), occurs on the Buhuka Flats (~84 ha) and ~83 ha occurs in the remainder of the CHAA (APPENDIX F, Figure G2). Suitable foraging habitat also occurs in the CHAA in the form of seasonally flooded grassland (73.1 ha in the Buhuka Flats and 0.6 ha along the pipeline route corridor), and open grassland (568 ha (Buhuka Flats)) (APPENDIX F, Figure G2). It is noted that In East Africa this species is most commonly found in human-modified habitats (Archibald et al. 2013). However, a model of habitat suitability for Grey Crowned Crane in Uganda (Stabach et al., 2009) indicates that the CHAA lies within an area of relatively low suitability for this species, more or less in between two key areas of habitat suitability – the southwestern portion of Uganda, and the area just north of Lake Albert along the Albert Nile river. Interestingly, these areas were correlated with having both the highest and lowest values of temperature seasonality in the country, as well as having suitable wetland habitat (Stabach et al., 2009). The importance of temperature variation in defining Grey Crowned Crane habitat suitability is further underlined by the reported threat of the loss of large tree roosting sites used by cranes for sheltering from the midday sun, a factor that may be crucial to crane conservation in warmer areas and during dry periods (Olupot, 2014).

Table G5: Population details for Grey Crowned Crane

Global listing*	Endangered, CITES Appendix II
National listing	Protected (Uganda Wildlife Bill 2017)
Restricted range	No

Migratory or congregatory*	No
Discrete management unit	CHAA (814 km^2)
Global population**	50,000 – 64,000
Global EOO#	3,561,114 km^2
Global AOO#	Unknown
Regional/national population*	13,000 – 20,000
Regional/national EOO*	Unknown
Regional/national AOO*	Unknown
Number of global discrete management units	Unknown

* IUCN (2017)

** BirdLife International (2017)

IUCN (2014)

Grey Crowned Crane has been recorded in the CHAA, with up to 14 individuals identified on the Buhuka Flats during the wet season surveys (APPENDIX B). It is possible that other individuals could occur within the wider CHAA, with a conservative estimate of between 15 and 20 individuals potentially occurring in this area at any one time, based on the relatively low habitat suitability of the CHAA modelled by Stabach et al. (2009), the transformation of the majority of the CHAA beyond the Buhuka Flats for agriculture, and the expected likely lack of suitable tree roosting sites in proximity to wetlands within the CHAA beyond the Buhuka Flats. As such, the whole CHAA was considered to be a DMU for this species that supports a sub-population of this species in the region. It could support 0.1% of the regional population (15 to 20 individuals of the Ugandan population of 13,000 to 20,000 individuals).

Hence, applying the quantitative and qualitative triggers for Criterion 1 critical habitat (APPENDIX A, Table B1) to this population identifies that it does not trigger Criterion 1. Therefore, this species has been assessed as not triggering critical habitat within the CHAA.

9.1.1.5 *White-backed Vulture (Gyps africanus)*

■ Potential critical habitat – Criterion 1

The White-backed Vulture is a globally listed Critically Endangered species (Table G6) (IUCN, 2017). It has a very large range from Senegal, Gambia and Mali in the west, throughout the Sahel region to Ethiopia and Somalia in the east, through East Africa into Mozambique, Zimbabwe, Botswana, Namibia and South Africa in the south (BirdLife International 2017). It is commonest and most widespread vulture in Africa, however, it is suffering rapid declines across much of this range (BirdLife International 2017, Kemp et al. 2014).

The White-backed Vulture is a gregarious species congregating at carcasses, in thermals and at roost sites. Indications are that this species migrates down the Rift Valley in Uganda in July (Kemp et al. 2014). Indeed, observations of this species made during the wet season survey of the CHAA (in May 2014, APPENDIX A), indicate that a group was moving down the valley.

As with most of the world's vultures, major threats to this species are mainly from the loss of wild ungulate populations, which has led to a loss in the availability of sufficient carrion, hunting for trade, persecution and poisoning, and collisions with power lines (BirdLife International 2017). In East Africa, poisoning (especially from the highly toxic pesticide carbofuran) appears to be the main problem; although this occurs mainly outside protected areas (Kemp et al. 2014). Recent research has indicated that the use of the veterinary anti-inflammatory drug, diclofenac, has resulted in dramatic declines in vulture numbers, particularly across Asia (for example, see Green et al. 2006, Harris 2013). If this situation has affected the vultures of Africa, in particular East Africa, it is unclear at this time.

This species' EOO substantially overlaps with the CHAA, and 20 individuals have been recorded in the CHAA (see Section 5.1.4 of the main report, APPENDIX B). This species prefers open wooded savannah, where it

requires tall trees for nesting (BirdLife International 2017). Nests are typically located in the crown of large trees or, less often, in an open fork, frequently along a watercourse; they can be frequently clumped in loose colonies of two to 13 nests (Kemp et al. 2014). Suitable breeding and foraging habitat for this species occurs across the CHAA (Figure G3), and includes open woodland (161.7 ha), woodland (190.4 ha), riverine woodland (69.8 ha), dense wooded grassland (554.7 ha), open wooded grassland (468.9 ha), wooded grassland (184.3 ha), open woodland/dense bushland (147.9 ha), and open wooded bushland (214.0 ha).

Table G6: Population details for White-backed Vulture

Global listing*	Endangered
National listing*	Not listed
Restricted range	No
Migratory or congregatory*	No
Discrete management unit	CHAA (814 km^2)
Global population*	270,000
Global EOO#	12,348,146 km^2
Global AOO#	Unknown
Regional/national population***	~40,000
Regional/national EOO*	Unknown
Regional/national AOO*	Unknown
Number of global discrete management units	Unknown

* BirdLife International (2017)

*** Kemp et al. (2014)

\# IUCN (2014)

The White-backed Vulture has been recorded in the CHAA, with up to 20 individuals identified soaring along the escarpment (APPENDIX B). It is possible that other individuals could occur within the wider CHAA. However, individuals of this species are very wide ranging, and are known to move up and down the Albertine Rift (Kemp et al. 2014). Therefore, it is difficult to put a precise number on the population utilising the CHAA. Regardless, the whole CHAA was considered to be a DMU for this species that supports a sub-population of this species in the region. It could support <0.05% of the regional population (20 individuals of the regional population of ~40,000 individuals).

Hence, applying the quantitative and qualitative triggers for Criterion 1 critical habitat (APPENDIX A, Table B1) to this population identifies that it does not trigger Criterion 1. Therefore, this species has been assessed as not triggering critical habitat within the CHAA.

9.1.1.6   Hooded Vulture (Necrosyrtes monachus)

■   Potential critical habitat – Criterion 1

The Hooded Vulture is a globally listed Endangered species (Table G7) (IUCN, 2017). It has a very large range, tending to be confined to sub-Saharan Africa, from Senegal and southern Mauritania, through south Niger and Chad to South Sudan, Ethiopia and Somalia, to Namibia and Botswana, Zimbabwe, Mozambique and north-east South Africa (Kemp and Christie 2013).

As with most of the world's vultures, major threats to this species are mainly from hunting for trade, persecution and poisoning (Kemp and Christie 2013, BirdLife International 2017). In Kampala, where scavenging birds were very conspicuous between the 1970s and mid-2000s, they have since noticeably decreased in numbers (Kemp and Christie 2013). Declines could also be attributed to land-use change through development, and improvements of abattoir hygiene and refuse disposal in some areas. Hooded Vultures also appear to suffer some mortality from avian influenza (H5N1), probably acquired from feeding on dead poultry (Kemp and Christie 2013). In East Africa, poisoning (especially from the highly toxic pesticide carbofuran) appears to be the main problem; although this occurs mainly outside protected areas (Kemp and Christie 2013). Recent

research has indicated that the use of the veterinary anti-inflammatory drug, diclofenac, has resulted in dramatic declines in vulture numbers, particularly across Asia (for example, see Green et al. 2006, Harris 2013). If this situation has affected the vultures of Africa, in particular East Africa is unclear at this time.

This species's EOO substantially overlaps with the CHAA; although it has not yet been recorded in the CHAA. This species prefers open woodland and savanna, also forest edge, and is generally absent from desert and dense forest, although it has been known to utilise secondary forest, clearings, settlements and urban areas (Kemp and Christie 2013). This species builds a small stick nest from April to July in the upper fork of large trees, usually deep within foliage and not on the crown (unlike other vulture species) (Kemp and Christie 2013).

Suitable breeding and foraging habitat for this species occurs across the CHAA (Figure G4), and includes open woodland (161.7 ha), woodland (190.4 ha), riverine woodland (69.8 ha), dense wooded grassland (554.7 ha), open wooded grassland (468.9 ha), wooded grassland (184.3 ha), open woodland/dense bushland (147.9 ha), and open wooded bushland (214.0 ha).

Table G7: Population details for Hooded Vulture

Global listing*	Endangered
National listing	Protected (Uganda Wildlife Bill, 2017)
Restricted range	No
Migratory or congregatory*	No
Discrete management unit	CHAA (814 km^2)
Global population*	197,000
Global EOO$^\#$	12,369,089 km^2
Global AOO$^\#$	Unknown
Regional/national population*	Unknown
Regional/national EOO*	Unknown
Regional/national AOO*	Unknown
Number of global discrete management units	Unknown

* BirdLife International (2017)

IUCN (2017)

The Hooded Vulture has not yet been recorded in the CHAA (APPENDIX B), although it is likely that it could occur. Individuals are probably sedentary in most areas, but may range over 200 km when not breeding (Kemp and Christie 2013). Therefore, it is difficult to put a precise number on the population utilising the CHAA, or even the region. Regardless, the whole CHAA was considered to be a DMU for this species that could support a sub-population of this species in the region. Therefore, the CHAA and EOO were used as a proxy for the population. Based on that assessment, the CHAA could support <0.01% of the global population of this species.

Hence, applying the quantitative and qualitative triggers for Criterion 1 critical habitat (APPENDIX A, Table B1) to this population identifies that it does not trigger Criterion 1. Therefore, this species has been assessed as not triggering critical habitat within the CHAA.

9.1.1.7   Nahan's Francolin (Ptilopachus nahani)

■   Potential critical habitat – Criterion 1, 2 and 5

The Nahan's Francolin is a globally listed Vulnerable species (Table G8) (IUCN, 2017). It has a very restricted distribution, being found only in north-east DRC (within the area bordered by the Aruwimi River, the Nepoko River and the Semliki River) and western and south-central Uganda (in particular the forests of Budongo, Bugoma and Mabira) (McGowan and de Juana 1994).

This species is confined to dense, mature, moist, sometimes swampy medium-altitude forest below 1,500 m (McGowan and de Juana 1994, BirdLife International 2017); and is reasonably common in Budongo Central

Forest Reserve (Plumptre et al. 2010, 2011). Large trees with appropriate buttress formation are important for breeding sites for this species (Sande et al. 2009a). Forest disturbance appears to reduce the home range of this species (Sande et al. 2009b).

The population trend of this species appears to be decreasing, with the primary threats thought to be habitat loss through logging and clearance of forest for charcoal burning and agriculture, particularly within Bugoma Central Forest Reserve (BirdLife International 2017). Fragmentation alone probably does not appear to adversely affect the species, but it does appear to be affected by habitat changes associated with human-induced fragmentation, such as the extensive removal of large trees (BirdLife International 2012ad, 2014i).

It appears to have a very restricted EOO, although populations in the wider DRC are unknown, hence its distribution may be larger than thought (BirdLife International 2017). This species's EOO overlaps with the CHAA; and has been recorded in the CHAA within Bugoma Central Forest Reserve (Plumptre et al. 2010, 2011). Suitable habitat for this species occurs only in Bugoma Central Forest Reserve (40,243 ha), within the CHAA (Figure G5).

Table G8: Population details for Nahan's Francolin

Global listing*	Vulnerable
National listing	Not listed
Restricted range	Yes
Migratory or congregatory*	No
Discrete management unit	CHAA (814 km^2)
Global population*	50,000 - 99,999
Global EOO$^#$	100,339 km^2
Global AOO$^#$	Unknown
Regional/national population*	44,038 (95% CI: 32,827-59,079)
Regional/national EOO	1046 km^2 (Budongo (435 km^2), Bugoma Forest (401 km^2) and Mabira Forest (210 km^2))
Regional/national AOO	1046 km^2 (Budongo (435 km^2), Bugoma Forest (401 km^2) and Mabira Forest (210 km^2))
Number of global discrete management units	3 (Budongo (435 km^2), Bugoma Forest (401 km^2) and Mabira Forest (210 km^2))

* IUCN (2017)   ** BirdLife International (2017)   # IUCN (2014)

The Nahan's Francolin has been recorded in the CHAA (Plumptre et al. 2010, 2011). Although the precise number of individuals occurring within the CHAA is unknown, the CHAA does support approximately 38% of this species's known regional AOO (Table G8). Therefore, it is conceivable that the CHAA could support ~16,700 individuals (38% of 44,038).

Hence, applying the quantitative and qualitative triggers for Criterion 1 critical habitat (APPENDIX A, Table B1) to this population identifies that it triggers only Criterion 1 Tier 1. Therefore, this species has been assessed as triggering critical habitat within the CHAA.

9.1.1.8   *Eastern Chimpanzee (Pan troglodytes schweinfurthii)*

■   Potential critical habitat – Criterion 1

The Eastern Chimpanzee is a globally listed Endangered species (IUCN, 2017; Wilson et al. 2008) (Wilson et al. 2008). Generally, Chimpanzees have a wide, but discontinuous distribution, across Africa, yet tend to be

confined to the equatorial belt (Oates et al. 2008). The Eastern Chimpanzee ranges from the Ubangi River/Congo River in Central African Republic and the DRC, to western Uganda, Rwanda and western Tanzania (Wilson et al. 2008).

They prefer mature moist and dry forests, either evergreen or semi-deciduous, and forest galleries extending into savanna woodlands (Wilson et al. 2008). They are omnivorous, and their diet is highly variable according to individual populations and seasons. Chimpanzees form social communities with home ranges larger in woodland forest mosaics than in mixed forest, averaging 12.5 km² (range 5 to 400 km²) (Wilson et al. 2008).

Due to high levels of exploitation, loss of habitat and habitat quality due to expanding human activities, this species is estimated to have experienced a significant population reduction in the past 20 to 30 years (Wilson et al. 2008). Major threats include habitat destruction and degradation (slash and burn agriculture, deforestation, logging), poaching (bush meat, pet trade, traditional medicine, crop protection), and disease (Oates et al. 2008).

This species's EOO overlaps with the CHAA; and it has been recorded in the CHAA, in particular, Bugoma Central Forest Reserve (Plumptre et al. 2010, 2011). Suitable habitat for this species occurs only in Bugoma Central Forest Reserve (401 km^2), within the CHAA (Figure G6).

Table G9: Population details for Eastern Chimpanzee

Global listing*	Endangered, CITES Appendix I
National listing*	VU, Protected (Uganda Wildlife Bill, 2017)
Restricted range	No
Migratory or congregatory	No
Discrete management unit	CHAA (814 km^2)
Global population*	172,700 - 299,700
Global EOO#	5,759,594 km^2
Global AOO#	Unknown
Regional/national population**	4000 - 5700
Regional/national EOO	1046 km^2 (Budongo (435 km^2), Bugoma Forest (401 km^2) and Mabira Forest (210 km^2))
Regional/national EOO	1046 km^2 (Budongo (435 km^2), Bugoma Forest (401 km^2) and Mabira Forest (210 km^2))
Number of global discrete management units	Unknown

* Oates et al. (2008)   ** Thompson and Wrangham (2013)   # IUCN (2014)

The Eastern Chimpanzee has been recorded in the CHAA (Plumptre et al. 2010, 2011). Although the precise number of individuals occurring within the CHAA is unknown, the CHAA does support approximately 38% of this species known regional EOO (Table G9). Therefore, it is conceivable that the CHAA could support between 1520 and 2160 individuals (38% of 4000 to 5700).

Eastern Chimpanzees are great apes, therefore, under the quantitative and qualitative triggers for Criterion 1 critical habitat (APPENDIX A, Table B1) they trigger Criterion 1 Tier 1. Therefore, this species has been assessed as triggering critical habitat within the CHAA.

9.1.1.9 *Migratory and Congregatory Species*

Migratory Birds

- Potential critical habitat – Criterion 3

The CHAA supports a diversity of migratory and congregatory species as listed under the Convention on Migratory Species (CMS), to which Uganda is a signatory (see Section 4.0 of the main report). All of these species are listed under Appendix II of the CMS. Species listed under Appendix II are identified as having an unfavourable conservation statues, that is, they may be threatened or near threatened, and, therefore, need international agreements for their conservation and management within the countries within which they are known to range (CMS 2014).

At least 12 Palearctic migratory birds could occur in the CHAA (see Section 5.1.4 of the main report, APPENDIX B, Table G1). These include, amongst others, Common Ringed Plover, Kittlitz's Plover, White-winged Tern, Great Snipe, Black-winged Pratincole, Collared Pratincole, Black-tailed Godwit, Eurasian Curlew, African Skimmer, Common Sandpiper, African Wattled Lapwing, and Spur-winged Lapwing. Although individual numbers of these species were low during the surveys conducted (see Section 5.1.4 of the main report), it could be expected that the CHAA may support substantial numbers of these species during peak migration times. In particular, around September and October; a survey for migratory species is planned for that time to gauge the importance of the CHAA for migratory birds. Nevertheless, the CHAA supports suitable habitat for all of the aforementioned species. In particular, the Buhuka Flats supports ~12 km of shoreline (Figure G7), which is favourable to wading and shore birds like the Common Ringed Plover, Kittlitz's Plover, White-winged Tern, Great Snipe, Black-tailed Godwit, Eurasian Curlew, African Skimmer, and Common Sandpiper. The flats also support ~850 ha of grassland and ~77 ha of seasonally flooded grassland (Figure 4a and b of the main report), that is favoured habitat of Black-winged Pratincole, Collared Pratincole, African Wattled Lapwing, and Spur-winged Lapwing.

Table G10: Population details for Common Ringed Plover

Global listing*	Least Concern
National listing*	-
Restricted range	No
Migratory or congregatory	Yes
Discrete management unit	CHAA (814 km^2)
Global population*	360,000 - 1,300,000
Global EOO#	NA
Global AOO#	NA
Regional/national population*	Unknown
Regional/national EOO#	NA
Regional/national AOO#	NA
Number of global discrete management units	unknown

* IUCN (2017)   # IUCN (2014)

Table G11: Population details for Kittlitz's Plover

Global listing*	Least Concern
National listing*	-
Restricted range	No
Migratory or congregatory	Yes
Discrete management unit	CHAA (814 km^2)
Global population*	Unknown
Global EOO#	NA
Global AOO#	NA

Regional/national population*	Unknown
Regional/national EOO#	NA
Regional/national AOO#	NA
Number of global discrete management units	unknown

* IUCN (2017)   # IUCN (2014)

Table G12: Population details for White-winged Tern

Global listing*	Least Concern
National listing*	-
Restricted range	No
Migratory or congregatory	Yes
Discrete management unit	CHAA (814 km^2)
Global population*	2,500,000 - 4,500,000
Global EOO#	NA
Global AOO#	NA
Regional/national population*	Unknown
Regional/national EOO#	NA
Regional/national AOO#	NA
Number of global discrete management units	unknown

* IUCN (2017)   # IUCN (2014)

Table G13: Population details for Great Snipe

Global listing*	Least Concern
National listing*	-
Restricted range	No
Migratory or congregatory	Yes
Discrete management unit	CHAA (814 km^2)
Global population*	465,000 - 1,040,000
Global EOO#	NA
Global AOO#	NA
Regional/national population*	Unknown
Regional/national EOO#	NA
Regional/national AOO#	NA
Number of global discrete management units	unknown

* IUCN (2017)   # IUCN (2014)

Table G14: Population details for Black-winged Pratincole

Global listing*	Near Threatened
National listing*	-
Restricted range	No
Migratory or congregatory	Yes
Discrete management unit	CHAA (814 km^2)
Global population*	220,000 - 290,000
Global EOO#	9,354,763 km^2

Global AOO[#]	NA
Regional/national population*	Unknown
Regional/national EOO[#]	4,498,364 km^2
Regional/national AOO[#]	NA
Number of global discrete management units	unknown

* IUCN (2017)   # IUCN (2014)

Table G15: Population details for Collared Pratincole

Global listing*	Least Concern
National listing*	-
Restricted range	No
Migratory or congregatory	Yes
Discrete management unit	CHAA (814 km^2)
Global population*	Unknown
Global EOO[#]	NA
Global AOO[#]	NA
Regional/national population*	Unknown
Regional/national EOO[#]	NA
Regional/national AOO[#]	NA
Number of global discrete management units	unknown

* IUCN (2017)   # IUCN (2014)

Table G16: Population details for Black-tailed Godwit

Global listing*	Near Threatened
National listing*	-
Restricted range	No
Migratory or congregatory	Yes
Discrete management unit	CHAA (814 km^2)
Global population*	427,000 – 805,000
Global EOO[#]	45,772,340 km^2
Global AOO[#]	NA
Regional/national population*	Unknown
Regional/national EOO[#]	11,050,681 km^2
Regional/national AOO[#]	NA
Number of global discrete management units	unknown

* IUCN (2017)   # IUCN (2014)

Table G17: Population details for Eurasian Curlew

Global listing*	Near Threatened
National listing*	-
Restricted range	No
Migratory or congregatory	Yes
Discrete management unit	CHAA (814 km^2)
Global population*	77,000 - 1,065,000

Global EOO#	31,500,728 km^2
Global AOO#	NA
Regional/national population*	Unknown
Regional/national EOO#	9,201,510 km^2
Regional/national AOO#	NA
Number of global discrete management units	unknown

* IUCN (2017)   # IUCN (2014)

Table G18: Population details for African Skimmer

Global listing*	Near Threatened
National listing*	Protected (Uganda Wildlife Bill 2017)
Restricted range	No
Migratory or congregatory	Yes
Discrete management unit	CHAA (814 km^2)
Global population*	15,000 - 25,000
Global EOO#	10,384,709 km^2
Global AOO#	NA
Regional/national population*	8,000 - 12,000
Regional/national EOO#	10,384,709 km^2
Regional/national AOO#	NA
Number of global discrete management units	unknown

* IUCN (2017)   # IUCN (2014)

Table G19: Population details for Common Sandpiper

Global listing*	Least Concern
National listing*	-
Restricted range	No
Migratory or congregatory	Yes
Discrete management unit	CHAA (814 km^2)
Global population*	2,600,000 - 3,200,000
Global EOO#	NA
Global AOO#	NA
Regional/national population*	Unknown
Regional/national EOO#	NA
Regional/national AOO#	NA
Number of global discrete management units	unknown

* IUCN (2017)   # IUCN (2014)

Table G20: Population details for African Wattled Lapwing

Global listing*	Least Concern
National listing*	Protected (Uganda Wildlife Bill, 2017)
Restricted range	No
Migratory or congregatory	Yes
Discrete management unit	CHAA (814 km^2)

Global population*	Unknown
Global EOO#	NA
Global AOO#	NA
Regional/national population*	Unknown
Regional/national EOO#	NA
Regional/national AOO#	NA
Number of global discrete management units	unknown

* IUCN (2017)   # IUCN (2014)

Table G21: Population details for Spur-winged Lapwing

Global listing*	Least Concern
National listing*	-
Restricted range	No
Migratory or congregatory	Yes
Discrete management unit	CHAA (814 km^2)
Global population*	Unknown
Global EOO#	NA
Global AOO#	NA
Regional/national population*	Unknown
Regional/national EOO#	NA
Regional/national AOO#	NA
Number of global discrete management units	unknown

* IUCN (2017)   # IUCN (2014)

Applying the quantitative and qualitative triggers for Criterion 3 critical habitat (APPENDIX A, Table B1) to the population details of each of these species in relation to the CHAA (see Table G10 to G21) and the known baseline (see APPENDIX B), identifies that none of them triggers Criterion 3. Therefore, these species have been assessed as not triggering critical habitat within the CHAA.

Congregatory Bats

■   Potential critical habitat – Criterion 3

The CHAA potentially supports populations of the migratory and congregatory African Straw-coloured Fruit-bat (*Eidolon helvum*), a Bent-wing Bat (*Miniopterus* sp.) and Large-eared Free-tailed Bat (*Otomops martiensseni*). Although these species do not migrate across vast distances and continents like birds, they can migrate hundreds of kilometres from hibernacula to breeding roosts (Monadjem et al. 2010). No roosting colonies of African Straw-coloured Bat were recorded in the CHAA, and it is more likely that individuals or small colonies of this gregarious species may occur in the CHAA. Certainly, it is doubtful that roosts would occur in the LSA. The Bent-wing Bats and the Large-eared Free-tailed Bat are obligate cavity or cave roosters (Dietz et al. 2009, Monadjem et al. 2010, Happold 2013b, Yalden and Happold 2013). Although the Large-eared Free-tailed Bat has not yet been recorded in the CHAA, a Bent-wing Bat has been recorded. This is interesting because Bent-wing Bats, being a obligate cave roosting species, which can form roosting colonies numbering thousands of individuals (Monadjem et al. 2010), are also known to share its roosting colonies with other species of bats, such as the Large-eared Free-tailed Bat (Large-eared Free-tailed Bat). As such, it is conceivable that one or more caves occur in the CHAA where-in these species may roost. The precise locality of these caves is not known; however, these could, more than likely occur somewhere along the escarpment.

Table G22: Population details for African Straw-coloured Fruit-bat

Global listing*	Near Threatened
National listing	Protected (Uganda Wildlife Bill, 2017)
Restricted range	No
Migratory or congregatory	Yes
Discrete management unit	CHAA (814 km^2)
Global population*	Unknown, suspected to be millions
Global EOO#	12,945,414 km^2
Global AOO#	NA
Regional/national population*	Unknown
Regional/national EOO#	Unknown
Regional/national AOO#	NA
Number of global discrete management units	unknown

* Mickleburgh et al. (2008a)

IUCN (2014)

The African Straw-coloured Fruit-bat has not yet been recorded in the CHAA, and the global population of this species is unknown; therefore, the global EOO and the CHAA were used as proxies for the global and local populations, respectively. The CHAA potentially supports <0.01% of the global population.

Hence, applying the quantitative and qualitative triggers for Criterion 3 critical habitat (APPENDIX A, Table B1) to the population details of African Straw-coloured Fruit-bat in relation to the CHAA (see Table G22) identifies that it does not trigger Criterion 3. Therefore, <u>this species has been assessed as not triggering critical habitat within the CHAA</u>.

Table G23: Population details for Large-eared Free-tailed Bat

Global listing*	Near Threatened
National listing*	-
Restricted range	No
Migratory or congregatory	Yes
Discrete management unit	CHAA (814 km^2)
Global population*	Unknown
Global EOO#	7,649,368 km^2
Global AOO#	NA
Regional/national population*	Unknown
Regional/national EOO#	Unknown
Regional/national AOO#	NA
Number of global discrete management units	unknown

* Mickleburgh et al. (2008c)

IUCN (2014)

The Large-eared Free-tailed Bat has not yet been recorded in the CHAA, and the global population of this species is unknown; therefore, the global EOO and the CHAA were used as proxies for the global and local populations, respectively. The CHAA potentially supports 0.01% of the global population.

Hence, applying the quantitative and qualitative triggers for Criterion 3 critical habitat (APPENDIX A, Table B1) to the population details of Large-eared Free-tailed Bat in relation to the CHAA (see Table G23)

identifies that it does not trigger Criterion 3. Therefore, <u>this species has been assessed as not triggering critical habitat within the CHAA</u>.

African Elephant (Loxodonta africana)

■ Potential critical habitat – Criterion 3

The African Elephant is also identified by the CMS as a migratory species (Table G1). This species occurs in the CHAA, and individuals have been recorded in the Bugoma Central Forest Reserve (Plumptre et al. 2010, 2011). However, the records suggest that the individuals occurring in the Bugoma Central Forest Reserve are lone, or single individuals (see Plumptre et al 2010, 2011), and certainly not large breeding herd that would migrate.

Table G24: Population details for African Elephant

Global listing*	Vulnerable, CMS Appendix II, CITES Appendix I
National listing*	Vulnerable; Protected (Uganda Wildlife Bill, 2017)
Restricted range	No
Migratory or congregatory	Yes
Discrete management unit	CHAA (814 km^2)
Global population*	Unknown
Global EOO#	3,543,323 km^2
Global AOO#	Unknown
Regional/national population*	2000 - 3000
Regional/national EOO#	103,983 km^2
Regional/national AOO#	NA
Number of global discrete management units	unknown

* Blanc (2008)

IUCN (2014)

The African Elephant has been recorded in the CHAA, although it appears that those were lone individuals. The precise population within the CHAA is unknown, as is the global population; although the population within Uganda is estimated to be between 2000 and 3000 individuals (Table G24). Therefore, the regional EOO and the CHAA were used as proxies to estimate the regional and local populations, respectively. The CHAA potentially supports 0.8% of the regional population.

Hence, applying the quantitative and qualitative triggers for Criterion 3 critical habitat (APPENDIX A, Table B1) to the population details of African Elephant in relation to the CHAA (see Table G24) identifies that it does not trigger Criterion 3. Therefore, <u>this species has been assessed as not triggering critical habitat within the CHAA</u>.

9.1.2 Ecosystems Potentially Triggering Criterion 4 Critical Habitat: Highly Threatened and/or Unique Ecosystems

Highly threatened or unique ecosystems are those (i) that are at risk of significantly decreasing in area or quality; (ii) with a small spatial extent; and/or (iii) containing unique assemblages of species including assemblages or concentrations of biome-restricted species (IFC, 2012).

In addition, areas determined to be irreplaceable or of high priority/significance based on systematic conservation planning techniques carried out at the landscape and/or regional scale by governmental bodies, recognized academic institutions and/or other relevant qualified organizations (including internationally-recognized NGOs) or that are recognized as such in existing regional or national plans, such as the NBSAP, would qualify as critical habitat per Criterion 4 (IFC, 2012).

9.1.2.1   Bugoma Central Forest Reserve

Bugoma Central Forest Reserve therefore triggers Critical Habitat on the basis of the following qualifying factors:

i)   It is at risk of significantly decreasing in area and quality as a result of human encroachment as a result of demand for ecosystem services by the local communities, as well as recent illegal land-grabbing activity - in 2016, the Muhangaizima Block was reportedly leased for sugar cane cultivation, with subsequent transformation activities affecting approximately 8000 ha of the CFR (ACBF, 2016);

ii)   It is conservatively assessed as Vulnerable (after Rodriguez et al. 2011) – suspected of undergoing a ≥30% decline in extent of occurrence over the last 50 years in the region (based on Plumptre 2002, Plumptre et al. 2003, 2007, 2010, 2011);

iii)   It supports a relatively unique assemblage of species including Uganda's only population of the range-restricted Nahan's Francolin (*Ptilopachus nahani*), as well as Endangered Eastern Chimpanzee (*Pan troglodytes schweinfurthii*), and Vulnerable African Elephant (*Loxodonta africana*) for which it is also of recognised importance as a climate change refugium; is a a recognised chimpanzee conservation unit (Plumptre et al. 2010), and is a recognised area of old growth forest (Plumptre et al. 2010, 2011); and

iv)   It is recognised as an Important Bird Area by the internationally-recognised NGO BirdLife International.

9.1.3   Species Potentially Triggering Criterion 5 Critical Habitat (Evolutionarily Distinct Species)

As discussed in Section 3.2.3.3 and APPENDIX A, quantitative thresholds for distinguishing the tiers of critical habitat have been developed by the IFC for Criteria 1 to 3, and the thresholds for Criterion 5 are purely qualitative.

This criterion therefore is defined by the presence within the CHAA of subpopulations of species that are phylogenetically or morphogenetically distinct and may be of special conservation concern given their distinct evolutionary history, including 'Evolutionarily Distinct and Globally Endangered' (EDGE) species (ZSL, 2017).

9.1.3.1   Shoebill (Balaeniceps rex)

The Shoebill is a globally listed Vulnerable species (Table G25) (IUCN, 2017). It has a very wide distribution, from South Sudan to Zambia, but is very locally distributed within that range and prefers large swamps (BirdLife International 2017).

This species is a true wetland specialist that is sedentary as an adult. It breeds and forages in seasonally flooded marshes where vegetation is dominated by a mixture of Papyrus (*Cyperus papyrus*), reeds (*Phragmites* spp.), cattails (*Typha* spp.) and grasses, particularly *Miscanthidium*, although it tends to avoid areas where the vegetation is taller than itself (BirdLife International 2017). Suitable habitat for breeding is very limited within the CHAA; however, it is conceivable that non-breeding individuals may occur in suitable habitat (seasonally-flooded marshes) within the CHAA.

In Uganda, this species shows a preference for feeding on Lungfish (*Protopterus aethiopicus*), although it does take a variety of species including Senegal Bichir, catfish (*Clarias* spp.) and tilapia (*Tilapia* spp.) (BirdLife International 2017), all species common in the CHAA (APPENDIX B).

Major threats to this species are mainly from the loss of suitable breeding wetlands, general habitat destruction and degradation, disturbance, hunting, and capture for the bird trade (BirdLife International 2017).

This species' EOO does not overlap with the CHAA, and it has not been recorded in the CHAA (see Table G1).

Table G25: Population details for Shoebill

Global listing*	Vulnerable, CITES Appendix II

National listing*	Vulnerable; Protected (Uganda Wildlife Bill, 2017)
Restricted range	No
Migratory or congregatory*	No
Discrete management unit	CHAA (814 km^2)
Global population**	<10,000
Global EOO$^{\#}$	Unavailable at time of writing
Global AOO$^{\#}$	Unknown
Regional/national population**	100 – 150
Regional/national EOO$^{\#}$	Unknown
Regional/national AOO$^{\#}$	Unknown
Number of global discrete management units	Unknown

* IUCN (2017)

** BirdLife International (2017)

$^{\#}$ IUCN (2014)

Hence, applying the qualitative triggers for Criterion 5 critical habitat (APPENDIX A) to the population details of Shoebills in relation to the CHAA (see Table G25) identifies that it does not trigger Criterion 5. Therefore, this species has been assessed as not triggering critical habitat within the CHAA.

9.1.3.2   Secretarybird (Sagittarius serpentarius)

The Secretarybird is a globally listed Vulnerable species (Table G26) (IUCN, 2017). It has a very wide distribution, from West Africa (Senegal and the Gambia) across to Ethiopia and Somalia, and south to South Africa (Kemp et al. 2014).

It prefers grassland or tree and grass savanna, favouring short grass with scattered *Acacia* thorn trees to provide sites for roosting and nesting; it is also found in large-scale agricultural areas and sub-desert areas; it rarely visits clearings in woodland or forest (BirdLife International 2017, Kemp et al. 2014). They tend to be sedentary (with regular seasonal breeding) in some areas, but nomadic in most areas in response to changes in rainfall, grazing and fires (Kemp et al. 2014).

Secretarybirds breed at any time of year, whenever food is abundant; build large nests on top of low trees, often flat-topped Acacias (Kemp et al. 2014).

This species can be common to rare and localised across its range, with recent evidence suggesting rapid decline; within Uganda it is never common, and is now largely confined to national parks (Kemp et al. 2014). Major threats coming from the excessive burning of grasslands, which may suppress populations of prey species, intensive grazing of livestock is also probably degrading otherwise suitable habitat (BirdLife International 2017). Disturbance by humans could affect breeding, while live trade of individuals has also been reported, along with indiscriminate poisoning at waterholes as possible threats (BirdLife International 2017).

This species' EOO overlaps substantially with the CHAA, yet it has not yet been recorded in the CHAA (see Appendix G). Suitable breeding and foraging habitat for this species occurs across the wider CHAA, and the CHAA, and includes open woodland, woodland, open wooded grassland, wooded grassland, and open grassland (Table 6).

Table G26: Population details for Secretarybird

Global listing*	Vulnerable, CITES Appendix II
National listing*	Protected (Uganda Wildlife Bill, 2017)
Restricted range	No
Migratory or congregatory*	No
Discrete management unit	CHAA (814 km^2)

Global population**	Unknown
Global EOO#	15,137,802 km^2
Global AOO#	Unknown
Regional/national population**	100 – 150
Regional/national EOO#	Unknown
Regional/national AOO#	Unknown
Global number of discrete management units	

* BirdLife International (2013h)

** BirdLife International (2014j)

IUCN (2014b)

Hence, applying the qualitative triggers for Criterion 5 critical habitat (APPENDIX A) to the population details of Secretarybirds in relation to the CHAA (see Table G26) identifies that it does not trigger Criterion 5. Therefore, this species has been assessed as not triggering critical habitat within the CHAA.

9.1.4   Species/Ecosystems triggering other Qualitative Critical Habitat Criteria

The near-shore habitats are both important fishing grounds and nursery habitat for fisheries, that support 11 fishing villages on the Buhuka Flats and surrounds (see Ecosystem Services Review). This triggers the qualitative Criterion 13 as described in APPENDIX F.

Furthermore, the near-shore habitats of Lake Albert within the CHAA could potentially constitute critical habitat under Criterion 1 if the mud snail *G. candida* is confirmed present in this area.

9.2   Confirmed Triggers of Critical Habitat in the CHAA

Table 4 presents a summary of the confirmed triggers of critical habitat in the CHAA.   The spatial representation of critical habitat within the CHAA is presented in Figure 16

Table 4: Triggers of critical habitat in the CHAA

Valued Component	Potential triggering criteria*	Critical Habitat Designation**	Habitat and reasoning
Mud Snail (*Gabbiella candida*)	1 and 2	Criterion 1 Tier 1	■ Could occur on near-shore aquatic habitats (Bugoma Lagoon, large bays, open sandy shores, shallow river-associated water) ■ See APPENDIX F for precise reasoning
Nahan's Francolin (*Ptilopachus nahani*)	2	Criterion 2 Tier 2	■ Occurs in Bugoma Central Forest Reserve, possibly one of less than 10 DMUs globally (including DRC) ■ Potential for CHAA to support >10% of this species' known global population ■ See APPENDIX F for precise reasoning
Eastern Chimpanzee (*Pan troglodytes schweinfurthii)*	1	Criterion 1 Tier 1	■ Occurs in Bugoma Central Forest Reserve ■ Great apes are an iconic species (see GN 74 and footnotes in PS6, IFC 2012a and b) ■ See APPENDIX F for precise reasoning
Bugoma Central Forest Reserve	4, 6, 7, 9, 11, 12, 13, 15, 16	Criterion 4	■ Threatened ecosystem – over 110 km^2 of forest surrounding the Bugoma CFR boundary has been cleared since the mid-1980s (Plumptre 2002); and in 2016, the Muhangaizima Block was reportedly leased for sugar cane cultivation, with subsequent transformation activities affecting approximately 8000 ha of the CFR (ACBF, 2016). ■ Therefore, conservatively assessed as Vulnerable (after Rodriguez et al. 2011) – suspected of undergoing a ≥30% decline in extent of occurrence over the last 50 years in the region (based on Plumptre 2002, Plumptre et al. 2003, 2007, 2010, 2011) ■ Of recognised importance as a climate change refugium for Vulnerable Nahan's Francolin and Endangered Eastern Chimpanzee (Ayebare et al. 2013), and a recognised chimpanzee conservation unit (Plumptre et al. 2010) ■ Recognised area of old growth forest (Plumptre et al. 2010, 2011) ■ Supports a population of Eastern Chimpanzee (McLennan 2008, Plumptre et al. 2003, 2010, 2011) that is recognised as being one for the four largest in the region (Plumptre et al. 2010); apart from being an Endangered species, chimpanzees are

			also recognised as key stone species and ecosystem engineers (Chapman et al. 2013) ■ The forest is recognised for its unique biodiversity values, including biome restricted species (Plumptre et al. 2011) ■ Local people harvest timber, fibre, fuel wood and charcoal, and non-timber forest products from the forest (Plumptre 2002) ■ Bugoma Central Forest Reserve is recognised as an Important Bird Area (BirdLife International 1998, IUCN 2010, 2014b) ■ Recognised as a high conservation priority area (NEMA 2010)
Near-shore habitats of Lake Albert	13	Criterion 13	■ The near-shore habitats are important fishing grounds that support 11 fishing villages on the Buhuka Flats and surrounds (see Ecosystem Services Review)

* IFC (2012b)

** In instances where more than one potential criterion could be triggered, only the highest-level designation is presented

Figure 16: Potential critical habitat in the CHAA
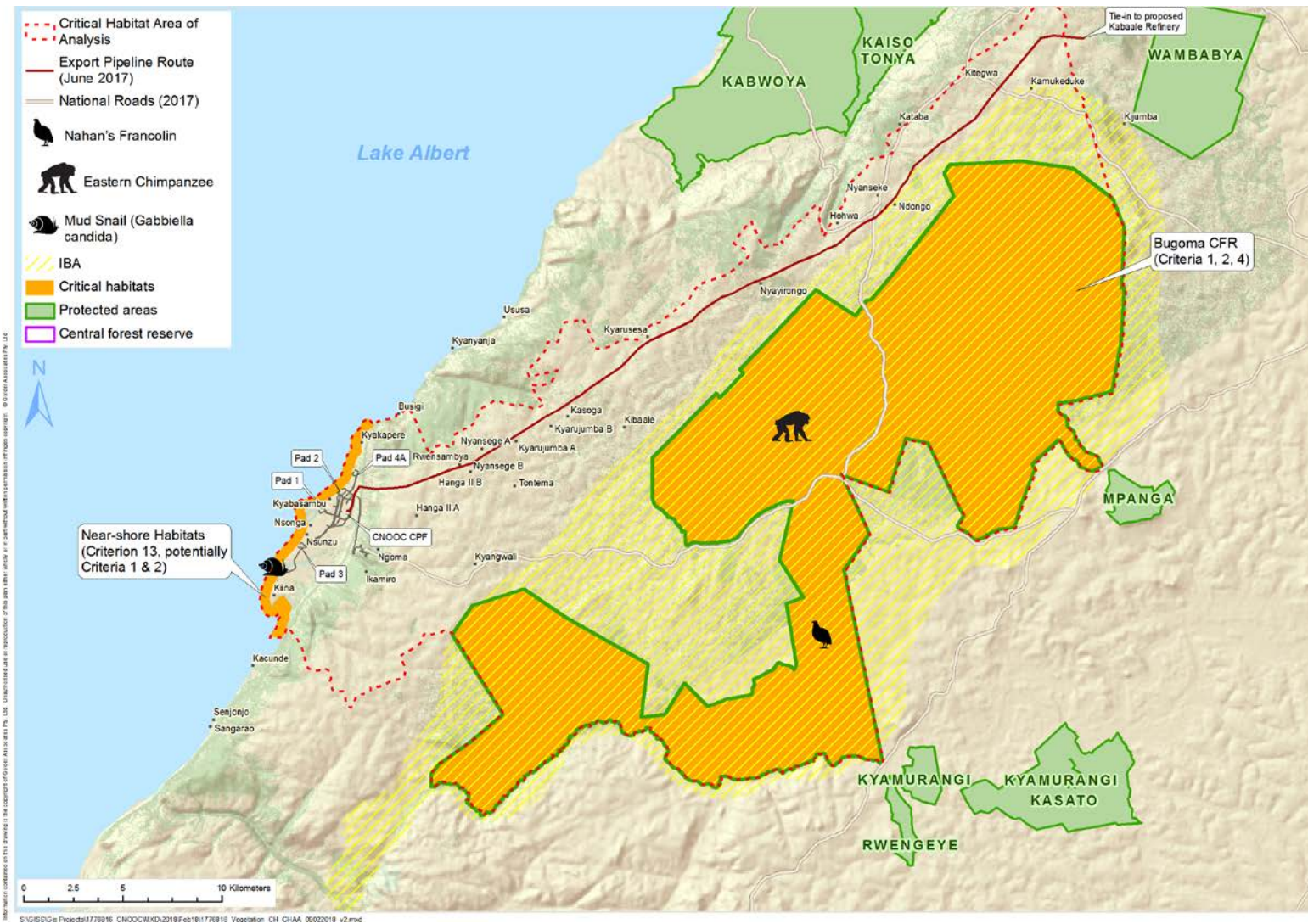
10.0   IMPACT ASSESSMENT – PRODUCTION FACILITY

This section presents an assessment of the possible interactions of biodiversity valued components with the production facility infrastructure and activities, and the resulting impacts during the construction, operation and decommissioning phases of the Project.

The biodiversity valued components for the Production Facility impact assessment are listed in Table 5 below. They include all of the species and habitats that trigger critical habitat designation within the CHAA. In addition, ecosystems of concern that will be potentially affected by the Project, and Grey Crowned Crane, were also included as valued components for impact assessment, for reasons outlined in the Table below. As mentioned in Section 10.1.2, potential impacts to other species of concern are assessed at the habitat level (ecosystems of concern).

Table 5: Biodiversity Valued Components for Impact Assessment

Valued Component	Confirmed CH Trigger? (see Table 4)	Reasoning (see Table 4)
Near-shore aquatic habitats of Lake Albert	■ Yes – Criterion 13 ■ Possibly Criterion 1 and Criterion 2 (G. candida)	■ The near-shore habitats are important fishing grounds that support 11 fishing villages on the Buhuka Flats and surrounds (see Ecosystem Services Review) ■ May support the CR and range-restricted species *Gabbiella candida*
Wetlands	■ No	■ Natural habitat – priority habitat according to IFC (2012) ■ Supports Endangered Grey Crowned Crane ■ Important in supply of ecosystem services to local communities (see Ecosystem Services Review)
Escarpment vegetation corridor	■ No	■ Natural habitat – priority habitat according to IFC (2012) ■ Forms part of a contiguous vegetation corridor that is part of the wider Murchison Falls National Park-Budongo-Bugoma-Kagombe-Itwara Forest Reserves-Semliki/Toro Wildlife Reserve corridor ■ The location of caves and cavities along the escarpment that could be important for cavity-roosting bats
Bugoma Central Forest Reserve	■ Yes – ■ Criterion 4 ■ Criterion 1 ■ Criterion 2	■ Triggers CH on the basis of being a highly threatened and unique ecosystem (Criterion 4) ■ Triggers Criterion 1 Tier 1 CH on the basis of support of a population of Eastern Chimpanzee, that is recognised as being one for the four largest in the region; apart from being an Endangered species, chimpanzees are also recognised as key stone species and ecosystem engineers ■ Triggers Criterion 2 Tier 2 CH on the basis of support of range-restricted Nahan's Francolin ■ Recognised area of old growth forest

Valued Component	Confirmed CH Trigger? (see Table 4)	Reasoning (see Table 4)
		■ The forest is recognised for its unique biodiversity values, including biome restricted species ■ Is an important ecosystem service supply area for local people who harvest timber, fibre, fuel wood and charcoal, and non-timber forest products from the forest ■ Bugoma Central Forest Reserve is recognised as an Important Bird Area ■ Nationally recognised as a high conservation priority area (NEMA 2010)
Mud Snail (*Gabbiella candida*)	■ Possibly Criterion 1 and Criterion 2	■ Could occur on near-shore aquatic habitats (Bugoma Lagoon, large bays, open sandy shores, shallow river-associated water) ■ Has not been confirmed in LSA to date and is included on basis of precautionary principle
Grey Crowned Crane	■ No	■ Although Grey Crowned Crane is not present in numbers that would trigger CH designation, it is an Endangered species and has been confirmed present on the Buhuka Flats during baseline fieldwork in 2014 and 2017 ■ Any potential Project impacts on a globally-recognised and nationally-protected Endangered species are unacceptable and warrant addressing via the impact assessment process
Nahan's Francolin (*Ptilopachus nahani*)	■ Yes – Criterion 2	■ Occurs in Bugoma Central Forest Reserve, possibly one of less than 10 DMUs globally (including DRC) ■ Potential for CHAA to support >10% of this species' known global population
Eastern Chimpanzee (*Pan troglodytes schweinfurthii*)	■ Yes – Criterion 1	■ Occurs in Bugoma Central Forest Reserve ■ Great apes are an iconic species of anthropological and evolutionary significance ■ They generally immediately trigger CH designation (see GN 74 and footnotes in PS6, IFC 2012a and b)

10.1 Construction and Decommissioning Phase Impacts

The anticipated impacts are expected to be similar for the construction and decommissioning phases, and will occur over a similar duration for both phases (that is, ~2 years). Therefore, for the intents of this impact assessment, the decommissioning phase impacts have been included with the construction phase impacts in their assessment.

The predicted impacts to valued components include: direct loss of habitat due to land take for the Project infrastructure (Table 6); sensory disturbances (from noise, vibration, light, and odour); changes to surface

water quality and flows, air emissions and the associated potential for pollution; erosion and sedimentation; and direct mortality of species of concern from vehicle movements and site preparation.

The predicted impacts are assessed in two broad categories:

■ Impacts on habitat and ecosystem integrity; including the near-shore environment of Lake Albert, the vegetation corridors along the escarpment, and wetlands in the LSA and CHAA.

■ Impacts on species of concern, specifically the Mud Snail *Gabbiella candida*.

For the assessment of impacts during the construction and decommissioning phase, the key questions were divided into sub-questions that focused on individual valued components within the CHAA and LSA. In answering each question, the individual components of the Project were considered with regards to their potential to affect a valued component. These questions are presented below.

10.1.1 What impact could the construction/decommissioning of the Project have on habitats and ecosystem integrity?

This section presents the assessment of impacts that the construction and decommissioning of the Project could have on the habitat and ecosystem integrity within the CHAA and the LSA. These habitats either do, or could, support populations of species of concern. Therefore, the assessment of potential impacts to those species, and others, occurring in the CHAA has been assessed in this section through the determination of the impacts to potential habitat (Table 6) for those species.

The impacts of the Project on critical habitat, as triggered by species of concern, are covered under the individual assessment of those species in Section 9.1.2. Other triggers of critical habitat are discussed, as relevant, in the appropriate sections.

Table 6: Area of vegetation communities at baseline, disturbance and loss due to Production Facility, and net change (% loss) in CHAA

Vegetation Community	Baseline CHAA (ha)*	Baseline Buhuka Flats (ha)	Loss to already permitted/ constructed infrastructure	Loss to proposed infrastructure (ha)	% Loss CHAA	% Loss Buhuka Flats
Bare Ground	24.0	5.0	1.9	0.3	9.0%	43.3%
Dense Bushland	1097.6	53.3	-	0.6	0.1%	1.1%
Dense Wooded Grassland	613.2	2.2	-	-	-	-
Grassland with Thicket	1101.1	255.6	4.2	6.7	1.0%	4.3%
Lagoons	33.2	32.5	-	0.1	0.6%	0.6%
Large Bays	73.7	2.7	-	-	-	-
Open Bushland and Shrubland	2896.3	27.5	0.1	0.2	0.0%	1.2%
Open Grassland	568.5	518.2	30.3	50.8	14.3%	15.6%
Open Sandy Shores	554.8	3.3	-	-	-	-
Permanent Wetland	83.8	83.7	-	-	-	-
Riverine Bushland	640.3	35.6	-	-	-	-
Riverine Woodland and Bushland	76.8	73.9	-	-	-	-

Rocky Escarpments	101.1	0.2	-	-	-	-
Seasonal Wetland	85.3	67.8	0.8	2.8	4.2%	5.3%
Settlement	207.9	142.2	0.3	2.8	1.5%	2.1%
Shallow River-Associated Waters	37.2	21.2	-	-	-	-

10.1.1.1 What impact could the construction/decommissioning of the Project have on the near-shore aquatic habitats of Lake Albert?

Impact Indicators

Indicators used to assess impacts of the Project on the habitat and ecosystem integrity of the near-shore environment of Lake Albert were changes in: regional representativeness; topography (geomorphology) and sediments; water quality; ecosystem composition; ecosystem configuration.

Loss of habitat due to direct disturbance and clearing associated with the Project was quantified by overlaying the current, baseline extent of the habitat with the Project footprint.

Additional, indirect impacts to habitat were estimated by applying a 1 km buffer to the Project footprint, forming the LSA. Specifically, the buffer was selected to account for changes in habitat quantity and/or quality that could be caused by sensory disturbance, changes in water quality, and air emissions and dust.

Changes in habitat composition and ecosystem configuration were assessed by identifying potential succession changes in species composition that could occur. This was accomplished by examining available literature about the ecology of Lake Albert, and scientific literature about the impacts of human activities on aquatic environments.

Impact Assessment

■ Representativeness

The CHAA supports 16.2 km of near-shore aquatic habitats, equating to about 810 ha (based on the near-shore habitat extending 0.50 km into the lake, see Section 7.1.1). Loss and degradation of these communities as a result of the Project has already occurred through the upgrade of the jetty area. Approximately 0.12 km of open sandy shoreline, extending 20 m into the lake, has been physically lost or severely disturbed by the construction of the jetty. This represents ~1% of the near-shore habitat within the CHAA, which is, consequently, a very localised impact, which is considered to be within the expected range of natural disturbance perturbations for the shoreline of Lake Albert. For example, through extreme weather events, lake level rise and fall, and longshore drift. The loss of this proportion of sandy shoreline community is, therefore, considered negligible in relation to the regional representativeness of this community; that is, a loss of 0.12 km of ~68 km (or 0.2%) of regional community.

The impact will be long-term, but largely reversible after decommissioning. Taking all factors into account, the magnitude of loss and disturbance will be low. However, this must be weighed against the very high sensitivity of the lake ecosystem, being a fresh water body that supports a high diversity of endemic and commercially important species of fish, threatened snails (the Critically Endangered mud snail, *Gabbiella candida*, and the Near Threatened Snail *Bellamya rubicunda*), threatened reptiles (the Vulnerable African Soft-shelled Turtle *Trionyx triunguis*) and threatened birds (the Endangered Grey-crowned Crane *Balearica regulorum*), as well as a shoreline important for many species of migratory birds.

■ Topography (geomorphology) and sediment transport

During construction, the existing jetty - consisting of a solid concrete structure extending some 20 m into the lake to provide sufficient draught during low water periods – will be upgraded; however, no material changes in the dimensions of the structure are anticipated. Approximately 1 km north along the shoreline beside Well

Pad 2, a water intake and water extraction pump station that also extends ~20 m into the lake is proposed for construction, which will see the alteration of ~0.12 km of open sandy shoreline.

The existing jetty's influence on the physical structure of the adjacent shoreline, and subsequent effects on the local geomorphology and longshore drift that maintain the shoreline, are not well understood; however, examination of recent aerial imagery suggests that some accretion of sediment on the eastern side of the jetty, and some erosion on the western side, is evident. Sediment drift is recognised as an important driver in shoreline ecosystems, contributing to the nutrient input that drives phytoplankton, zooplankton and fish communities (Parks et al. 2013). Various studies have shown that structures constructed on shorelines may disrupt hydrodynamic flow patterns, creating a barrier for sediment movement along the shore that can have a number of effects on faunal communities such as altered patterns of larval supply and food availability, and subsequent indirect effects on distribution and abundance of fish, turtles and birds through habitat modification and loss (in Walker et al. 2008). However, the zone of influence of structures constructed on shorelines is likely to be variable, depending on factors such as prevailing current direction, wave strength, and underlying substrate as well as the physical properties of the structure itself.

Given that there are not expected to be material changes in the dimensions of the jetty following upgrade works; it is not expected that its proposed upgrade will alter, in a substantial way, the geomorphological processes and sediment drift that currently govern the shoreline ecosystem of the Buhuka Flats, additional to the sediment deposition and erosion either side of the jetty that has already taken place. However, there is potential for the construction of the new water intake and water extraction pump station to affect geomorphological processes and sediment drift down-shore of Well Pad 2; which in combination with the existing jetty structure, could potentially affect the sediment drift or shoreline morphodynamics between Well Pad 2 and Bugoma Lagoon.

■   Water Quality

Sediment Loads

The construction of the jetty upgrade and water intake station has the potential to alter the water quality within the immediate surrounds of the construction activities through disturbance of the lake bed, and introduction of sediment into the water column during the works. It is expected that these increased sediment loads will dissipate reasonably quickly following completion of the jetty upgrade. The sediment loads in the vicinity of the jetty are not expected to exceed those that would normally be expected during windy periods on the lake and the consequent turbid conditions caused by those winds. Furthermore, these works are not expected to permanently alter the water chemistry in the vicinity of the jetty given the large buffering capacity of the lake compared to the scale of the works (see Surface Water Specialist Report, Volume 4, Study 2). Therefore, it can be expected that the upgrade of the jetty will not significantly affect the sediment loads and water quality of the near-shore habitats during construction.

The construction of the Kingfisher camps/parking lots/materials yards, airstrip extension, CPF, new in-field roads, crusher plant/spoil area A and development of existing well pads and associated infrastructure could cause increased sedimentation of near-shore habitats on the Buhuka Flats. Sediment generated during construction of the CPF itself, and other onshore infrastructure, could enter the lake during storm flows over the three-year construction period, peaking during site establishment when vegetation is being cleared and civil earthworks are ongoing. The soils of the Buhuka Flats are dispersive (Golder Associates 2014d), and active soil erosion is evident in the LSA. With the construction of the Project's components, and the consequent exposed areas of soil, there is a potential that, without adequate erosion and sediment control measures in place, sediment loads within the watercourses draining the Project footprint could increase. Cleared areas will be prone to sheet flow and scour, and high sediment loads could be expected, particularly in River 1, which will receive the drainage from the CPF earthworks and temporary camp (Figure 17). Additional sediment loads will also be contributed from the construction of the permanent camp. These sediment-laden watercourses report to Lake Albert and the Bugoma Lagoon, and, hence, there is a potential for increased sediment loads in the near-shore environments. Near-shore habitats particularly at risk include the lagoon, and to a lesser extent, the shallow river-associated habitats. Nevertheless, the watercourses draining the CHAA support dense emergent vegetation (see Section 7.1.1). Such vegetation forms an

impactive filter for most sediment (IECA 2008), therefore, it can be expected that sediment loads reporting to the near-shore habitats, at least via the Kamansinig River, River 1 and Masika River, could be minimal. Sediment loads from overland (stormwater) flows may not be retarded by vegetation, and hence may report to the near-shore habitats, contributing to measurable increased turbidity during and after storms, where River 1 discharges to the Lake.
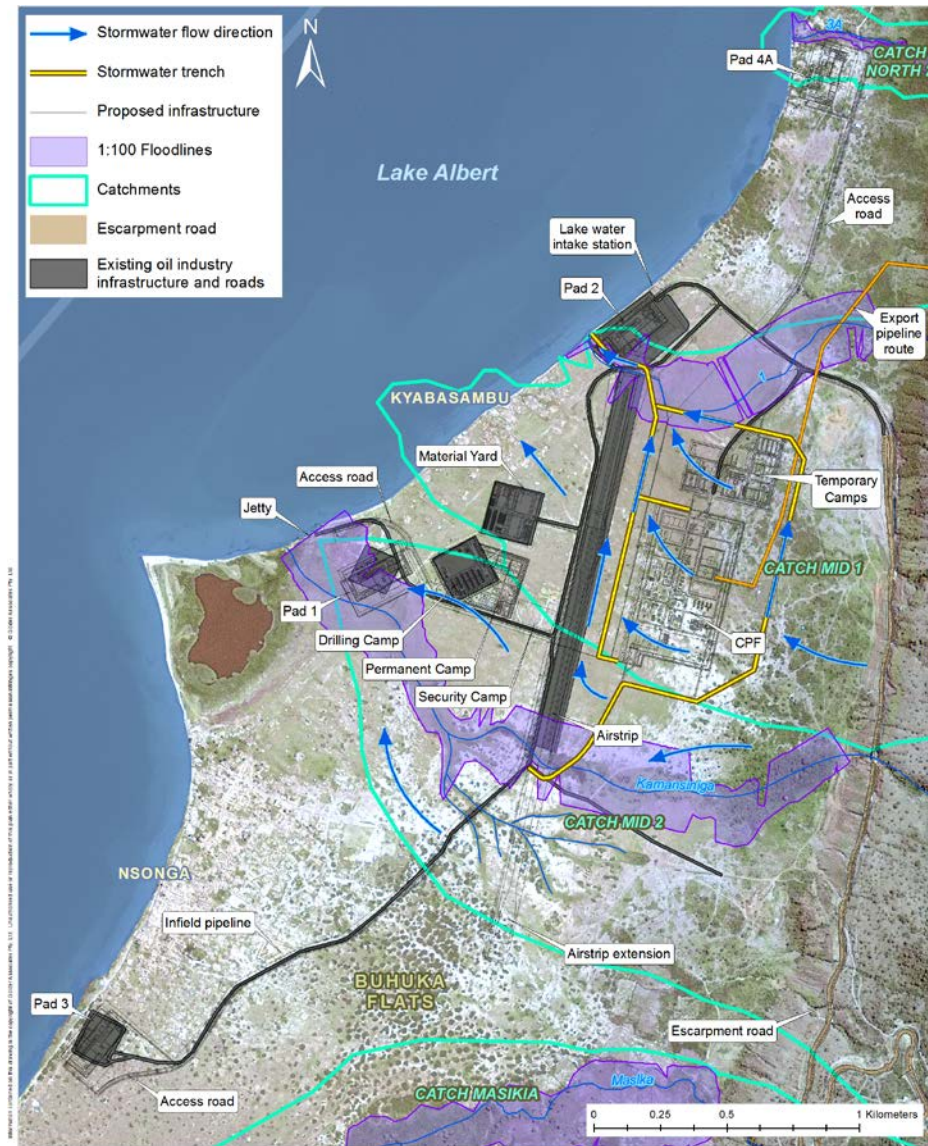
Figure 17: Rivers and catchments on Buhuka Flats

<u>Oil and Chemical Pollution</u>

Accidental spillages of small quantities of fuels and chemicals, and rain wash from oily construction equipment working on the jetty and water intake station during construction could report to the near-shore habitats of the CHAA, via stormwater drainage into River 1, and subsequently Lake Albert, south west of Well Pad 2. There is a real potential for this to occur as part of the jetty upgrade, expansion of Well Pad 1, and construction of new Well Pads. Both the jetty and the proposed expansion of Well Pad 1 are located on the lake shore, with no meaningful buffer between the facilitates and the lake; in these areas, the impact of this contamination would be more obvious than on land, and would also be harder to contain and clean up.

A further risk could result from the construction and drilling of the wells. While control systems such as bunding are proposed to manage contaminated stormwater and wash-water from the well pads, the presence of drilling crews on site for over a year, using potentially hazardous drilling fluid and other hazardous materials; and the absence of a buffer between the well pads and the lake (or, in the case of Well Pad 1, the seasonal wetland); makes it likely that occasionally-contaminated drainage could reach the lake, unless there is a very high level of control of day-to-day activities.

These risks should be assessed in the context of the sensitivity of the near-shore environment to oil and chemical spills. Certain invertebrate species (for example, aquatic snails (Araujo et al. 2012), mayflies (Savić et al. 2011)) and juvenile fish (for example, Agamy 2013) are highly sensitive to chemical pollutants, particularly hydrocarbons. Currently, the concentrations of hydrocarbons and other pollutants in the lake water are below levels that could cause harm to the environment (Surface Water); this is supported by the healthy aquatic communities observed in the lake's near-shore habitats (see Section 6.2). Therefore, impacts arising from potential changes to the water quality are predicted to be beyond the expected range of natural disturbance perturbations.

As such, without adequate spill prevention and clean-up measures in place, the entrainment of chemical and oil pollution to Lake Albert could have a detrimental impact on the near-shore habitats of the CHAA through the introduction of toxic compounds and pollutants. Such a spill could also have a detrimental impact on the aquatic invertebrate community and juvenile fish occurring in these habitats; this includes the Critically Endangered Mud Snail (*Gabbiella candida*) (if it does occur in the area).

Discharge of treated sewerage

The only continuous discharge into the lake during the construction phase will be from the sewage treatment plants. The effluent will be treated to meet the Ugandan effluent quality discharge standards (see Surface Water). At peak construction, the discharge will be around 300 m^3/day at the EPC contractor plant, and 50 m^3/day at the drilling camp plant. Both of these discharges will enter the lake via River 1, just south of Well Pad 2. The currents in the near-shore area of the LSA are not well known, so dispersion of nutrients in the sewage effluent have not been modelled. However, given the point source discharge, and the quantity of effluent involved, there is a risk of localised eutrophication, causing algal growth and possibly even fish kills around the discharge point. Impacts on water quality as a result of this potential eutrophication are predicted to be beyond the expected range of natural disturbance perturbations.

■ Ecosystem composition

All six of the main habitat types in Lake Albert, as identified for fishes by Wandera and Balirwa (2010) (that is, shallow river-associated waters, open sandy shores, lagoons, large bays, rocky escarpments, and, open-water habitats), occur within the near-shore areas of the CHAA (see Section 7.1.1, Figure 5). Similarly, the species guilds associated with the near-shore habitats of the CHAA, in particular fish, are well represented throughout those regions of the lake that have been investigated (for example, see Wandera and Balirwa 2010, Taabu-Munyaho et al. 2012). Consequently, at baseline, the composition of these ecosystems can be said to be in good condition and reflective of the aquatic diversity of Lake Albert. Similarly, these aquatic habitats have a well-developed structure, that is, well-defined aquatic plant layers associated with underwater features and substrates.

Tthe construction of the Project is likely to result in localised alteration of the ecosystem composition of the aquatic communities; particularly the open sandy shoreline habitat in the vicinity of the proposed water intake and water extraction pump station, and the sewage effluent discharge outfall. Although the upgrade of the existing jetty is not expected to substantially alter that section of open sandy shoreline within which it is located; a degree of sediment deposition and erosion has already taken place on either side of the structure; therefore similar effects are anticipated up-current and down-current of the proposed water intake and water extraction pump station near Well Pad 2, which would be beyond the expected range of natural disturbance.

The point source effluent discharge, and the quantity of effluent involved, presents a risk of localised eutrophication, which could cause changes in algal growth rates, and aquatic vegetation community

composition, thereby changing diversity and complexity of the aquatic habitats and their ability to support associated aquatic faunal communities. Impacts from the changes to ecosystem composition as a result of this eutrophication are predicted to be beyond the expected range of natural disturbance perturbations.

Although the open sandy shoreline habitat of itself is not very complex, consisting of a gently sloping lake bed comprised of fine and medium-grained sediments (Wandera and Balirwa 2010), with occasional aquatic plants; it could support species that trigger critical habitat including the Critically Endangered mud snail (*G. candida*) and African Soft-shelled Turtle (*T. triunguis*); therefore, any negative impacts on this habitat have the potential to be of major significance, and residual impacts will likely require offsetting.

- Ecosystem configuration

The construction of the CPF is expected to last for three years, and drilling will continue on individual well pads for a period of seven years. Although the upgrading of the jetty is not expected to substantially alter the configuration of the aquatic ecosystems and habitats in the CHAA, the construction of the new water intake and pump station could interrupt the connectivity amongst the near-shore aquatic habitats in its vicinity, to an extent beyond the range of natural perturbances.

Impact Classification

The near-shore aquatic habitat's sensitivity is high because these habitats potentially support populations of the Critically Endangered Mud Snail (*G. candida*), the Vulnerable African Soft-shelled Turtle (*T. triunguis*), and the range-restricted and Near Threatened Snail (*Bellamya rubicunda*). Near-shore aquatic habitat constitutes Tier 2 Critical Habitat for the Mud Snail (*G. candida*) (Table 4). Impacts on this habitat are therefore classified on the basis of high sensitivity to potential effects of the proposed development.

- Representativeness

Impacts to the representativeness of the habitat will be adverse. The geographical extent of impacts will be local because impacts are restricted to the LSA, and will only constitute approximately 0.2% loss of sandy shore habitat in the wider area. Impact duration will be into the far future (that is, ~25 years) because the jetty will remain in place even after the project is decommissioned. The changes to the representativeness of the near-shore habitats are expected to be reversible over time as naturalised geomorphological processes re-establish in the vicinity of the jetty and water intake station following construction, and re-establish following decommissioning. The magnitude of the impacts of construction/decommissioning on representativeness of the near-shore aquatic habitats is low; however, this must be weighed against the high sensitivity of these habitats. Therefore, the magnitude and sensitivity combine to produce an overall impact of moderate significance to representativeness prior to the application of project-specific mitigation measures (Table 7).

Following the application of appropriate mitigation measures, the impact significance is expected to remain the same, that is, moderate, primarily because the magnitude will still remain the same due to the loss of habitat, and the sensitivity of the receptor will remain the same.

- Topography (geomorphology), sediment load, and water quality

Impacts to the topography (geomorphology), sediment, and water quality will be adverse. The geographical extent of impacts will be regional because impacts are restricted to the CHAA. Impact duration will be short-term (that is, ~2 years) because impacts are expected to be limited to the construction phase.

The magnitude of the impact of the upgrade of the jetty and construction of the water intake pump station on topography (geomorphology) and sediment transport is medium, as although there will be no material change to the jetty's current dimensions, the water intake pump station will be constructed at a new location; and to date, the jetty appears to have caused some observable impact on the movement of sediment along the lake shore (build-up of sediment on the eastern side, and erosion on the western side). The geographical extent of any impacts will be restricted to the LSA, and the duration of impacts will be short-term (that is, ~3 years) because impacts are expected to be limited to the construction/decommissioning phase. Therefore, the significance of impact of the jetty upgrade and the construction of the new water intake pump station is considered to be **major.** Following the application of appropriate mitigation measures, the impact significance

on topography (geomorphology) and sediment transport is expected to be reduced to moderate, primarily because the magnitude will become low, and the sensitivity of the receptor will remain the same.

The magnitude of the impact of construction/decommissioning of the production facility and subsequent increased sediment load on water quality is medium, because, prior to any mitigation, there is potential for pollution to alter the quality of near-shore habitats. The geographical extent of impacts will be regional, being restricted to the CHAA, because, for example, possible effects on nursery areas for fish could eventually be felt across the entire Lake. The duration will be short-term (that is, ~3 years), that is, limited to the construction/decommissioning phase. Therefore, the medium magnitude of the impact and high sensitivity of the near-shore habitats combine to produce a major overall impact level to water quality as a result of increased sediment load during the construction/decommissioning of the production facility, pre-mitigation (Table 7). Following the application of appropriate mitigation measures, the impact significance is expected to be reduced to minor, primarily because the magnitude will become low, and the sensitivity of the receptor will remain the same.

In the context of the absence of a meaningful buffer between the well pads and the lake, the magnitude of the impact of the potential entrainment of small quantities of oil, chemicals and potentially hazardous drilling fluid into stormwater and wash water from the well pads on water quality is medium. This is because prior to the application of site-specific mitigation measures, the potential for pollution to alter water quality and affect highly sensitive aquatic species is substantial. As was the case for sediment load, the geographical extent of impacts could be regional. The duration will be short-term (that is, ~3 years) i.e. limited to the construction phase. As mentioned previously, the near-shore aquatic habitat's sensitivity is high, therefore, the magnitude and sensitivity combine to produce a major overall impact level to water quality as a result of potential contamination with oil and potentially hazardous chemicals during the construction/decommissioning of the production facility and drilling of the wells, pre-mitigation (Table 7). Following the application of appropriate mitigation measures, the impact significance is expected to be reduced to minor, primarily because the magnitude will become very low.

The magnitude of the impact of construction/decommissioning of the production facility and subsequent discharge of treated sewage effluent prior to mitigation is medium; given the quantity of effluent involved, the extent of changes to ecosystem composition brought about by increased algal growth (above that normally occurring) and eutrophication in the vicinity of the point source discharge could be significant. Therefore, the medium magnitude and high sensitivity combine to produce a major overall impact level to ecosystem composition during the construction/decommissioning phase of the Project, pre-mitigation (Table 7). Following the application of appropriate mitigation measures, the impact significance is expected to be reduced to minor, primarily because the magnitude will become negligible, and the sensitivity of the receptor will remain the same.

■ Ecosystem composition

Impacts to the ecosystem composition of near-shore habitats will be adverse. The geographical extent of impacts will be local because impacts are restricted to the LSA, in the vicinity of the jetty and proposed water intake pump station. Impact duration will be short-term (that is, ~3 years) because impacts are expected to be limited to the construction/decommissioning phase, and impacts would be largely reversible following construction, and later following decommissioning. The magnitude of the impact on ecosystem composition is low because, prior to mitigation, the potential for localised changes to ecosystem composition potentially brought about by changes in sediment erosion/deposition patterns, spread of invasive species, and changes in aquatic invertebrate, fish and plant communities around the treated sewage discharge point is possible. Therefore, the low magnitude and high sensitivity combine to produce a moderate overall impact level to ecosystem composition during the construction/decommissioning phase of the Project, pre-mitigation (Table 7).

Following the application of appropriate mitigation measures, the impact significance is expected to be reduced to minor, primarily because the magnitude will become negligible, and the sensitivity of the receptor will remain the same.

■ Ecosystem configuration

Adverse construction/decommissioning impacts on ecosystem configuration are predicted to occur with the construction of the new water intake pump station. The magnitude of the resultant impacts to the ecosystem configuration of near-shore habitats is predicted to be low, as the geographical extent of impacts will be local - restricted to the LSA, in the vicinity proposed water intake pump station, although impact duration will be long-term because impacts are expected to be continue beyond the construction phase and into the operation phase.

Therefore, the low magnitude and high sensitivity combine to produce a moderate overall impact level to ecosystem composition during the construction/decommissioning phase of the Project, pre-mitigation (Table 7). Following the application of the recommended mitigation measures, the impact significance is expected to remain moderate, as impacts of a low magnitude will continue for the operational lifetime of the pump station, and the sensitivity of the receptor will remain the same.

Table 7: Potential impacts in the construction phase to near-shore habitats

Indicator of potential impact	Pre-mitigation			Post-mitigation (pre-offsets)		
	Magnitude	Sensitivity of the Receptor	Significance	Magnitude	Sensitivity of the Receptor	Significance
Representativeness	Low - 2	High - 4	Moderate – 8	Low - 2	High - 4	Moderate – 8
Topography (geomorphology) and sediment transport	Medium - 3	High - 4	Major – 12	Low - 2	High - 4	Moderate – 8
Water quality – sediment loads	Medium - 3	High - 4	Major – 12	Negligible - 1	High - 4	Minor – 4
Water quality –oil and chemical pollution	Medium - 3	High - 4	Major – 12	Negligible - 1	High - 4	Minor – 4
Water quality - sewerage	Medium - 3	High - 4	Major – 12	Negligible - 1	High - 4	Minor – 4
Ecosystem composition	Low - 2	High - 4	Moderate – 8	Negligible - 1	High - 4	Minor – 4
Ecosystem configuration	Low - 2	High - 4	Moderate – 8	Low - 2	High - 4	Moderate – 8

Prediction Confidence

Given the information available, there is a reasonable understanding of the potential Project impacts to the near-shore habitats of the CHAA. However, there is some uncertainty in regard to the irreplaceability and vulnerability of those habitats in the CHAA. Given the current uncertainty in relation to climate change and possible scenarios with the level of Lake Albert, which has, in the recent and not so recent past, varied quite dramatically (Talbot et al. 2006), it is conceivable that level of the lake may increase or decrease thereby altering near-shore habitats.

The spatial extent of the near-shore habitats in the CHAA was broadly mapped based on knowledge of the site, baseline studies, literature and reports (see Section 7.1.1). The actual extent of possible habitat may have been over-estimated.

10.1.1.2 What impact could the construction/decommissioning of the Project have on the wetlands in the Buhuka Flats region of the CHAA?

Impact Indicators

Indicators used to assess impacts of the Project on the habitat and ecosystem integrity of the wetlands of the CHAA were changes in: regional representativeness; ecosystem composition; and ecosystem configuration.

Loss of habitat due to direct disturbance and clearing associated with the Project (including existing, permitted infrastructure, and proposed infrastructure not yet built) was quantified by overlaying the current, baseline extent of the vegetation communities with the current and proposed Project footprint.

Additional, indirect impacts to habitat were estimated by applying a 0.50 km buffer to the Project infrastructure. Specifically, the buffer was selected to account for changes in habitat quantity and/or quality that could be caused by edge effects, fragmentation, sensory disturbance, changes in water quantity and quality (drivers of ecosystem processes and functions), and air emissions and dust.

Changes in habitat composition and ecosystem configuration were assessed by identifying potential changes in species composition that could occur, and the disruption of known corridors. This was accomplished by examining available scientific literature about the ecology of wetlands (permanent and seasonally flooded grasslands).

Impact Assessment

■   Representativeness

In the Buhuka Flats, the CHAA supports approximately 151 ha of wetlands (see Table 6). These are comprised of permanent wetlands (83 ha, or 55% of wetlands in the Buhuka Flats) and seasonally flooded grasslands (69 ha, or 45%).

Wetlands in the LSA are associated with drainage off the escarpment, which is seasonal to varying degrees. The shallow gradients across the Buhuka Flats encourage wetland formation, and most of the stream channels are associated with fringing wetland vegetation and seasonally flooded grasslands. The Kamansinig River is hydrologically linked to the Bugoma Lagoon, the large papyrus-fringed wetland south-west of well pad 1.

Construction/decommissioning of the Project infrastructure will affect both the permanent wetlands and the seasonally flooded grasslands of the LSA. Figure 18 shows the main areas of direct impact. Table 8 quantifies the impact, based on the area of physical disturbance during construction and the expected long-term (or permanent) impact after construction and decommissioning. It should be noted that the infield access roads have already been licensed and built (see Table 8), but are included in this discussion of impacts for completeness. The construction right-of-way for both roads and flow lines is 20 m wide.

The road and flow line to well-pad 3 cut across the permanent wetlands of the lower Masika River; the in-field road and flow line from well-pad 3 to well-pad 2 cut across seasonally flooded grassland; the extension of the airstrip has resulted in the loss of approximately 1 ha of seasonally flooded grassland; and the extension of well pad 1 will result in the direct loss of an additional 4.8 ha of seasonally flooded grassland. This loss equates to approximately 4.7 ha (3.11%) of wetlands in the CHAA.

Table 8: Wetland areas directly affected by the construction of the production facility

Project Infrastructure Name	Wetland Area Affected (ha)*	Propoprtionate loss (%)
	Kamansinig River	
Infield Access Road**	1.5	0.99%
Infield Flowline	0.5	0.33%
Well Pad 1	2.7	1.78%

Project Infrastructure Name	Wetland Area Affected (ha)*	Propoprtionate loss (%)
	Kamansinig River	
Total	4.7	3.11%

*   Blue cells show temporary construction impact. White cells show long term / permanent impact
** Licensed and built
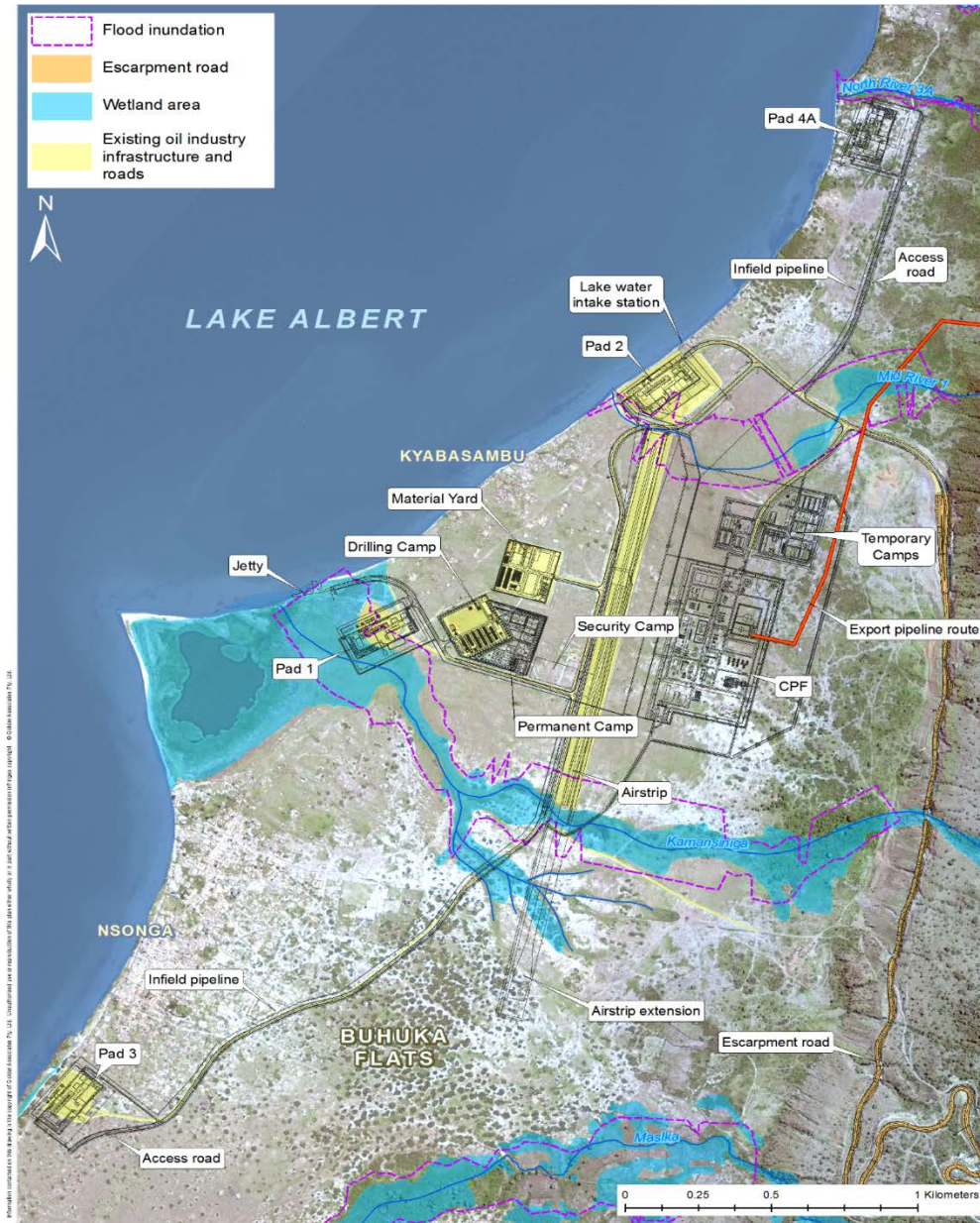
Figure 18: Wetlands in the Buhuka Flats directly impacted by construction/decommissioning of the Production Facility

The loss of this quantity of wetlands in relation to their representation in the wider CHAA and the Buhuka Flats is not insubstantial (~4% - 5%); furthermore, because this loss is brought about by the construction of linear features, there is a potential for the downstream wetland habitat to be affected if proper management controls are not implemented.

Impacts from the changes to representation of the wetlands in the CHAA are predicted to be beyond the expected range of natural disturbance perturbations.

■   Wetland Structure and Ecosystem Composition

Roads

The construction of linear infrastructure, such as roads through wetland communities is known to have detrimental impacts on the functioning, processes and species composition of these communities (Roise et al. 2004).   Road construction may result in significant loss of biodiversity at both local and regional scales due to restricted movement between populations, increased mortality, habitat fragmentation and edge effects, invasion by exotic species, or increased human access to wildlife habitats, all of which are expected to increase local extinction rates or decrease local recolonisation rates (Findlay and Bourdages 2000).   Consequently, it could be expected that, particularly the construction of the airstrip and in-field roads through the seasonally flooded grassland would have already altered the ecosystem processes and functions driving these wetlands, especially downstream. This could have occurred if flow paths for water, both surface and sub-surface, were not maintained (see Chapter X.0 Surface Water). If these flow paths are not maintained on an ongoing basis, there is a potential that the wetland community downstream of the obstruction could become altered – typically via redirection of flows, and/or flow concentration and channel incision in downstream wetlands that were previously supplied by diffuse, dispersed flows. In an environment like the Buhuka Flats, where soils are clayey and dispersive, the risk of incised drainage and associated loss of wetland function due to concentration of water flows is high. The vegetation within these seasonally flooded grasslands is adapted to seasonal inundation, and, therefore, is dependent upon that cycle of wet and dry for survival. Additional, associated impacts that could occur in tandem with channel incision and subsequent wetland desiccation include exotic species invasion.

As part of standard construction methods, wetland/drainage line crossings have been installed as part of the in-field road and airstrip construction. Nevertheless, even with such measures in place, there is still a potential for changes to the wetland character to occur. For example, there is the potential for erosion downstream of the crossings, backwater upstream of the crossings, and erosion at the entrance to the crossing structures. The airstrip is one area in particular where construction across a drainage line might lead to decreased flows and erosion downstream of the airstrip (Golder Associates 2014b). This could lead to changes in the ecosystem functions and processes in the downstream wetlands.

There is an existing example of this on the Kamansinig River, where a road crossing upstream of the airfield leads to a quarry near the base of the escarpment (Figure 19). The damage was done by inappropriate culvert design (size, numbers and spacing), mostly in the wrong place, which has resulted in an altered flow regime, and subsequent desiccation of the wetland downstream of the impeding feature (the road), and increased wetness upstream of the road. The long-term impacts of the flow impediment created by the road include encroachment of terrestrial and exotic plant species to areas of the wetland that have become desiccated, and changes in vegetation community upstream – from seasonally flooded grassland communities to plants more characteristic of permanently saturated conditions, such as *Phragmites* sp. and *Typha* sp. During times of peak rainfall, outflow to the downstream areas is likely to be concentrated at a single spill point, and could contribute to channel erosion and further desiccation of the downstream wetland areas over time.

In addition, these wetland communities are already under pressure from livestock grazing, and harvesting of fibre for house construction. It is possible that these communities may change in the long-term as grazing pressure increases, and the human population of the Buhuka Flats increases (Golder Associates 2014e). These changes could alter the habitat structure and composition, which, in turn, could affect the utilisation of these wetlands by the currently resident species guilds.

Impacts to ecosystem composition of the wetlands in the CHAA are predicted to be beyond the expected range of natural disturbance perturbations.

Figure 19: Impact of a poorly-designed road crossing on wetland in Buhuka flats

Flowlines

Buried pipelines crossing rivers and wetlands will not (of themselves) obstruct surface water flow. The backfill into the trench is not normally cemented or compacted, which, for small diameter pipelines, minimises the risk of impact on subsurface flow. The risk to wetland function is mainly due to the disruption of wetland vegetation and soils by heavy machinery, particularly when tracked vehicles are used that have greater impact on soil structure and the soil profile is overturned due to careless construction management. Disruption of flows and ecosystem composition may also occur if fill material is imported into the wetland to provide stability for excavators and pipe layers, and is not completely removed and replaced with the natural soils after construction. This may result in long-term changes in vegetation composition and changes in flow patterns, with similar downstream consequences to those described under 'roads'.

Impacts on wetland fauna will depend on the changes in wetland vegetation as a result of construction; in addition, the noise and sensory disturbances created by the construction equipment could alter the behaviour of species frequenting the wetlands during construction/decommissioning. For example, wading birds and Grey Crowned Cranes are unlikely to tolerate construction nuisance within 500 m and could avoid these areas entirely during the construction period. If construction occurs during the breeding season of the Grey Crowned Crane (that is, the dry season (Archibald et al. 2013)), which could be breeding in the permanent wetland associated with the Masika River, then disturbance from the construction activities could cause nest abandonment (Strasser et al. 2013).

Wellpad 1 expansion

The extension of well pad 1 will impact directly on wetland functioning in the seasonally-flooded grassland associated with the lower reaches of the Kamansinig River. The existing well pad is within the northern edge of these seasonally flooded grasslands. The expanded well pad will extend the impact on the wetland into the centre of the floodplain. The darker colour of the wetland in the satellite image in Figure 20 shows its position in relation to the well pad. The magnitude of this impact is considered to be high from legal and functional perspectives – the location is prohibited by Ugandan legislation (Uganda Wildlife Act, 2000), and contrary to the natural habitat conservation guidelines of IFC PS6 - and the impact on wetland function could be material, interfering with subsurface flow and surface flow during peak flow events. The vegetation within these seasonally flooded grasslands is adapted to seasonal inundation, and, therefore, is dependent upon that cycle of wet and dry for survival. The noise and sensory disturbances created by the construction equipment could

alter the behaviour of species frequenting the wetlands, particularly Grey Crowned Crane. Coupled with the very high sensitivity of this system, with its hydrological interconnectivity to the Bugoma lagoon, the impact significance will be high**.**

Increased runoff from construction areas

The majority of the area affected by construction of the CPF will drain north into River 1 (Figure 20). Perimeter drains upslope of the CPF will divert clean stormwater flow around the platform and discharge directly to River 1. The first 15 minutes of stormwater draining from potentially contaminated areas such as the platforms will be diverted to a testing and treatment tank, before being discharged to River 1 once acceptable standards have been reached. After the first 15 minutes, stormwater from potentially contaminated areas will be discharged directly to River 1 via the perimeter drains. Stormwater from the construction of most of the permanent camp, the extension of well pad 1 and the southern section of the flow line linking well pad 1 to the CPF will drain southward into the Kamansinig River, and will follow the same standard clean and dirty water practises. Figure 20 shows the most likely direction of flow from the construction sites.

Drainage volumes during storm events are expected to be larger (due to the removal of vegetation and the compaction of ground surfaces, and hardstand areas), and, consequently, peak-flow volumes will be larger. Additionally, concentration of stormwater flows into the drainage lines will significantly increase the risk of channel incision, which in the flat environment between the escarpment and the lake, may result in drying out of the associated wetlands due to more rapid drainage of the area. The magnitude of this impact will be exacerbated by the soils, which are dispersive (see Soils Assessment, Volume 4, Study 4), prone to gully erosion, and, therefore, highly likely to form incised channels.
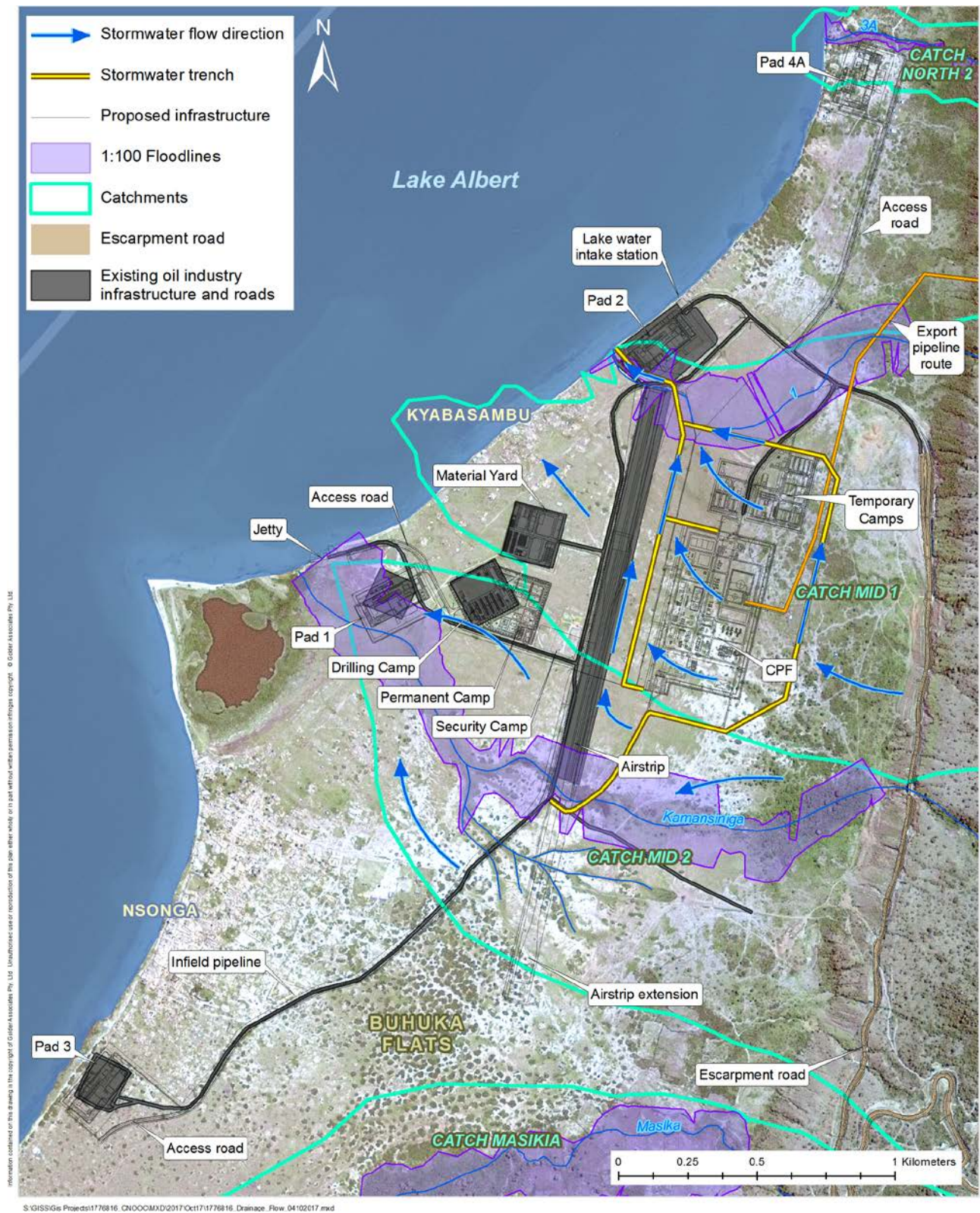
Figure 20: Direction of storm flows from construction sites

■ Water Quality and Ecosystem Composition

Impacts to ecosystem composition of the wetlands in the CHAA are predicted to be well beyond the expected range of natural disturbance perturbations; factors affecting wetland water quality that could impact ecosystem composition, including erosion and sedimentation, fuel and chemical spills, discharge of hydrotest water, disposal of treated effluent, overturning of acid sulphate soils and population increases are discussed below.

Erosion and Sedimentation

The construction of the Kingfisher camps/parking lots/materials yards, airstrip extension, CPF, new in-field roads, crusher plant/spoil area A, , and associated infrastructure could cause increased erosion and sediment-laden run-off to report to the wetlands surrounding the Project footprint. The soils of the Buhuka Flats are dispersive (Golder Associates 2014d), and active soil erosion is evident in the LSA. With the construction of the Project's components, and the consequent exposed areas of soil, there is a potential that, without adequate erosion and sediment control measures in place, sediment loads within the watercourses draining the Project footprint could increase. Hence, there is a potential for increased sediment loads in the wetland habitats. The watercourses and associated wetlands draining the LSA support dense emergent vegetation (see Section 6.1.1.1). Such vegetation can form an impactive filter for most sediment (IECA 2008); therefore, it can be expected that sediment loads reporting to downstream wetland habitats could be minimal. Nevertheless, if sediment loads are substantial, there is a potential for that sediment to smother wetland vegetation and interfere with aquatic invertebrates. If this occurs, it could detrimentally affect the wetland processes and functions, which, in turn, could alter wetland composition, albeit on a localised scale.

As part of standard construction methods, appropriate drainage line crossings will be installed as part of the in-field road and airstrip construction. Nevertheless, even with such measures in place, there is still a potential for changes to the wetland character to occur. For example, there is the potential for erosion downstream of the crossings, backwater upstream of the crossings, and erosion at the entrance to the crossing structures. The airstrip is one area in particular where construction across a drainage line might lead to decreased flows and erosion downstream of the airstrip (Golder Associates 2014b). This could lead to changes in the ecosystem functions and processes in the downstream wetlands.

Hydrocarbon and Chemical Spills

Accidental spillage of fuels and chemicals during the construction/decommissioning of the CPF are possible, where the most complex construction activities will take place over a period of 3 years, involving a wide range of potentially toxic materials (refer to Waste). On the well pads, the presence of drilling crews for around a year, using large quantities of potentially hazardous drilling fluid and other hazardous materials, increases the risk of escape of contaminated water into watercourses and subsequently the wetlands of the LSA. The highest risk is most likely at Well Pad 1, most of which is being extended into the seasonally-flooded grassland wetland associated with the Kamansinig River.

Certain invertebrate species (for example, aquatic snails (Araujo et al. 2012), mayflies (Savić et al. 2011)) and juvenile fish (for example, Agamy 2013) are highly sensitive to chemical pollutants, particularly hydrocarbons. Currently, the concentrations of hydrocarbons and other pollutants in the water of the Bugoma Lagoon are below levels that could cause harm to the environment (Golder Associates 2014b); this is supported by the healthy aquatic communities observed in the lagoon's and Masika River wetland habitats (see Section 6.2). The proximity of the main areas of construction to wetlands on the Flats provides little buffer in the event that minor day-to-day spillages escape from the work areas, which increases the risk of impact.

Discharge of Hydrotest Water

The commissioning of pressure vessels and flow lines involves hydrotesting, in which the vessels are filled with water and pressurised to verify their integrity. On occasions, biocides and corrosion inhibitors are added to the water, depending on the residence time, before it is discharged. Details are not presently available, but is it is assumed that this water will be discharged into the nearest drainage lines. Without management, its

release can present a severe risk to the aquatic environment, resulting in possible mortality and degradation of downstream ecosystems and species.

Disposal of Treated Sewage Effluent

Treated sewage effluent in excess of 300 m^3/day will be discharged for much of the construction phase. The effluent will be treated to meet the Ugandan effluent quality discharge standard (see Surface Water). It is proposed that the effluent from the temporary camp will be discharged into River 1, north of the camp. The effluent from the drilling camp will be discharged into River 1.

Wetlands are efficient nutrient sinks and have been used in both controlled and uncontrolled conditions to polish sewage effluent. Depending on the point of discharge, River 1 is likely to be tolerant of the additional daily flow and the addition of nutrients, which will promote the growth of emergent wetland vegetation.

Overturning of Acid Sulphate Soils

The potential for the occurrence of acid sulphate soils in the permanent wetland associated with the Masika River should not be discounted. Typically, submerged sediments in inland aquatic ecosystems have very little oxygen below the first few millimetres, and can, therefore, be sites where sulphur compounds are formed, which can lead to potential acid sulphate soils (EPHC 2011). When these soils are disturbed and exposed to oxygen, such as through the construction of a trench through a wetland, the sulphur compounds react with the oxygen in the air and the water to produce sulphuric acid. If the amount of acidity produced by this process is greater than the system's ability to absorb, or neutralise that acidity, then the acidity, or pH, of the system falls (EPHC 2011). The formation and release of this acid can lead to adverse impacts to aquatic habitats. Assuming the wetland does not have a high capacity to neutralise the acid, the process of forming the acid can consume oxygen, and, in extreme cases, can remove all of the oxygen from the water column, resulting in the death of aquatic organisms. The acid formed by this process may also lead to the mobilisation and availability of heavy metals (such as, cadmium and lead), aluminium, iron, and arsenic into the environment. These elements can be toxic to aquatic life (EPHC 2011).

Within Uganda, these soils are typically associated with papyrus peats and other permanent wetlands (Golder Associates 2014d). The permanent wetland associated with the lower reaches of the Masika River, has a potential to harbor potential acid sulphate soils. Therefore, if these soils are disturbed, for example, during the construction of trenches for flowlines, there is a potential for acid formation and the consequent toxic impacts to the ecosystem. If severe enough, such toxic impacts can cause the permanent dieback of wetland vegetation and alter wetland functioning and processes (EPHC 2011).

However, while acid sulphate soils may be present in the permanent wetlands along the Masika River to the south and in the Buhuka Lagoon, they are not expected in the seasonal wetlands that will be affected by construction of the production facility and the toxic effect of acid generation associated with their disturbance should not arise.

Increase in Population on Buhuka Flats

Indirect impacts on wetlands as a result of water quality impacts could occur as a result of the migration of people onto the Buhuka Flats in search of work. Existing sanitary conditions on the Flats are poor, with all of the streams that drain across the Flats being contaminated with faecal waste from both animals and humans (see Social Impact Assessment, Volume 4, Study 10). Increasing population pressures on the flats will exacerbate these conditions. Increased grazing pressure and erosion from denuded areas around expanding settlements will increase erosion and sedimentation in the wetlands.

- Ecosystem configuration

Roads are known to be significant barriers to, or can alter behaviours of, a range of wetland wildlife, from: amphibians (for example, Pontoppidan et al. 2013); to turtles (for example, Langen et al. 2012). Depending on the species, the presence of the existing in-field roads may affect individuals in many direct and indirect ways.   For example, roads may inhibit seasonal migration and may cause an impactive loss of habitat due to

avoidance. The presence of the in-field roads through the wetlands of the Buhuka Flats are not expected to be major barriers to movement for those species inhabiting them. These roads are only expected to be 5 m wide and unsealed, and, once construction is complete, they will convey limited traffic volumes. Therefore, they are not expected to be major barriers.

The construction of the existing and proposed in-field roads and airstrip has/will cut currently contiguous wetlands in the LSA. If not managed correctly during the construction process, that is, the installation of appropriate drainage connections, these Project components could cause permanent barriers between the two newly separated wetland habitats – as has already been demonstrated at the road crossing adjacent to the airstrip (Figure 19). The process of clearing the wetlands for the construction of the roads and airstrip will create edge impacts, and result in the fragmentation of the wetland habitats. As already discussed, vegetation clearing creates edges or boundaries where habitat meets a disturbance. These edges open up habitat in areas where it was previously continuous, and this generally changes the abiotic conditions (for example, temperature, light, and moisture regimes) (Porensky and Young 2013). Edges also often result in changes in species composition along the edge, with the edges typically becoming dominated by pioneer and weedy species adapted to the particular microclimate experienced on the edge (Porensky and Young 2013). Fragmentation of wetland habitat is known to reduce the viability of many species and the wetland as a whole, with the viability of the particular fragment dependent on its size, proximity and, hence, connectivity to other wetland habitats (Uzarski et al. 2009).

What long-term impacts the construction of these roads and the airstrip could have on the wetland communities' configuration are unknown; in particular their resilience. What is known is that these wetland communities are already under pressure from livestock grazing, and harvesting of fibre for house construction.

Impacts to ecosystem configuration of the wetlands in the CHAA are predicted to be beyond the expected range of natural disturbance perturbations.

Impact Classification

The wetland's sensitivity is high because these habitats, particularly the permanent wetlands, are potential breeding habitat for Grey Crowned Cranes (a species of concern). The wetlands are also already under stress from livestock grazing and harvesting of fibre. This high sensitivity is weighed against the magnitude of each of the impacted indicators as described in the paragraphs below, in order to derive the overall impact level for each indicator.

■ Representativeness

Impacts to the representativeness of the habitat will be adverse. The geographical extent of impacts will be local because impacts are restricted to the LSA on the Buhuka Flats, and will constitute loss of approximately 4.2% of seasonally flooded grassland communities in relation to the CHAA. The flowline construction impacts will be generally short-term (subject to appropriate construction management); and while permanent wetland habitat loss will be caused by well pad 1 and its proposed expansion, and by the access roads, the relatively small area covered results in an overall impact of low magnitude. In the context of high wetland sensitivity, this results in impacts of moderate significance.

Following the application of appropriate mitigation measures, the impact significance is expected to remain minor, as some permanent wetland loss to the roads and expansion of well pad 1 will remain in place even after the project is decommissioned. The changes to the representativeness of the wetland communities, although probably irreversible, are expected to be amendable via offsetting (see Section 13.0).

■ Wetland Structure and Ecosystem Composition

Impacts to the ecosystem composition will be adverse. The geographical extent of impacts will be local because impacts are restricted to the LSA. Impact duration will be into the far future (that is, ~25 years) because impacts are expected last as long as the in-field roads and airstrip are in place. The magnitude of the impact on ecosystem composition is medium because, prior to the implementation of the recommended site-specific mitigation, the potential for changes to wetland structure and ecosystem composition potentially

brought about by the roads, flowlines, well pad 1 extension, potentially contaminated runoff from construction areas and population/livestock head increases are likely, which could result in edge effects, changed flow regimes, and erosion and sedimentation of affected wetlands. Therefore, the magnitude and high sensitivity of the wetlands combine to produce a major overall impact level to ecosystem composition during construction/decommissioning of the Project, pre-mitigation (Table 9).

Following the application of appropriate mitigation measures, including appropriate construction management methods, the impact significance is expected to remain moderate, because although the magnitude will become low, the sensitivity of the receptor will remain the same.

■ Water Quality and Ecosystem Composition

Impacts to the ecosystem composition will be adverse. The geographical extent of impacts will be local because impacts are restricted to the LSA. Impact duration will be for the duration of construction, which is expected to take approximately 3 years. The magnitude of the different project-specific impacts on ecosystem composition varies, as discussed under each of the subheadings below.

Erosion and Sedimentation

Clearing of vegetation will result in increased sediment loads in stormwater flows. These impacts will be of short duration, most likely occurring as a result of significant rain events, and will be most frequent in the early stages of construction when bulk earthworks are in progress and large areas of exposed earth are available. Impacts will be local (mainly in the catchment of River 1 and, to a lesser degree, in the Kamansinig River catchment). They will generally be reversible, and, consequently, have a medium magnitude. Wetland plant species are generally tolerant of occasional increases in sediment load in stormwater flows, and can serve as an effective sediment filter. In cases of severe and/or ongoing sediment loading, detrimental impacts on wetland vegetation and macro-invertebrates could be likely, which could detrimentally affect wetland processes and functions and, in turn, wetland composition at a localised scale. Overall wetland sensitivity to sediment increase is considered to be high; therefore the overall significance of this impact is moderate**.**

Following the application of appropriate mitigation measures, the impact significance is expected to reduce to minor, because the majority of sediment would not reach the rivers, lagoon or lake in one flush.

Hydrocarbon and Chemical Spills

The concentrations of hydrocarbons and other industrial pollutants in the wetlands of the LSA are presently below levels that cause harm in the aquatic environment (Golder Associates 2014b). Some invertebrate species (such as aquatic snails, described in Araujo et al. 2012), mayflies (Savić et al. 2011)) and juvenile fish (Agamy 2013) are particularly sensitive to these pollutants. The proximity of the main areas of construction to wetlands on the flats provides little buffer in the event that spillages escape from the work areas, which increases both the risk of impact, and the potential magnitude of such an event. In the absence of daily monitoring and management of site activities by competent personnel, the potential impact magnitude could be high, resulting in an overall impact of major significance.

Following the application of appropriate mitigation measures, the impact magnitude is expected to reduce to medium, which in combination with the high sensitivity of the wetland habitat, results in an overall impact of moderate significance.

Discharge of Hydrotest Water

Details on the use of biocides and corrosion inhibitors in the hydrotest water are not presently available, but for the purposes of the assessment it is assumed that they are present, and the hydrotest water will be discharged into the nearest drainage lines. Without management, this one-off release can present a severe risk to the aquatic environment, resulting in possible mortality and/or degradation of downstream species and ecosystems. Unmitigated impacts will be long term, only partly reversible, local in geographic extent, and, therefore, of low magnitude. Combined with high receptor sensitivity, this will result in impacts of major significance, prior to mitigation.

Following the application of appropriate mitigation measures, the impact magnitude is expected to reduce to low, which in combination with the high sensitivity of the wetland habitat, results in an overall impact of moderate significance.

Disposal of Treated Sewage Effluent

Assuming that the point of discharge is located further upstream where the permanent wetland vegetation is established in that area and has the capacity to act as a buffer, River 1 is likely to be tolerant of the additional daily flow and the addition of nutrients, a change in species composition due to the promotion of the growth of emergent wetland vegetation could occur, with some species that adapt well to nutrient-enrichment (persistent emergent plants such as sedges (eg. *Scirpus sp.)*, rushes (*Juncus sp.),* common reed (*Phragmites sp.)* and cattails (*Typha sp.*) could proliferate. The magnitude of this impact is considered low, which, combined with high receptor sensitivity, will result in impacts of moderate significance.

Overturning of Acid Sulphate Soils

Acid sulphate soils are not expected in the seasonally-flooded grassland wetlands that will be affected by construction of the production facility; therefore, the toxic effect of acid generation associated with their disturbance should not arise.

The permanent wetland associated with the lower reaches of the Masika River, has a potential to harbor potential acid sulphate soils. Therefore, if these soils are disturbed during the construction of the flowlines between the well pads, there is a potential for acid formation and the consequent toxic effects to the ecosystem.

It is assumed that the potential acid sulphate soils in the permanent wetlands in the CHAA will be adequately managed during construction, and no lasting effects will occur. The magnitude of this impact is thus considered neglible, which, combined with high receptor sensitivity, will result in impacts of minor significance

Increase in Population on Buhuka Flats

In the absence of project interventions, the impact of increased population density (and associated increases in grazing livestock) on the Buhuka Flats is expected to be long-term, and to have a material effect on water quality in the wetlands across the Flats through reductions in sanitary water quality, exacerbation of wetland erosion, increased harvest of plant species used for traditional home construction, increased fire frequency and increased grazing pressure. The effects will be irreversible, and of high magnitude. In the context of the high wetland sensitivity, the predicted impact significance is major, prior to mitigation.

Following the application of appropriate mitigation measures, including appropriate construction management methods, the impact significance is expected to remain moderate, as although the magnitude will become low, the sensitivity of the receptor will remain the same.

■　**Ecosystem Configuration**

Impacts to the ecosystem configuration will be adverse. The geographical extent of impacts will be local because impacts are restricted to the LSA. Impact duration will extend into the far future (that is, ~25 years) because impacts are expected to continue as long as the in-field roads and airstrip are in place. The magnitude of the impact on ecosystem configuration is medium because, prior to the application of the site-specific mitigation measures (Section 9.0), the potential for changes to ecosystem configuration is possible, especially from fragmentation.

As mentioned, the wetland's sensitivity is high because these habitats, particularly the permanent wetlands, are potential breeding habitat for Grey Crowned Cranes. The wetlands are also already under stress from increased fire frequency, livestock grazing and harvesting of fibre. Therefore, the magnitude and sensitivity

combine to produce a major overall impact level to ecosystem configuration during the construction phase of the Project, pre-mitigation (Table 11).

Following the application of site-specific mitigation measures (Section 12.2), the impact significance is expected to remain moderate, although the magnitude will become low, yet the sensitivity of the receptor will remain the same.

Impact Significance Rating

Table 9: Potential impacts in the construction phase to the wetlands of the CHAA

Indicator of potential impact	Pre-mitigation			Post-mitigation (pre-offsets)		
	Magnitude	Sensitivity of the Receptor	Significance	Magnitude	Sensitivity of the Receptor	Significance
Representativeness	Medium – 3	High – 4	Major – 12	Low – 2	High – 4	Moderate – 8
Ecosystem composition – wetland structure	Medium – 3	High – 4	Major – 12	Low – 2	High – 4	Moderate – 8
Ecosystem composition – water quality						
Erosion and sedimentation	Medium – 3	High – 4	Major – 12	Low - 2	High – 4	Moderate - 6
Hydrocarbon and chemical spills	High – 4	High – 4	Major – 16	Low - 2	High – 4	Moderate - 8
Discharge of hydrotest water	Medium – 3	High – 4	Major – 12	Low - 2	High – 4	Moderate - 8
Disposal of treated sewage effluent	Low - 2	High – 4	Moderate – 8	Negligible - 1	High – 4	Minor – 4
Overturning of acid sulphate soils	Negligible - 1	High – 4	Minor - 4	Negligible - 1	High – 4	Minor - 4
Population increase	High – 4	High – 4	Major – 16	Low – 2	High – 4	Moderate – 8
Ecosystem configuration	Medium – 3	High – 4	Major – 12	Low – 2	High – 4	Moderate – 8

Prediction Confidence

Given the information available, there is a reasonable understanding of the potential Project impacts to the wetlands of the Buhuka Flats region of the CHAA. However, there is some uncertainty in regard to the irreplaceability and vulnerability of those habitats in the CHAA. Given the current uncertainty in relation to climate change and possible scenarios, as well as increasing human pressures, how important these habitats will become in the future is uncertain.

The spatial extent of habitats in the CHAA was broadly mapped based on knowledge of the site, baseline studies, literature and reports (see Section 6.1). The actual extent of possible habitat may have been over-estimated.

10.1.1.3 What impact could the construction/decommissioning of the Escarpment Road have on the escarpment vegetation corridors?

While the escarpment road has been licensed and built on the basis of an earlier impact assessment (AWE, 2014c), the loss of escarpment habitat is considered and included here for completeness, and because more accurate post-construction information is now available about the area disturbed.

Impact Indicators

Indicators used to assess impacts of the Project on the habitat and ecosystem integrity of the vegetation corridors on the escarpment were changes in: regional representativeness; ecosystem composition; and ecosystem configuration.

Loss of habitat due to direct disturbance and clearing associated with the Project was quantified by overlaying the current, baseline extent of the vegetation communities with the Project footprint. This included the escarpment road (which, it is recognised, is covered by a separate ESIA process, see AWE (2014c); however, the inclusion of this road in this assessment is important because of its cumulative impacts on the vegetation of the escarpment) (ref. Cumulative Impact Assessment).

Additional, indirect affects to habitat were estimated by applying a 0.50 km buffer to the temporary camp and quarry at the top of the escarpment, and the footprint of the escarpment road. Specifically, the buffer was selected to account for changes in habitat quantity and/or quality that could be caused by edge effects, fragmentation, sensory disturbance, barriers to movement, changes in water quantity and quality, and air emissions and dust.

Changes in habitat composition and ecosystem configuration were assessed by identifying potential changes in species composition that could occur, and the disruption of known movement corridors. This was accomplished by examining available literature about the ecology of the vegetation communities on the escarpment, and scientific literature about the impacts of human activities on corridors, and consultation with experts.

Impact Assessment

■ Representativeness

The CHAA supports approximately 2443 ha of escarpment corridor vegetation communities (see Section 6.3.1.1.2), which are bounded on the east by agriculturally modified landscapes, and the Buhuka Flats on the west (Figure 11). As mentioned, these vegetation communities form part of a contiguous vegetation corridor that is part of the wider Murchison Falls National Park-Budongo-Bugoma-Kagombe-Itwara Forest Reserves-Semliki/Toro Wildlife Reserve corridor (Plumptre et al. 2003) (see Section 7.1.2). Therefore, their continuous extent represents an important landscape feature in the CHAA.

The escarpment road traverses for approximately 5.5 km through the escarpment vegetation communities before it arrives on the Buhuka Flats. The total area of escarpment habitat that has been permanently lost as a result of the road's construction is 12.8 ha; this comprises: 1.9 ha of open wooded bushland; 4.6 ha of open wooded grassland; 2.9 ha of dense bushland; 3.1 ha of dense wooded grassland; 0.1 ha of riverine woodland; and 0.1 ha of open grassland (Table 10). A further 3.6 ha has been temporarily disturbed along the edges of the road. Approximately 4.5 ha of open wooded bushland was lost to the temporary camp on top of the escarpment, this area has since been rehabilitated. All these vegetation communities are widely represented on the escarpment, and the CHAA.

The total loss within the CHAA equates to: 1% of open wooded bushland; 0.6% of open wooded grassland; 0.4% of dense bushland; 0.2% of dense wooded grassland; 0.1% of riverine woodland; and 0.02% of open grassland.

Table 10: Permanent loss of escarpment vegetation due to construction of escarpment road

Vegetation Type	Total area in the CHAA (ha)	Total area in Escarpment corridor (ha)	Area lost to Road (ha)	% loss in CHAA	% loss in escarpment corridor
Cultivation and settlement	31860.9	0.1	0.1	0.0%	100.0%
Dense bushland	1097.6	337.7	2.9	0.3%	0.9%
Dense wooded grassland	613.2	589.0	3.1	0.5%	0.5%
Open grassland	568.5	31.5	0.1	0.0%	0.3%
Open wooded bushland	523.0	214.0	1.9	0.4%	0.9%
Open wooded grassland	1900.9	552.2	4.6	0.2%	0.8%
Riverine woodland	74.8	69.8	0.1	0.2%	0.2%

The loss of this quantity of vegetation in relation to the total amount in the CHAA is not substantial. Nevertheless, the loss of this vegetation does open up and cut a previously contiguous tract of vegetation with a linear corridor that introduces edge effects and the concomitant aspects associated with those, as discussed below.

Impacts from the changes to representativeness are predicted to be beyond the expected range of natural disturbance perturbations.

■ Ecosystem composition

The construction of the road is expected to have contributed to losses of biodiversity at both local and regional scales due to it restricting movement between populations, increasing mortality, habitat fragmentation and edge effects, facilitating invasion by exotic species, or increased human access to wildlife habitats, all of which are expected to increase local extinction rates or decrease local recolonisation rates (Findlay and Bourdages 2000). Indeed, the construction of any linear corridor (such as the road) through an area of relatively intact vegetation, like that on the escarpment, creates edge effects that could, in the long-term, alter the composition of the ecosystem through which the road traverses. Vegetation clearing creates edges or boundaries where habitat (for example, riverine woodland) meets a disturbance (for example, the road). Edges associated with disturbance are different than transition areas, or ecotones, amongst vegetation communities, because disturbance edges tend to be abrupt with a high degree of contrast between two areas (for example, road and open wooded grassland). Edges open up habitat in areas where it was previously continuous, and this generally changes the abiotic conditions (for example, temperature, light, and moisture regimes) (Porensky and Young 2013). Edges often result in changes in species composition along the edge, with the edges typically becoming dominated by pioneer species adapted to the particular microclimate experienced on the edge (Porensky and Young 2013). Often, these microclimates are favoured by weed species. However, certainly for fauna species, and depending on the species, edges can have either a positive or negative impact on habitat quality and quantity (Prevedello et al. 2013, Wellicome et al. 2014). Given the length of the escarpment road (approximately 5.8 km) traversing the escarpment vegetation communities, this equates to approximately 11.6 km of edges in the escarpment vegetation corridor, which would have otherwise not existed.

The escarpment road is sealed for its length down the escarpment. Sealing of the road presents other aspects that may affect the ecosystem composition of the communities on either side of the road. For example, concentrating water run-off from the sealed surface, which could carry contaminants, such as fuel, heavy metals and poly-aromatic hydrocarbons, to watercourses not otherwise influenced by such run-off. This could possibly lead to changes in water quality of local watercourses and erosion regimes.

The construction of the Kingfisher camps/parking lots/materials yards, airstrip extension, CPF, pipeline, new in-field roads, crusher plant/spoil area A, new well pads, and associated infrastructure will not directly lead to

changes in the composition of vegetation communities on the escarpment; however, indirect impacts from the changes to ecosystem composition are predicted to be well beyond the expected range of natural disturbance perturbations.

■ Ecosystem configuration

Roads, and especially sealed roads are known to be significant barriers, or alter behaviours, of a range of wildlife, from: small ground-dwelling mammals, insects, reptiles and amphibians (for example, Brehme et al. 2013, Pontoppidan et al. 2013, Rotholz and Mandelik 2013); to bats (for example, Berthinussen and Altringham 2012); to birds (for example, Kociolek et al. 2011); to primates (for example, Mammides et al. 2009); to large ungulates (for example, Leblond et al. 2013, Meisingset et al. 2013). Depending on the species, the presence of roads may affect individuals in many direct and indirect ways. For example, roads may inhibit seasonal migration and may cause an impactive loss of habitat due to avoidance.

The construction of the Kingfisher camps/parking lots/materials yards, airstrip extension, CPF, pipeline, new in-field roads, crusher plant/spoil area A, new well pads, and associated infrastructure will not directly lead to changes in the configuration of vegetation communities on the escarpment. The construction of the escarpment road is also unlikely to have had any direct impact on the configuration of vegetation communities on the escarpment. As in the case of ecosystem composition, the most significant changes in ecosystem configuration on the escarpment are already occurring as a result of increased migration into the area facilitated by the new ease of access, and associated degradation of escarpment vegetation, creating barriers to species movement. Ecosystem configuration impacts being caused by ongoing habitat degradation due to increased population and road traffic during operation are discussed in Section 10.2.1.

Direct impacts from the changes to ecosystem configuration on the escarpment as a result of the road are beyond the expected range of natural disturbance perturbations.

Impact Classification

The vegetation community of the escarpment's sensitivity is medium because these habitats are already under stress from livestock grazing and harvesting of fuel wood and non-timber forest products. They also form part of a wider wildlife corridor, which is recognised for its regional importance.

Impacts to the representativeness of the habitat will be adverse. The geographical extent of impacts will be local because impacts are restricted to the LSA, and will only constitute approximately 0.02 % loss of vegetation communities in relation to the CHAA. Impact duration will be into the far future (that is, ~25 years) because the road down the escarpment will remain in place even after the project is decommissioned. The changes to the representativeness of the vegetation communities, although possibly irreversible, are expected to be amendable via offsetting (see Section 13.0). The magnitude of the impacts of the road on representativeness of the vegetation communities of the escarpment is medium. Therefore, the magnitude and sensitivity combine to produce a moderate overall impact level to representativeness during the construction phase of the Project, pre-mitigation (Table 11). Following the application of appropriate mitigation measures, the impact significance is expected to remain moderate, as the magnitude will become low, while the sensitivity of the receptor will remain the same.

Impacts to the ecosystem composition will be adverse. The geographical extent of impacts will be local because impacts are restricted to the LSA. Impact duration will be into the far future (that is, ~25 years) because impacts are expected last as long as the road is in place. The magnitude of the impact on ecosystem composition is medium because, prior to any mitigation, the potential for changes to ecosystem composition potentially brought about by edge impacts is possible. Therefore, the magnitude and sensitivity combine to produce a moderate overall impact level to ecosystem composition during the construction phase of the Project, pre-mitigation (Table 11). Following the application of appropriate mitigation measures, the impact significance is expected to remain moderate, as although the magnitude will become low, the sensitivity of the receptor will remain the same.

Impacts to the ecosystem configuration will be adverse. The geographical extent of impacts will be regional because impacts are restricted to the CHAA. Impact duration will extend into the far future (that is, ~25 years)

because impacts are expected to continue as long as the road is in place. The magnitude of the impact on ecosystem configuration is medium because, prior to mitigation, the potential for changes to ecosystem configuration is possible, especially inference with wildlife movement corridors. Therefore, the magnitude and sensitivity combine to produce a moderate overall impact level to ecosystem composition during the construction phase of the Project, pre-mitigation (Table 11).

Following the application of appropriate mitigation measures, the impact significance is expected to remain moderate, as although the magnitude will become low, the sensitivity of the receptor will remain the same.

Table 11: Potential impacts in the construction phase to the vegetation communities of the escarpment

Indicator of potential impact	Pre-mitigation			Post-mitigation (pre-offsets)		
	Magnitude	Sensitivity of the Receptor	Significance	Magnitude	Sensitivity of the Receptor	Significance
Representativeness	Medium – 3	Medium – 3	Moderate – 9	Low – 2	Medium – 3	Moderate – 6
Ecosystem composition	Medium – 3	Medium – 3	Moderate – 9	Low – 2	Medium – 3	Moderate – 6
Ecosystem configuration	Medium – 3	Medium – 3	Moderate – 9	Low – 2	Medium – 3	Moderate – 6

Prediction Confidence

Given the information available, there is a reasonable understanding of the potential Project impacts to the vegetation communities of the escarpment, and the wildlife corridors of which they form part. However, there is some uncertainty in regard to the irreplaceability and vulnerability of those habitats in the CHAA. Given the current uncertainty in relation to climate change and possible scenarios, as well as increasing human pressures, how important these habitats will become in the future is uncertain. Indications are that they will increase in importance (Ayebare et al. 2013), provided human pressures do not overwhelm them.

The spatial extent of habitats in the CHAA was broadly mapped based on knowledge of the site, baseline studies, literature and reports (see Section 7.1.2). The actual extent of possible habitat may have been over-estimated.

10.1.1.4 *What impact could the construction/decommissioning of the Project have on the Bugoma Central Forest Reserve?*

Impact Indicators

The Ugandan Government will be responsible for upgrading the roads that the oil industry will need for access. Scheduled 'oil industry' road upgrades to support the Kingfisher development include those shown in Figure 21. Although it is recognised that CNOOC will not be upgrading the roads, and the Ugandan Government will be responsible for the upgrades; any effects associated with, and stemming from the proposed road upgrades can be seen to be induced impacts arising as a consequence of the Project's development.
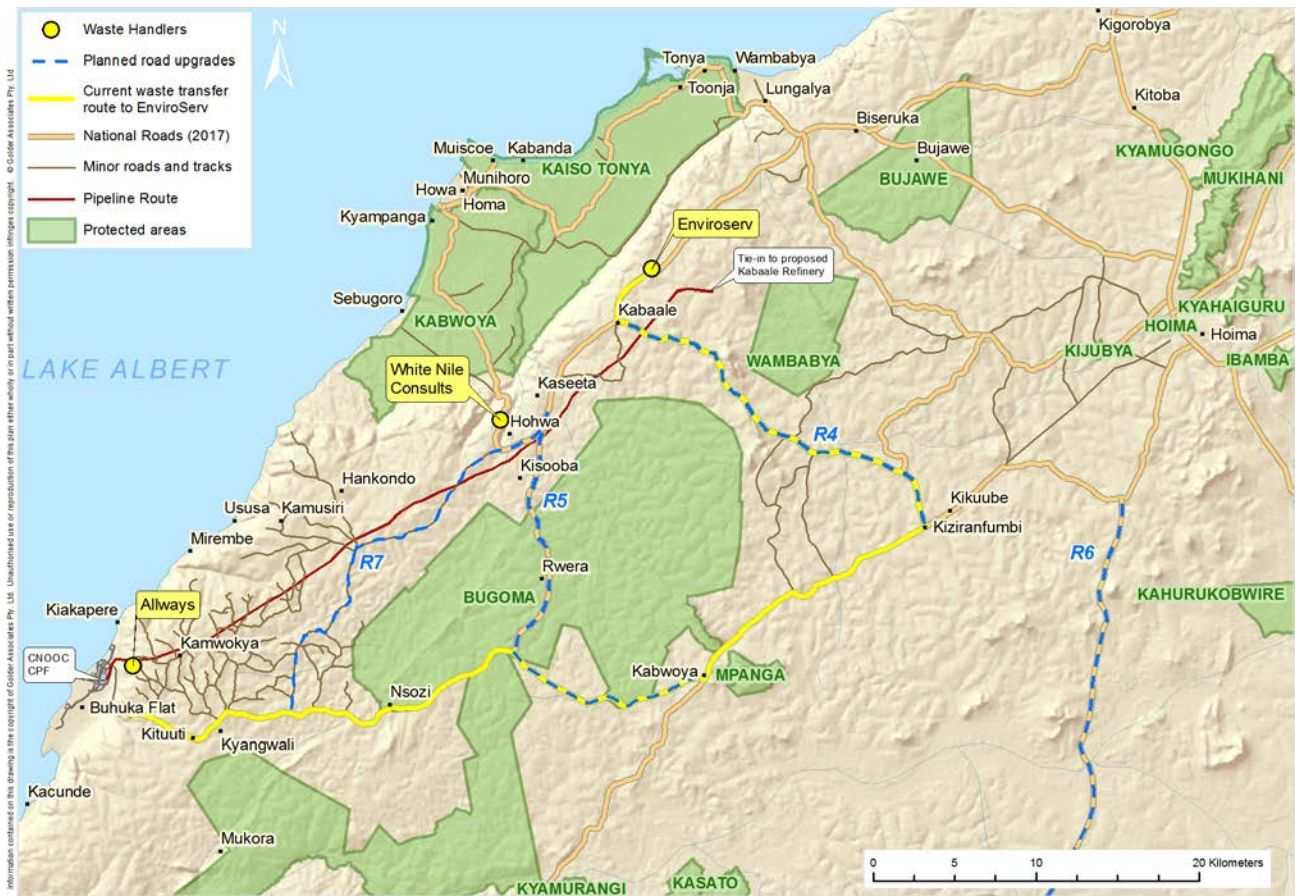
Figure 21: Proposed Government road upgrades in the region

A formal impact classification based on indicators was developed for induced and cumulative impacts to the Bugoma Central Forest Reserve; the impacts are discussed, and their significance assessed through a **reasoned narrative**. An overall impact significance classification is then developed. This was accomplished by examining available literature about the ecology of the Bugoma Central Forest Reserve (BCFR), and scientific literature regarding the effects of migration and human population pressure on forests in Africa.

The impacts were assessed in light of the guidance provided by IFC (2013), and in consideration of other known projects being developed in the wider area. In particular, the development of the oil processing facility at Kabaale, the oil developments around the Kaiso-Tonya area (AECOM 2012), the Hoima-Mputa-Fort Portal-Nkenda power line, and the potential for regional population increases in the wider area.

Impact Assessment

The Bugoma Central Forest Reserve (Bugoma CFR) is identified as a valued component for this impact assessment, certainly in terms of biodiversity (see Section 6.3.1.1.4). As identified in that section, apart from being one of the last stands of tropical semi-deciduous forests in the region, it also supports known populations of the Endangered Eastern Chimpanzee and range-restricted Nahan's Francolin (Plumptre et al. 2011), potential non-breeding habitat for the Endangered Madagascar Pond Heron (see Section 6.3.3.1), as well as elephants and a host of other threatened and irreplaceable species.

The R5 passes through the centre of Bugoma CFR in a north-south direction for approximately 9.7 km, and the P1 road runs along part of the main south-western and south-eastern boundaries of the Bugoma CFR, passing through the reserve in an east-west direction for approximately 3.5 km near Kisaru. Both roads are currently unsealed and relatively narrow, and become impassable from time to time in the wet season. No data traffic data are available for the roads.

The construction of the roads will cause the direct loss of forest species in the area of the road widening. Depending on the final road width (assuming a width of 10 m), the construction methodologies used and the need to accommodate traffic, this could result in the permanent removal of around 9.7 ha of forest habitat along the R5 section of road, and 3.5 ha along the P1 section of road from Kiziranfumbi and Nsozi.

The Bugoma Central Forest Reserve is home to populations of threatened species and an array of other species (see Plumptre et al. 2010, 2011). Many of these species will move within the forest and between sections of the forest. Although the negative effects of roads on wildlife in tropical rainforests, like Bugoma Central Forest Reserve, are poorly understood, indications are that: (1) many species avoid roads altogether (especially, medium-sized mammals, diurnal, solitary and group living animals, and ungulates); and (2) high vegetation cover on the road verges (Figure 22) increases crossing probability substantially (van der Hoeven et al. 2010). Currently, the road side vegetation on the R5 and P1 roads would encourage wildlife to cross (Figure 22). This could place them in the direct paths of traffic.

During construction, Project-generated traffic will consist of 65 trucks per day over a 2.5 year period, amounting to approximately one truck every 10 minutes during daylight hours. This, combined with a general increase in vehicular traffic to the area facilitated by the improving road surfaces, is predicted to cause increased disturbance to faunal species within the Bugoma CFR, as well as increase the risk of direct mortality of wildlife due to traffic collisions. Impacts to species of concern associated with Bugoma CFR (Eastern Chimpanzee and Nahan's Francolin) due to increased risk of traffic collisions during the construction phase are addressed in Section 9.1.2.

Figure 22: The P1 road through Bugoma Central Forest Reserve

Impact Classification

Impacts from the upgrade of the R5 and the P1 roads and the resultant increased traffic (reducing adjacent habitat integrity as a result of noise, vibration etc) along that road during the construction of the Project will be adverse. The geographical extent of impacts will be regional because effects are restricted to the R5 and the P1 road corridors in the CHAA. Impact duration will be short-term (that is, limited to the road upgrade

construction, and the construction phase of the Project, that is, ~2 years). The magnitude of the effects of construction, in the context of habitat loss, on the Bugoma Central Forest Reserve is low.

The sensitivity of the Bugoma Central Forest Reserve is high because it is a threatened ecosystem that is already under pressure. Therefore, the intensity and sensitivity combine to produce a moderate overall impact level during the road upgrade and construction phase of the Project, pre-mitigation (Table 12).

The mitigation hierarchy is an important process that has been used to minimise impacts to the Bugoma Forest Reserve. The focus for the continued use of the mitigation hierarchy during the road upgrade and construction will be continued development and implementation of mitigation measures through monitoring and adaptive management; including suggested measures for the Ugandan Government to apply in the management of the upgrade of the P1 Road (see Section 11.0).

Following the application of appropriate mitigation measures, the impact significance is expected to decrease to minor, primarily because the intensity could become negligible, although the sensitivity of the receptor will remain the same (Table 12).

Table 12: Potential impacts in the construction phase to the Bugoma Central Forest Reserve

	Pre-mitigation			Post-mitigation (pre-offsets)		
	Magnitude (the expected size of the impact)	Sensitivity of the Receptor	significance	Magnitude (the expected size of the impact)	Sensitivity of the Receptor	significance
Habitat and ecosystem integrity	Low – 2	High – 4	Moderate – 8	Negligible – 1	High – 4	Minor – 4

As noted above, the focus for reducing impacts to the Bugoma Central Forest Reserve is mitigation to lessen various types of disturbance that may occur (Section 11.0). Optimising mitigation will reduce the need for offsetting. However, offsetting options to compensate for residual impacts to the forest have been identified and are discussed in Section 10.0.

10.1.2 What impact could the construction/decommissioning of the Project have on species of concern?

This section presents the assessment of the impacts that the Project construction/decommissioning could have only on those species of concern that potentially trigger critical habitat, as identified in Section 6.3.3; that is, the Mud Snail (*Gabbiella candida*), Grey Crowned Crane (*Balearica regulorum*), Nahan's Francolin (*Ptilopachus nahani*) and Eastern Chimpanzee (*Pan troglodytes*). Potential impacts to other species of concern are assessed at the habitat level (see Section 7.3.1.1).

10.1.2.1 What impact could the construction/decommissioning of the Production Facility have on the Mud Snail (Gabbiella candida)?

The Mud Snail (*Gabbiella candida*) is a Critically Endangered and range-restricted species. Currently, the only known populations occur around Butiaba (see Section 6.3.3.1), which is on the eastern shore of Lake Albert approximately 90 km north of the LSA. Although this species was not confirmed within the CHAA during the course of baseline studies, there is a potential that this species could occur in the near-shore habitats of the CHAA, based on its known habitat preferences, and those of other Mud Snail species (*Gabbiella* spp.), which have previously been recorded in both the same locality as this species at Butiaba, as well as in the LSA. Hence, a precautionary approach has been adopted, and *G. candida* is assumed to occur in the near-shore habitats of the CHAA.

Impact Indicators

Indicators used to assess impacts of the construction of the Project on the Mud Snail were: habitat quantity and quality; and habitat connectivity, because no individuals were recorded, yet potential habitat is present.

Habitat loss due to direct disturbance and clearing of habitat was assessed by calculating the loss of suitable habitat from the CHAA as a result of the construction of the Project. Changes to habitat quality were assessed by the prediction of sediment loads and changes to water quality in the water column from construction activities.

Changes in habitat connectivity were assessed by identifying potential barriers to genetic movement, and source populations. This was accomplished by visually examining the spatial distribution of critical habitat in relation to the Project footprint, to qualitatively identify areas where critical habitat becomes fragmented.

Impact Assessment

■ Habitat Quality and Quantity

Very little information is available for this species. Information about the genus *Gabbiella* indicates that this group is generally found in lakes, rivers and, less commonly, in small water bodies, and rarely in habitats that dry out (Kristensen and Stensgaard 2010). Two sister species (*G. humerosa* and *G. walleri*) were recorded in the LSA (see Section 3.3.2.4, APPENDIX C). These two species have also been recorded in the same locality and habitat as *G. candida* (GBIF, 2014). Therefore, the habitat preferences of those two species were used as a model to predict the potential impacts of changes to habitat quantity and quality for this species.

The two sister Mud Snail species recorded from the CHAA were collected from bottom substrates in the open sandy shore habitats in the LSA. These habitats are characterised by a gently sloping lake bed extending from the shore line to deeper water. The substrate is typically comprised of sand and finer sediments (Wandera and Balirwa 2010). This habitat constitutes approximately linear (lake shore) 10.5 km of the CHAA, most of which is located within the LSA.

The jetty will be upgraded, although there are not expected to be material changes in its dimensions. Currently, it consists of a solid concrete structure extending some 20 m into the lake to provide sufficient draught during low water periods. Although the existing jetty structure appears to have caused some accretion of sediment on the eastern side of the jetty, and some erosion on the western side, the proposed jetty upgrade is not expected to alter the geomorphological processes and sediment drift that currently govern the shoreline ecosystem of the Buhuka Flats, additional to the sediment deposition and erosion either side of the jetty that has already taken place.

The new water intake and pump station will extend a similar distance (~20 m) into the lake. The construction works will affect, through direct disturbance, approximately 0.04 ha or 0.005% of potential habitat (810 ha of near-shore aquatic habitats) for the Mud Snail in the CHAA. Additionally, there is potential for this proposed structure to affect geomorphological processes and sediment drift down-shore of Well Pad 2; which in combination with the existing jetty structure, could potentially affect the sediment drift or shoreline morphodynamics between Well Pad 2 and Bugoma Lagoon. Since sediment drift is recognised as an important driver in shoreline ecosystems, contributing to the nutrient input that drives phytoplankton, zooplankton and fish communities (Parks et al. 2013); there is potential for the Mud Snail habitat to be affected, beyond the area of primary disturbance.

The new water intake and pump station also has the potential to alter the water quality within the immediate surrounds of the construction activities through disturbance of the lake bed, and introduction of sediment into the water column over the short-term during the works. It is expected that these increased sediment loads will dissipate reasonably quickly following completion of the construction works. The sediment loads in the vicinity of the new water intake and pump station are not expected to exceed those that would normally be expected during windy periods on the lake (see Golder Associates 2014g), and the consequent turbid conditions caused by those winds. Furthermore, these construction works are not expected to permanently alter the water chemistry in the vicinity of the new water intake and pump station given the large buffering capacity of the lake compared to the scale of the works, and the short-term duration of the works. Therefore, it can be expected

that the construction of the new water intake and pump station will not affect the sediment loads and water quality of the near-shore habitats following completion of works.

Accidental spillages of small quantities of fuels and chemicals during the construction of the Production Facility components (not including significant/catastrophic spillages, which are described in Volume 2, Chapter 2.0) could end up in River 1 and, ultimately report to the near-shore habitats of the CHAA south-west of well pad 2. There is also a real potential for accidental spillages to occur as part of the jetty upgrade works, and during the construction of the new water intake and pump station. A further risk will result from the construction and drilling of the wells. While control systems are proposed to manage contaminated stormwater and wash-water from the well pads, the presence of drilling crews on site for approximately a year, using potentially hazardous drilling fluid and other hazardous materials; and the absence of a buffer between the well pads and the lake (in the case of well pad 1, the seasonal wetland); makes it likely that occasionally contaminated drainage will reach the lake unless there is a very high level of control of day-to-day activities. Aquatic snails are highly sensitive to chemical pollutants, particularly hydrocarbons (Araujo et al. 2012). Currently, the concentrations of hydrocarbons and other pollutants in the lake waters of the near-shore habitats are below levels that could cause harm to the environment (Golder Associates 2014b); this is supported by the healthy aquatic communities observed in the lake's near-shore habitats (see Section 6.2). As such, without a very high level of control of day-to-day activities and adequate spill prevention and clean-up measures in place during construction, accidental spillages of fuels and chemicals could, depending on the volume spilt, have a detrimental impact on the near-shore habitats of the LSA through the introduction of toxic compounds and pollutants. Such a spill could have a detrimental impact on the Mud Snail.

Discharge of treated sewerage during construction could affect water quality and algal growth rates, potentially affecting the quality of the Mud Snail's preferred habitat. However, *Gabbiella* sp. are detritivores/omnivore living on muddy lake bottoms and plants, and *Gabbiella humerosa*, the sister species of *Gabbiella candida*, appears to benefit from increased eutrophication (Van Damme & Lange, 2017). Therefore, the discharge of treated sewerage during construction may not have a detrimental impact on the Mud Snail.

The construction of the Kingfisher permanent and temporary camps/parking lots/materials yards, airstrip extension, CPF, new in-field roads, crusher plant/spoil area A, expansion of exploration well pads to production well pads (particularly the expansion of well pad 2 to its full size), and associated infrastructure could cause increased sedimentation of near-shore habitats on the Buhuka Flats. The soils of the Buhuka Flats are dispersive (Golder Associates 2014d), and active soil erosion is evident in the LSA. With the construction of the Project's components, and the consequent exposed areas of soil, there is a potential that, without adequate erosion and sediment control measures in place during construction, sediment loads within the watercourses (particularly River 1, which will receive the drainage from the CPF earthworks and temporary camp) draining the Project footprint could increase. These sediment-laden watercourses report to Lake Albert, and, hence, there is a potential for increased sediment loads in the near-shore habitats. Near-shore habitats particularly at risk include the lagoon, and to a lesser extent, the shallow river-associated habitats, both potential habitat for the Mud Snail. Nevertheless, the watercourses draining the LSA support dense emergent vegetation (see Section 6.1.1.1). Such vegetation forms an impactive filter for most sediment (IECA 2008), therefore, it can be expected that sediment loads reporting to the near-shore habitats, at least, via the Kamansinig River, River 1 and Masika River, could be minimal. Sediment loads from overland flows may not be as retarded by vegetation, and hence may report to the near-shore habitats and affect them detrimentally. However, little construction storm water will flow into the Kamansinig River and the seasonal wetlands upstream of the Bugoma Lagoon, since only the expansion of Well Pad 1 and roughly half of the construction area of the permanent camp fall within its catchment (Figure 20). The seasonal wetland will provide efficient attenuation of sediment, and a significant increase in sediment concentrations in the lake or in Bugoma lagoon are unlikely.

Impacts on habitat quality and quantity for *G. candida* arising from direct disturbance, changes in sediment dynamics and potential accidental spillages of small quantities of fuels and chemicals during construction are predicted to be beyond the expected range of natural disturbance perturbations. Potential loss of critical habitat for the Mud Snail requires the consideration of offsets to meet IFC requirements.

■ Habitat Connectivity

The construction of the Project is expected to last for three years (the jetty upgrade has already been completed). Besides the upgrading of the jetty, it is unlikely that construction activities could substantially alter the habitat connectivity of the near-shore habitats in the CHAA. No structures are being put in place that will alter the natural connectivity of the aquatic habitats of the lake. It is expected that the connectivity amongst the aquatic habitats will remain the same during construction as they were during baseline.

Impact Classification

The Mud Snail's sensitivity is high because this species is Critically Endangered, and potentially triggers a Tier 1 critical habitat designation.

Impacts to the Mud Snail's habitat quantity and quality will be adverse. The geographical extent of impacts will be local because impacts are restricted to the LSA, with approximately 0.04 ha or 0.005% of potential habitat affected. Impact duration will be short-term (that is, limited to the construction phase of ~3 years) because disturbances arising from construction activities are expected to dissipate within a short time after cessation of activities. Although the jetty structure will remain in place into the far future (that is, ~25 years) after the project is decommissioned, the changes to the open sandy shore habitat in the vicinity of the jetty are expected to be reversible over time as natural geomorphological processes re-establish the open sandy shoreline. The magnitude of the physical impacts of construction on the habitat quantity and quality of the Mud Snail is expected to be low. Following the application of appropriate mitigation measures, the impact significance for physical impacts on habitat quality and quantity is expected to remain the same, that is, moderate, primarily because the magnitude will still remain the same due to habitat disturbance during construction (Table 13).

Adverse impacts on habitat quality are expected as a result of accidental spillages of small quantities of fuels and chemicals (including potentially hazardous drilling fluid) during the construction of the Project components and installation of the wells, ultimately reporting to the near-shore habitats of the Lake. Although the impact duration will be short-term, and should be reversible with time as the Lake waters dilute and disperse the contaminants, the magnitude of the impacts of accidental entrainment of contaminants to *G. candida's* habitat could be high. Therefore, the magnitude and sensitivity combine to produce a moderate overall impact on physical habitat quality and quantity during the construction phase of the Project, and a major overall impact on habitat quality and quantity as a result of contamination, pre-mitigation (Table 13). The strict application of the recommended mitigation measures (Section 11.2.1) will reduce the risk, and thus the likely magnitude, of potential habitat contamination for the Mud Snail, reducing the overall impact significance to moderate.

Impacts to the Mud Snail's habitat connectivity will be neutral. The geographical extent of impacts will be local because impacts are restricted to the LSA, with approximately 0.04 ha or 0.005% of potential habitat affected. Impact duration will be short-term (that is, limited to the construction phase of ~3 years) because disturbances arising from construction activities are expected to dissipate within a short time after cessation of activities, and no barrier to habitat connectivity will be constructed. Although the existing jetty structure will remain in place into the far future after the project is decommissioned (that is, ~25 years), the proposed upgrade works will not result in changes to current jetty footprint and subsequently the open sandy shore habitat in the vicinity of the jetty. The application of the recommended site-specific mitigation measures in the construction of the new water intake and pump station (Section 11.0) are expected to minimise any detrimental effects on longshore sediment drift and morphodynamics, and any subsequent negative effects on the habitat connectivity of the Mud Snail, to a point where the magnitude of the potential impact is negligible. Therefore, the magnitude and sensitivity combine to produce a minor overall impact on habitat connectivity for *G. candida* during the construction phase of the Project, pre-mitigation (Table 13.

Table 13: Potential impacts in the construction phase to the Mud Snail

Indicator of potential impact	Pre-mitigation			Post-mitigation (pre-offsets)		
	Magnitude (the expected size of the impact)	Sensitivity of the Receptor	Significance	Magnitude (the expected size of the impact)	Sensitivity of the	Significance

					Recept or	
Habitat quality and quantity (physical impacts)	Low – 2	High – 4	Moderate – 8	Low – 2	High – 4	Moderate – 8
Habitat quality and quantity (contamination)	High – 4	High – 4	Major - 16	Low – 2	High - 4	Moderate – 8
Habitat connectivity	Negligible – 1	High – 4	Minor – 4	Negligible – 1	High – 4	Minor – 4

Prediction Confidence

Given the information available, there is a reasonable understanding of the potential Project impacts to the near-shore habitats of the CHAA, and hence potential local populations of Mud Snail. However, there is some uncertainty with regard to this species actually occurring in the CHAA. As such, the above assessment has been undertaken based on a precautionary approach.

The spatial extent of the near-shore habitats in the CHAA was broadly mapped based on knowledge of the site, baseline studies, literature and reports (see Section 6.3.1.1.1). The actual extent of possible habitat may have been over-estimated.

10.1.2.2   *What impact could the construction/decommissioning of the Production Facility have on Grey Crowned Crane?*

The Grey Crowned Crane is an Endangered species. Up to 14 individuals were regularly recorded on the Buhuka flats during baseline surveys, and a pair of Grey Crowned Crane was observed on the Flats during social baseline survey work conducted in November 2017. More than three-quarters of the world's Grey Crowned Cranes occur in Uganda and Kenya in East Africa, leading Uganda to develop a species action plan for their conservation in-country. The population of Grey Crowned Crane using the Buhuka flats is thus regarded as highly sensitive, and the wetlands of the Flats are considered an important conservation unit for the species.

The construction of the Production Facility could directly impact Grey Crowned Crane breeding and foraging habitat on, given that construction impacts on wetlands in the Buhuka Flats are expected (Section 9.1.1.2). In addition, although it is recognised that the escarpment road has already been licensed and built on the basis of an earlier impact assessment (AWE, 2014c), the induced effects of its operation on the Buhuka Flats wetland habitats used by Grey Crowned Crane are expected to exacerbate predicted construction phase impacts on this species in the Buhuka Flats locality, and this is included for completeness.

The potential direct, indirect and induced impacts of the construction of the Production Facility to the Grey Crowned Crane are presented below.

Impact Indicators

Indicators used to assess effects of the construction of the Production Facility on Grey Crowned Crane were: habitat quantity and quality, habitat connectivity, abundance and distribution, and survival and reproduction.

Habitat loss due to direct disturbance and clearing of habitat was assessed by calculating the loss of suitable habitat from the CHAA as a result of the construction of the various Project components and infrastructure. Changes to habitat quality due to indirect disturbance were estimated by applying a 200m buffer to the infrastructure footprint. Specifically, the buffer was selected to account for changes in habitat quantity and/or quality caused by indirect disturbance arising from light, noise, vibration, and edge effects.

Changes in habitat connectivity were assessed by identifying potential barriers to movement and loss of corridors. This was accomplished by visually examining the spatial distribution of critical habitat for Grey Crowned Crane in relation to the infrastructure to qualitatively identify areas where habitat becomes fragmented.

Potential changes in abundance and distribution, and survival and reproduction were assessed qualitatively by considering changes in disturbances (that is, vehicle traffic, light, noise, vibration) and site clearing activities. These disturbances were considered in light of known or inferred effects to the survival and reproduction of Grey Crowned Crane, where data on these types of effects are available.

Impact Assessment

- Habitat Quality and Quantity

Grey Crowned Crane is distributed across eastern and southern Africa. Populations in many areas including Uganda have experienced rapid declines during the past 45 years (BirdLife International, 2018) for reasons including habitat loss to farming, human presence causing disturbance, collection of chicks for domestication, disruption of breeding activity, loss of roosting sites (large trees located remotely from areas frequented by humans) and dry-season fires in wetland habitats (Olupot, 2014). Its habitat preferences are diverse, including wetlands with tall emergent vegetation, open riverine woodland, shallowly flooded plains and temporary pools with adjacent grasslands, open savannas, croplands, pastures, fallow fields and irrigated areas (Archibald et al, 2018). It prefers short to medium height open grasslands adjacent to wetlands for foraging, which is consistent with the seasonally flooded grassland wetlands in the Buhuka Flats. For breeding, it prefers marshes with water 1 m deep and emergent vegetation 1 m above the water (Archibald et al, 2018); habitat which corresponds to the permanent wetlands of the Buhuka Flats.

Direct loss of suitable foraging habitat (seasonally flooded grassland) to the Project footprint will consist of 5.8 ha or 8.4% of a total of 69 ha of seasonally flooded grassland in the Buhuka Flats area. No direct losses of permanent wetlands are anticipated on the Flats. Some large trees with cultural importance have reportedly been removed from the Buhuka Flats during construction activities. Such trees are important roosting resources for Grey Crowned Crane and their loss could influence their presence in/use of the area for foraging and breeding (Olupot, 2014).

Although Grey Crowned Crane can tolerate a low degree of anthropogenic disturbance in foraging habitat (e.g. subsistence and commercial farming practises), in Ugandan wetlands it has been observed to be intolerant of human proximity within 100-200m (Olupot, 2014), flying away on approach; a factor which also affects breeding success as breeding birds flush from nests on approach, causing increased rates of predation, reduced time at the nest (either incubating or feeding), and ultimately nest abandonment. How tolerant foraging/roosting/breeding Grey Crowned Crane may be to indirect disturbances, such as noise, light, vibration and edge effects, is not known. The application of a 200m buffer around the Project infrastructure footprint indicates that approximately 4.64 ha of seasonally flooded wetland habitat will be reduced in quality as a result of sensory disturbance.

This equates to a total potential habitat loss in the Buhuka Flats region of the CHAA from direct losses from vegetation clearing, and indirect losses from sensory disturbances and edge effects associated with the Production Facility of up to 10.44 ha (0.09% of 11,579 ha of wetlands in CHAA; 15% of 69 ha seasonally flooded grassland in the Buhuka Flats).

Effects from loss of habitat are predicted to be beyond the expected range of natural disturbance perturbations (for example, fire), although not beyond the human-induced rate of degradation via cattle grazing pressure etc.

- Habitat Connectivity

The effect of the Project construction as a barrier to the movement of Grey Crowned Crane is likely to be adverse. The construction activity will create sensory disturbances in the short-term, which can elicit reduced use or complete avoidance of affected areas, thereby creating movement barriers (for example, see Kolowski and Alonso 2009, Gleeson and Gleeson 2012). It is noted that the construction of power lines between the

CPF and development wells will present a significant barrier to movement for Grey Crowned Crane, as this species is susceptible to in-flight collisions with overhead powerlines (BirdLife International, 2018); however, the construction of powerlines does not form part of this impact assessment and is instead discussed in the cumulative impact assessment (ref. Cumulative Impact Assessment). Construction of linear infrastructure (roads and flowlines) through wetlands has the potential to create temporary barriers to movement as a result of the associated disturbance due to human presence in the area.

Effects from loss of habitat are predicted to be well beyond the expected range of natural disturbance perturbations.

■   Abundance and Distribution

Up to 14 individuals of Grey Crowned Crane were frequently observed on the Flats during the baseline fieldwork conducted in 2014. Given the extent of their tolerance of human presence (approx. 100m – 200m), the large-scale changes in the human population on the Flats that have occurred since the construction of the escarpment road are likely to have affected Grey Crowned Crane occurrence on the Buhuka Flats.

For the purposes of this assessment, it is assumed that Grey Crowned Crane remains present in suitable habitat (permanent and seasonal wetlands) in the Buhuka Flats. The construction of the Production Facility is likely to exacerbate existing levels of sensory disturbance in the locality, with resultant effects on habitat quality and the distribution of the species. The loss of foraging habitat to the Project footprint is also likely to affect the abundance and distribution of Grey Crowned Crane in the CHAA.

Effects on the abundance and distribution of Grey Crowned Crane are predicted to be well beyond the expected range of natural disturbance perturbations.

■   Survival and Reproduction

During the baseline fieldwork conducted in May 2014, the formation of breeding pairs of observed Grey Crowned Crane was indicated. Grey Crowned Crane nests are typically constructed within or on the edges of marshes with water of 1m depth and emergent vegetation 1m high (BirdLife International, 2018). Loss and degradation of wetland habitat on the Buhuka Flats is expected to decrease the likelihood of Grey Crowned Crane selecting these areas for breeding.

As mentioned above, direct disturbance via human proximity within 100-200m causes breeding birds to flush from nests on approach (Olupot, 2014), which may result in increased rates of predation, reduced time at the nest, either incubating or feeding, and ultimately nest abandonment, affecting reproductive success. It is assumed for this assessment that indirect disturbances arising from noise, light, vibration and edge effects are also likely to affect the breeding success of Grey Crowned Crane on the Buhuka Flats.

Removal of large trees which have importance as night-time roosts and day-time shelter from the midday sun has been indicated in localised declines in Grey Crowned Crane in Uganda (Olupot, 2014); the loss of such trees is therefore expected to have implications for the survival of flocks and individuals in the area.

The installation of powerlines as part of the Project infrastructure presents a serious risk of in-flight collisions, resulting in mortalities of individual birds – these impacts are addressed in the cumulative impact assessment (ref Cumulative Impact Assessment).

These effects to the survival and reproductive success of Grey Crowned Crane are predicted to be well beyond the expected range of natural disturbance perturbations.

Impact Classification

The Grey Crowned Crane sensitivity is high because it is Endangered, and triggers Tier 2 critical habitat.

Impacts to Grey Crowned Crane habitat quantity and quality will be adverse. The geographical extent of impacts will be local because effects are restricted to those areas within 200 m of the Production Facility infrastructure footprint, with approximately 5.8 ha (8.4%) of potential habitat in the Buhuka Flats being

permanently lost, and 10.44 ha (6.6 %) of potential habitat in the Buhuka Flats indirectly affected. Impact duration will be short-term (that is, limited to the construction phase of the Project, that is, ~3 years). Changes to the habitat quality and quantity from sensory disturbances arising from construction activities are expected to be reversible after completion of the works. The magnitude of the effects of construction on Grey Crowned Crane habitat quantity and quality is considered medium. Therefore, the magnitude and sensitivity combine to produce a major overall impact level during the construction phase of the Project, pre-mitigation. Following the application of appropriate mitigation measures, the impact significance is expected to decrease to moderate, because the magnitude of effects could be reduced to low, and the sensitivity of the receptor will remain the same (Table 14).

Impacts to Grey Crowned Crane habitat connectivity will be adverse. The geographical extent of impacts will be local because effects are restricted to those areas where wetlands will be crossed by linear infrastructure i.e. access roads. Impact duration will be long-term, as the presence of access roads will commence during construction and remain in place throughout the operational lifetime of the Project, although sensory disturbances arising from construction activities are expected to dissipate within a short time after completion of the construction phase. The magnitude of the effects of construction on Grey Crowned Crane habitat connectivity is low, as the species is mobile and capable of flight to preferred areas. Therefore, the magnitude and sensitivity combine to produce a moderate overall impact level during the road upgrade and construction phase of the Project, pre-mitigation. Following the application of appropriate mitigation measures, the impact significance is expected to remain moderate, primarily because the magnitude will remain low as long as the roads are present, and the sensitivity of the receptor will remain the same (Table 14).

Impacts to Grey Crowned Crane abundance and distribution will be adverse. The geographical extent of impacts will be local because effects are restricted to wetlands within 200m of the proposed Production Facility infrastructure on the Buhuka Flats. Impact duration will be short-term (that is, limited to the construction phase of ~3 years) because physical and sensory disturbances arising from construction activities are expected to dissipate within a short time after cessation of activities. There is a possibility that individuals could be killed or severely disturbed during the construction phase; however, in the context of overall species abundance, these losses or disturbances are expected to be reversible after completion of the works. The magnitude of the effects of construction on Grey Crowned Crane abundance and distribution is thus considered medium. Therefore, the magnitude and sensitivity combine to produce an impact of major significance during the construction phase of the Project, pre-mitigation. Following the application of appropriate mitigation measures, the impact significance is expected to decrease to moderate, because the magnitude of effects could be reduced to low, and the sensitivity of the receptor will remain the same (Table 14).

Impacts to the survival and reproduction of Grey Crowned Crane will be adverse. The geographical extent of impacts will be local because effects are restricted to wetlands within 200m of the proposed Production Facility infrastructure on the Buhuka Flats. Impact duration will be short-term (that is, limited to the construction phase of ~3 years) because physical and sensory disturbances arising from construction activities are expected to dissipate within a short time after cessation of activities. A threshold of 10% for this species' survival and reproduction in the CHAA is reasonable, and it is considered probable that at least this number of individuals in the local population within the Buhuka Flats will be affected. The magnitude of the effects of construction on the survival and reproduction of the Grey Crowned Crane is therefore medium. Therefore, the magnitude and sensitivity combine to produce a major overall impact level during the construction phase of the Project, pre-mitigation. Following the application of appropriate mitigation measures, the impact significance is expected to decrease to moderate, primarily because the intensity could become low, although the sensitivity of the receptor will remain the same (Table 14).

Table 14: Potential construction phase impacts to Grey Crowned Crane

Indicator of potential impact	Pre-mitigation			Post-mitigation (pre-offsets)		
	Magnitude (the expected	Sensitivity of the Receptor	Significance	Magnitude (the expected	Sensitivity of the Receptor	Significance

	size of the impact)			size of the impact)		
Habitat quality and quantity	Medium - 3	High – 4	Major - 12	Low – 2	High – 4	Moderate - 8
Habitat connectivity	Low – 2	High – 4	Moderate - 8	Low – 2	High – 4	Moderate - 8
Abundance and distribution	Medium - 3	High – 4	Major - 12	Low – 2	High – 4	Moderate - 8
Survival and reproduction	Medium - 3	High – 4	Major - 12	Low – 2	High – 4	Moderate - 8

Prediction Confidence

Given the information available, there is a reasonable understanding of the potential Project impacts on the Grey Crowned Crane and its habitat in the CHAA.

The spatial extent of the wetland habitats in the CHAA was broadly mapped based on knowledge of the site, baseline studies, literature and reports (see Section 6.3.1.1.1). The actual extent of possible habitat may have been over-estimated.

10.1.2.3   *What impact could the construction/decommissioning of the Production Facility have on Nahan's Francolin?*

Nahan's Francolin is a Vulnerable and range-restricted species. It has a very restricted distribution, being found only in north-east DRC and western and south-central Uganda; in particular, the forests of Budongo, Bugoma and Mabira (McGowan and de Juana 1994). It has been recorded within Bugoma Central Forest Reserve within the CHAA.

This species triggers Tier 2 critical habitat (Section 6.3.2.2, APPENDIX F) under Criterion 2. Tier 2 habitats are considered to be sensitive, and, therefore, if a project is located in such a habitat, the IFC considers that compliance with the provisions of paragraph 17 of PS 6 (IFC 2012a) would be difficult. In summary, a project will not be developed in Tier 2 habitat unless: no other viable alternatives exist; and, the project does not lead to measurable and irreversible adverse impacts to the valued component that triggered critical habitat; and, the project does not lead to a net reduction in the global and/or national/regional population of the triggering species (such as Nahan's Francolin) over a reasonable period of time; and, a robust, appropriately designed, and long-term biodiversity monitoring and evaluation programme is part of the project's Environmental and Social Management System (ESMS). A Biodiversity Action Plan (BAP) will then be developed to achieve net gain for the affected species.

Although it is expected that the construction of the Production Facility will not have direct impacts to Nahan's Francolin, the proposed upgrade of the R5 and P1 roads by the Ugandan Government for the benefit of the Project (Figure 21) could have induced and cumulative impacts to this species and Bugoma Central Forest Reserve (see also Section 7.3.1.1.4). The IFC's PS1, paragraph 2, recognises that certain effects and impacts arising from a Project may be "the responsibility of the government or other third-parties over which the client does not have control or influence" (IFC 2012c). Nevertheless, although CNOOC cannot control the actions of the government, the ESMS for the Project must identify the Ugandan Government's role, and the corresponding risks they present to CNOOC and the Project (IFC 2012c). Furthermore, the ESMS must identify opportunities for CNOOC to collaborate with the Ugandan Government in order to achieve outcomes that are consistent with PS6.

The proposed Government upgrade of R5 and P1 roads is one such opportunity. The potential induced and cumulative effects of that proposed development to this species are presented below.

Impact Indicators

Indicators used to assess effects of the upgrade of the R5 and P1 on Nahan's Francolin were: habitat quantity and quality, habitat connectivity, abundance and distribution, and survival and reproduction.

Habitat loss due to direct disturbance and clearing of habitat was assessed by calculating the loss of suitable habitat from the CHAA as a result of the upgrade of the R5 and P1 roads, approximately 9.7 km and 3.5 km respectively of which passes through Bugoma CFR. Direct habitat loss due to vegetation clearance for road widening was estimated using a footprint of 10 m width. Habitat loss due to indirect disturbance and edge effects was estimated by applying a 200 m buffer to the road corridor. Specifically, the buffer was selected to account for changes in habitat quantity and/or quality caused by indirect disturbance like light, noise, vibration, and edge effects.

Changes in habitat connectivity were assessed by identifying potential barriers to movement and loss of corridors. This was accomplished by visually examining the spatial distribution of critical habitat in relation to the road corridor to qualitatively identify areas where habitat becomes fragmented.

Potential changes in abundance and distribution, and survival and reproduction were assessed qualitatively by considering changes in disturbances (that is, vehicle traffic, light, noise, vibration) and site clearing activities. These disturbances were considered in light of known or inferred effects to the survival and reproduction of other francolin/buttonquail species for which data on these types of effects are available.

Impact Assessment

■   Habitat Quality and Quantity

This species is confined to dense, mature, moist, sometimes swampy medium-altitude forest below 1,500 m (McGowan and de Juana 1994, BirdLife International 2014i); and is reasonably common in Budongo Central Forest Reserve (Plumptre et al. 2010, 2011). Suitable habitat was predicted to cover an area of ~35,201 ha (352 km^2) in the CHAA, principally in the Bugoma Central Forest Reserve. Direct habitat loss of suitable habitat as a result of clearing to widen the road corridor will be 9.7 ha of forest habitat along the R5 section of road, and 3.5 ha along the P1 section of road (based on approximately 9.7 km of the R5 and 3.5 km of the P1 traversing dense forest habitat (Figure 21), and a conservative clearing width of 10 m either side of the current road), representing 13.2 ha or 0.03% of suitable habitat present at baseline.

The Nahan's Francolin's degree of vulnerability to disturbance is unknown. Birds are known to be sensitive to land use and habitat alteration (Lussier et al. 2006). The behavioural response of species to disturbance will depend on species-specific tolerance levels, disturbance type and frequency, group size for socially-foraging animals, and local conditions such as the availability of alternative foraging sites (Madsen 1998). Many studies have reported a reduction in breeding success attributable to human disturbance (for a review, see Hill et al. 1992). Mechanisms include: increased rates of predation, nest abandonment and reduced time at the nest, either incubating or feeding. Clearly, a reduction in breeding output may have conservation implications and consequences for the population. How tolerant the Nahan's Francolin may be to indirect disturbances, such as noise, light, vibration and edge effects, is not known. However, assuming it is sensitive to such disturbance because it is a shy, forest-dependent species (Sande et al. 2009a), then with a 200 m buffer applied to the road upgrade's footprint, approximately 264 ha of potential Nahan's Francolin habitat will be lost or reduced in quality as a result of edge effects, and possibly sensory disturbance. This equates to a potential habitat loss in the CHAA from vegetation clearing, sensory disturbances and edge effects of up to 277 ha (0.8%).

Effects from loss of habitat are predicted to be well beyond the expected range of natural disturbance perturbations (for example, fire), although not beyond the human induced deforestation rate.

■   Habitat Connectivity

The effect of the road upgrade as a barrier to the movement of Nahan's Francolin is unknown. Roads are recognised as creating sensory disturbances, which can elicit reduced use or complete avoidance of affected areas, thereby creating movement barriers (for example, see Kolowski and Alonso 2009, Gleeson and Gleeson 2012). However, given that the R5 and P1 already exist, if the Nahan's Francolin is sensitive to such effects, then it is reasonable to assume the existing roads are already a barrier to a greater or lesser degree. The upgrade of the road will bring increased sensory disturbance in the short-term, during upgrade construction, and then a potential for long-term effects as traffic along the road increases. Certainly, for the duration of the construction of the Project and the movement of components to the Buhuka Flats, traffic volumes on the road are expected to increase significantly (ref. Section 9.1.1.4).

Effects from loss of habitat connectivity are predicted to be well beyond the expected range of natural disturbance perturbations (for example, fire), although not beyond the human induced deforestation rate.

■ Abundance and Distribution

Nahan's Francolin is reported to be relatively common in the Bugoma Central Forest Reserve (Plumptre et al. 2011). What effects the upgrade of the road, and the predicted increased traffic levels along the road during the construction of the Project, could have on the abundance and distribution of this species is unknown. Although this species within the forest is reported to be relatively common (*viz.*, Plumptre et al. 2011), the distribution of individuals within this habitat is unknown.

It is conceivable that the current road could act as a barrier and sensory disturbance to this species, and, as such, its distribution and abundance around the road corridor could be affected. That is, the local population along the road could be less than the surrounding forest. However, the actuality of this scenario is unknown.

Consequently, it is assumed that the current distribution of this species is evenly spread within suitable habitat in the Bugoma Central Forest Reserve, including along the current road. With the construction of the road upgrade, and the increased traffic along the road during the construction of the Project, it is reasonable to assume that the distribution of this species may be altered. Individuals may avoid the resultant sub-optimal habitat brought about by the upgrade construction activities and increased traffic volumes. Additionally, the increased traffic on the road could lead to an increase in direct mortality of individuals, with individuals potentially being killed by that traffic.

Effects from the upgrade construction and increased traffic volumes during construction of the production facility are predicted to be well beyond the expected range of natural disturbance perturbations, although not beyond the disturbance from the human-induced deforestation rate.

■ Survival and Reproduction

The Nahan's Francolin's degree of vulnerability to direct disturbance, particularly during the breeding season, is not well understood. Nahan's Francolin is reliant upon large trees, with appropriate buttress formation, for breeding sites (Sande et al. 2009a). The reduction of the number of suitable breeding sites, through the removal of such large trees, can, therefore, be expected to reduce the breeding success of this species. Generally, for birds, the behavioural response of species to disturbance will depend on species-specific tolerance levels, disturbance type and frequency, group size for socially-foraging animals, and local conditions such as the availability of alternative breeding sites (Madsen 1998). Many studies have reported a reduction in breeding success attributable to human disturbance (for a review, see Hill et al. 1992). Mechanisms include: increased rates of predation, nest abandonment and reduced time at the nest, either incubating or feeding. Clearly, a reduction in breeding output may have conservation implications and consequences for the local population of Nahan's Francolin.

How tolerant the Nahan's Francolin may be to indirect disturbances, such as noise, light, vibration and edge effects, during the breeding season, are also not completely understood. What is known is that disturbance of mature forest generally appears to reduce the home range of this species (Sande et al. 2009b), and hence its potential to find suitable mates. Assuming it is sensitive to sensory disturbance because it is a shy, forest-dependent species (Sande et al. 2009a), the construction of the road upgrade, and the disturbance arising from the increased traffic levels on the road during the construction of the Project could affect the breeding

success of those individuals living in close proximity to the road. In addition, if the birds attempt to cross the upgraded road in order to forage within their usual range, they will risk collision with Production Facility construction-related traffic, resulting in mortality.

These effects to the survival and reproductive success of Nahan's Francolin are predicted to be well beyond the expected range of natural disturbance perturbations, although not beyond the human induced deforestation rate.

Impact Classification

The Nahan's Francolin's sensitivity is high because it triggers Tier 2 critical habitat.

Impacts to the Nahan's Francolin's habitat quantity and quality will be adverse. The geographical extent of impacts will be local because effects are restricted to those areas within 200 m of the R5 and P1 road corridors in the CHAA, with approximately 277 ha (0.8%) of potential habitat affected. Impact duration will be short-term (that is, limited to the road upgrade construction, and the construction phase of the Project, that is, ~2 years). Changes to the habitat quality and quantity from sensory disturbances arising from construction activities are expected to be reversible after completion of the works. The magnitude of the effects of construction on the habitat quantity and quality of the Nahan's Francolin is low. Therefore, the magnitude and sensitivity combine to produce a moderate overall impact level during the road upgrade and construction phase of the Project, pre-mitigation (Table 15). Following the application of appropriate mitigation measures, the impact significance is expected to decrease to minor, primarily because the magnitude could become negligible, although the sensitivity of the receptor will remain the same (Table 15).

Impacts to the Nahan's Francolin's habitat connectivity will be adverse. The geographical extent of impacts will be local because effects are restricted to those areas within the 10 m R5 and P1 road clearance footprint in the CHAA, with approximately 13.2 ha or 0.03% of potential habitat affected. Impact duration will be short-term (that is, limited to the road upgrade and construction phase of ~2 years) because physical and sensory disturbances arising from construction activities are expected to dissipate within a short time after cessation of activities. Changes to the habitat connectivity from sensory disturbances arising from construction activities are expected to be reversible after completion of the works. The magnitude of the effects of construction on the habitat connectivity of the Nahan's Francolin is Low. Therefore, the magnitude and sensitivity combine to produce a moderate overall impact level during the road upgrade and construction phase of the Project, pre-mitigation (Table 15).

Following the application of appropriate mitigation measures, the impact significance is expected to decrease to minor, primarily because the magnitude could become negligible, although the sensitivity of the receptor will remain the same (Table 15).

Impacts to the Nahan's Francolin's abundance and distribution could be adverse. The geographical extent of impacts will be local because effects are restricted to those within 200 m of the R5 and P1 road corridors in the CHAA, with approximately 277 ha (0.8%) of potential habitat affected. Impact duration will be short-term (that is, limited to the road upgrade and construction phase of ~2 years) because physical and sensory disturbances arising from construction activities are expected to dissipate within a short time after cessation of activities. There is a possibility that individuals could be killed or severely disturbed during the construction phase; however, these losses or disturbances are expected to be reversible after completion of the works. The magnitude of the effects of construction on the abundance and distribution of the Nahan's Francolin is Low. Therefore, the magnitude and sensitivity combine to produce a moderate overall impact level during the road upgrade and construction phase of the Project, pre-mitigation (Table 15).

Following the application of appropriate mitigation measures, the impact significance is expected to decrease to minor, primarily because the magnitude could become negligible, although the sensitivity of the receptor will remain the same (Table 15).

Impacts to the survival and reproduction of Nahan's Francolin could be adverse. The geographical extent of impacts will be local because effects are restricted to those areas within the 10 m R5 and P1 road clearance footprint in the CHAA, with approximately 13.2 ha or 0.03% of potential habitat affected. Impact duration will

be short-term (that is, limited to the road upgrade and construction phase of ~2 years) because physical and sensory disturbances arising from construction activities are expected to dissipate within a short time after cessation of activities. No large, buttressed trees, utilised as breeding sites, are expected to be removed during the road upgrade. There is a possibility that individuals could be killed or severely disturbed during the construction phase; however, those losses or disturbances are expected to be reversible after completion of the works. A threshold of 10% for this species' survival and reproduction in the CHAA is reasonable, and it is expected that this number of individuals in the local population within Bugoma Central Forest Reserve will not be affected. The magnitude of the effects of construction on the survival and reproduction of the Nahan's Francolin is therefore low. Therefore, the magnitude and sensitivity combine to produce a moderate overall impact level during the road upgrade and construction phase of the Project, pre-mitigation (Table 15).

Following the application of appropriate mitigation measures, the impact significance is expected to decrease to minor, primarily because the magnitude could become negligible, although the sensitivity of the receptor will remain the same (Table 15).

Table 15: Potential impacts in the construction phase to the Nahan's Francolin

Indicator of potential impact	Pre-mitigation			Post-mitigation (pre-offsets)		
	Magnitude	Sensitivity of the Receptor	Significance	Magnitude	Sensitivity of the Receptor	Significance
Habitat quality and quantity	Low – 2	High – 4	Moderate – 8	Negligible – 1	High – 4	Minor – 4
Habitat connectivity	Low – 2	High – 4	Moderate – 8	Negligible – 1	High – 4	Minor – 4
Abundance and distribution	Low – 2	High – 4	Moderate – 8	Negligible – 1	High – 4	Minor – 4
Survival and reproduction	Low – 2	High – 4	Moderate – 8	Negligible – 1	High – 4	Minor – 4

Prediction Confidence

Given the information available, there is a reasonable understanding of the potential effects that the upgrade works associated with the R5 and P1 roads, and traffic associated with the construction of the Project, could have on the Nahan's Francolin and its habitat in the CHAA.

The spatial extent of the dense forest habitat in the CHAA was broadly mapped based on knowledge of the site, baseline studies, literature and reports (see Section 6.3.1.1.1). The actual extent of possible habitat may have been over-estimated.

10.1.2.4 What impact could the construction/decommissioning of the Production Facility have on Eastern Chimpanzee?

The Eastern Chimpanzee is an Endangered species. The population of Eastern Chimpanzees in the Bugoma Central Forest Reserve is recognised as being one for the four largest in the region (Plumptre et al. 2010). Hence, the forest is recognised as an important chimpanzee conservation unit by the IUCN (Plumptre et al. 2010).

This species triggers Tier 1 critical habitat (Section 6.3.2.2, APPENDIX F). Tier 1 habitats are considered to be very sensitive, and, therefore, if a project is located in such a habitat, the IFC considers it unlikely that the client will be able to comply with the provision of PS 6, in particular paragraphs 17, 18 and 19 (IFC 2012a, as presented in APPENDIX B). In summary, a project will not be developed in Tier 1 habitat unless: no other viable alternatives exist; and, the project does not lead to measurable and irreversible adverse impacts to the valued component that triggered critical habitat; and, the project does not lead to a net reduction in the global

and/or national/regional population of the triggering species (i.e. Eastern Chimpanzee) over a reasonable period of time; and, a robust, appropriately designed, and long-term biodiversity monitoring and evaluation programme is part of the project's Environmental and Social Management System (ESMS). A Biodiversity Action Plan (BAP) will be developed to achieve net gain for the affected species.

Although it is expected that the construction of the Production Facility will not have direct impacts to Eastern Chimpanzees, the proposed upgrade of the R5 by the Ugandan Government (Figure 21) for the benefit of the Project could have induced and cumulative impacts to this species and Bugoma Central Forest Reserve (also see Section 6.1.1.4). The IFC's PS1, paragraph 2, recognises that certain effects and impacts arising from a Project may be "the responsibility of the government or other third-parties over which the client does not have control or influence" (IFC 2012c). Nevertheless, although CNOOC cannot control the actions of the government, the ESMS for the Project must identify the Ugandan Government's role, and the corresponding risks they present to CNOOC and the Project (IFC 2012c). Furthermore, the ESMS must identify opportunities for CNOOC to collaborate with the Ugandan Government in order to achieve outcomes that are consistent with PS6.

The proposed Government upgrade of the R5 is one such opportunity. The potential induced and cumulative effects to from this upgrade to the Eastern Chimpanzee are presented below.

Impact Indicators

Indicators used to assess effects of the upgrade of the R5 on Eastern Chimpanzee were: habitat quantity and quality, habitat connectivity, abundance and distribution, and survival and reproduction.

Habitat loss due to direct disturbance and clearing of habitat was assessed by calculating the loss of suitable habitat from the CHAA as a result of the upgrade of the road. Habitat loss due to indirect disturbance and edge effects was estimated by applying a 500 m buffer to the road corridor. Specifically, the buffer was selected to account for changes in habitat quantity and/or quality caused by indirect disturbance like noise, vibration and traffic. The buffer width was determined based known chimpanzee sensitivities to noise disturbance (Parren and Byler 2003, Rabanal et al. 2010). The amount of loss or degradation of habitats within the buffer was evaluated across a range of possibilities, including that habitats become completely unavailable to chimpanzees during the construction phase. Evaluating the potential for complete avoidance of the buffer area is a conservative approach, which addresses uncertainty about the attenuation distance of sensory disturbances for chimpanzees, even though the likelihood of strict avoidance throughout the entire buffer may be low.

Changes in habitat connectivity were assessed by identifying potential barriers to movement and loss of corridors. This was accomplished by visually examining the spatial distribution of critical habitat in relation to the road corridor to qualitatively identify areas where habitat becomes fragmented.

Potential changes in abundance and distribution were assessed qualitatively by considering changes in disturbances (that is, vehicle traffic, light, noise, vibration) and site clearing activities. These disturbances were considered in light of known or inferred effects to the survival and reproduction of other populations of chimpanzees for which data on these types of effects are available.

To assess effects to survival and reproduction as a result of in-migration and potential associated increases in poaching and disease spread, in-migration rates were predicted based on the predictions in Golder Associates (2014h). A literature review of the impact of contact with humans was also conducted

Impact Assessment

■ Habitat Quality and Quantity

Eastern Chimpanzees appear to range throughout the Bugoma Central Forest Reserve, both on the northern southern sides of the existing P1 road (Plumptre et al. 2010). Chimpanzees build nests to sleep in each night (Thompson and Wrangham 2013). Based on the data presented in Plumptre et al. (2010), the distribution of nesting sites appears to be widely distributed through the forest; the exception being within the vicinity of the

existing Nsozi-Kabwoya road. Here the frequency of nest encountered by those workers was a lot lower than elsewhere in the forest. This suggests that the Eastern Chimpanzees within the Bugoma Central Forest Reserve are actively avoiding the road, preferring to sleep some distance away from the disturbances arising from the road. The observation supports the findings of Parren and Byler (2003) that chimpanzees actively avoid environments where they will be disturbed at night.

Based on the above, the habitat along the current P1 and R5 roads could be considered foraging, or non-core, habitat (after Parren and Byler 2003). The entire Bugoma Central Forest Reserve is considered suitable habitat for Eastern Chimpanzees, as well as the areas beyond the boundaries of the forest reserve (see McLennan 2008). However, for the intents of this impact assessment, the habitat within and immediately surrounding the Bugoma Central Forest Reserve was only considered.

Suitable habitat was predicted to cover an area of ~40,200 ha (402 km^2) in the CHAA, principally in the Bugoma Central Forest Reserve. Direct loss of suitable habitat as a result of clearing to widen the road corridor will be approximately 26.4 ha (based on ~9.7 km of the proposed R5 upgrade, and 3.5 km of the proposed P1 upgrade, traversing suitable habitat (Figure 21), and a conservative clearing width of 10 m either side of the current road for upgrade purposes), representing 0.07% of critical habitat present at baseline.

The degree of vulnerability to disturbance experienced by chimpanzees is reasonably well known (for example, see Parren and Byler 2003, Rabanal et al. 2010, Thompson and Wrangham 2013). The chimpanzees living in and around the Bugoma Central Forest Reserve most likely experience sensory disturbances at present from human activities, given the high human populations living around the reserve. Indeed, groups are known to forage in the agricultural fields surrounding the forest, and hence, would more than likely be used to human noises and disturbances (McLennan 2008). As such, the potential sensory disturbances arising from the road upgrade construction and increased traffic during the Project's construction are likely to be minimal. Nevertheless, the magnitude of noise may not be the most important determinant of chimpanzee response. Instead, chimpanzees may respond to 'new' noises or may associate particular noises with other occurrences (for example, machine noise may be associated with human presence, which chimpanzees may, in turn, associate with the presence of danger). Where humans pose a threat, chimpanzees generally avoid them (Hockings and Humle 2009, Parren and Byler 2003). Therefore, the degree of avoidance may depend on the behaviour of people, highlighting the importance of managing contractor activity.

Avoidance of industrial activity, like earth moving, by chimpanzees also varies. Chimpanzees have been recorded to leave their range as a result of logging activities heard from a distance of 5 to 10 km, and there are suggestions that this could cause lasting avoidance of disturbed areas (Parren and Byler 2003). Such avoidance may explain why chimpanzee densities were consistently lower in logged areas in Kibale National Park, compared to unlogged areas, although avoidance of hunting as a result of logging activity may also have been a factor (Chapman and Lambert 2000). However, Rabanal et al. (2010) did not find large-scale spatial responses to oil and gas related noise disturbance, in Loango National Park, Gabon; although chimpanzees avoided sites where explosions were used for exploration for a period of four months after the activity had ceased (Rabanal et al. 2010). The chimpanzees within the Bugoma Central Forest Reserve are, therefore, likely to show localised patterns of avoidance, particularly near the immediate road corridor during upgrade construction phase when noise and human activity will be most intense.

The introduction and spread of invasive species during the road upgrade is not expected to cause a change in habitat quality and quantity for the Eastern Chimpanzees. Populations of invasive species currently occur along the road corridor. The construction activities could create new sites for the colonisation of invasive species present in the area, although it is doubtful that the current populations of these species will increase dramatically.

With the above in mind, then with a 500 m buffer applied to the road upgrade's footprint, approximately 660 ha of Eastern Chimpanzee habitat will be reduced in quality as a result of sensory disturbance. This equates to a total potential habitat loss in the CHAA from vegetation clearing, sensory disturbances and edge effects of up to 686.4 ha (1.7%). The reality of this quantity is doubtful given that upgrade construction works may not occur along the entire length at once; however, there is a potential that the sensory disturbance arising from the increased traffic associated with the Project's construction may affect the habitat quality along the length

of the road through the forest, as there is presently very little traffic on the roads through the centre of the reserve.

Although the effects on habitat quantity are probably not beyond the human induced deforestation rate, the disturbance arising from the Project construction traffic and subsequent effects on habitat quality is predicted to be well beyond the expected range of natural disturbance perturbations.

■ Habitat Connectivity

The upgrade of the R5 and P1 Roads will directly remove suitable habitat for the Eastern Chimpanzees. It may also affect that habitat within the 500 m buffer through indirect impacts like edge effects and sensory disturbance. However, the chimpanzees within Bugoma Central Forest Reserve are assumed to be accustomed to human activity, and they may, more than likely, regularly cross roads within their range. Therefore, it is possible that they will not avoid the road corridor when construction activity is not occurring. However, during upgrade construction works, they may avoid those sections where construction activity is occurring.

While the Bugoma Central Forest Reserve chimpanzees are accustomed to some human activity, including occasional road traffic, and they are known to regularly cross roads within their range, the magnitude of the impact caused by construction activities (both road building and particularly, the CNOOC production facility construction traffic) is likely to be significantly greater than is currently experienced. The probable split between construction traffic on the R5 and the P1 is not known, nor is the extent of avoidance behaviour by the chimpanzees to increasing degrees of nuisance and perceived threat. However, it is reasonable to assume that the order of magnitude increase in traffic will materially affect the behaviour of the animals, and will discourage regular road crossings. As such, the impact of the increased Project construction traffic as a barrier to chimpanzee movements is predicted to be of moderate magnitude.

■ Abundance and Distribution

The Bugoma Central Forest Reserve supports one of the top four Eastern Chimpanzee populations in Uganda, with a population of between 450 and 850 individuals (Plumptre et al. 2010). The construction works associated with the upgrade of the R5 Road are not expected to detrimentally affect the abundance of chimpanzees in the forest. Their localised distribution may be altered temporarily as they avoid sensory disturbances associated with the construction works. However, these distributions are expected to return to baseline conditions when the works cease.

Construction traffic will increase to frequencies where interaction between vehicles and animals crossing the road could be likely on occasions. How the chimpanzees would behave in the face of an oncoming vehicle is unknown. The probability of collisions and the potential magnitude of this impact on abundance and distribution is still thought to be low, but it is no longer negligible, as is the case at present where traffic volumes are limited.

Effects from the increased traffic volumes arising from the construction of the Production facility are predicted to be well beyond the expected range of natural disturbance perturbations, although not beyond the disturbance from the human-induced deforestation rate and habitat loss, and bush meat hunting in Bugoma Central Forest Reserve.

■ Survival and Reproduction

As mentioned, the chimpanzees within the forest appear to currently avoid the road corridor for night-time nesting and other activities (after Plumptre et al. 2011). Furthermore, given that the chimpanzees within the forest are more than likely used to human activities in and around the forest, they are predicted to adapt to most of the sensory disturbance arising from the construction activities. The survival and reproduction of the Eastern Chimpanzees within the Bugoma Central Forest Reserve are not expected to be affected as a result of the road upgrade construction works; however, the increased traffic associated with the Project's construction presents an increased collision risk and risk of injuries and mortalities.

The increased traffic on the upgraded road, associated with the Project construction, has the potential to cause direct mortality of individuals, should such individuals cross the road. What effect the loss of individuals from the population could have is unknown. It is doubtful that the population could be reduced by 10% and, hence, reach that critical population threshold due to road mortalities alone; however, any mortality or injury to individuals of Eastern Chimpanzee as a result of collisions with Project construction vehicles is considered unacceptable.

These effects to the survival and reproductive success of Eastern Chimpanzees are predicted to be beyond the expected range of natural disturbance perturbations, although not beyond the human induced deforestation rate, habitat degradation and bush meat hunting. In the short-term, the survival and reproduction of individual chimpanzees within the forest could be detrimentally affected by the significant increase in construction traffic associated with the construction of the Production Facility.

Impact Classification

The Eastern Chimpanzee's sensitivity is high because it is Endangered.

Impacts to the Eastern Chimpanzee's habitat quantity and quality will be adverse. The geographical extent of impacts will be local because effects are restricted to those areas immediately adjacent to the R5 and P1 Road corridor in the CHAA, with approximately 504 ha (1.2%) of potential habitat affected. Impact duration will be short-term (that is, limited to the road upgrade construction, and the construction phase of the Project, that is, ~3 years). Changes to the habitat quality and quantity from sensory disturbances arising from construction activities are expected to be reversible after completion of the works. The magnitude of the effects of construction on the habitat quantity and quality of the Eastern Chimpanzee is low.   Therefore, the intensity and sensitivity combine to produce a moderate overall impact level during the road upgrade and construction phase of the Project, pre-mitigation (Table 16). Following the application of appropriate mitigation measures, the impact significance is expected to decrease to minor, primarily because the magnitude could become negligible, although the sensitivity of the receptor will remain the same (Table 16).

Impacts to the Eastern Chimpanzee's habitat connectivity are expected, primarily as a result of the significant increase in traffic associated with the trucks being used during construction of the Production Facility. The geographical extent of impacts will be local because effects are restricted to those areas immediately adjacent to road corridor in the CHAA, with approximately 504 ha, or 1.2%, of potential habitat affected. Impact duration will be short-term (that is, limited to the construction phase of ~3 years) because physical and sensory disturbances arising from the road upgrade works, and the physical barrier to movement presented by the Production Facility construction traffic are expected to dissipate within a short time after cessation of upgrade activities, and so are expected to be reversible after completion of the works. The magnitude of the effects of construction of the Production Facility on the habitat connectivity of the Eastern Chimpanzee is thus considered medium. Therefore, the magnitude and sensitivity combine to produce a major overall impact level during the road upgrade and construction phase of the Project, pre-mitigation (Table 16). Following the application of recommended mitigation measures, the impact significance is expected to be reduced to minor, primarily because the magnitude would become negligible, although the sensitivity of the receptor will remain the same (Table 16).

Impacts to the Eastern Chimpanzee's abundance and distribution, primarily as a result of the increased traffic volumes during construction of the Production Facility, could be adverse. The geographical extent of impacts will be local because effects are restricted to those areas immediately adjacent to the R5 Road corridor within the Bugoma CFR. Impact duration will be short-term (that is, limited to the road upgrade and Production Facility construction phase of ~3 years) because physical and sensory disturbances arising from construction activities and traffic are expected to dissipate within a short time after cessation of activities. Although there is a possibility that individuals could be killed or severely disturbed during the construction phase, this is unlikely to have a material effect on the species abundance or distribution of Eastern Chimpanzee. The magnitude of the potential construction impacts on the abundance and distribution of the Eastern Chimpanzee is low. Therefore, the magnitude and sensitivity combine to produce a moderate overall impact level during the road upgrade and construction phase of the Project, pre-mitigation (Table 16). Following the application of the recommended mitigation measures (Section 11.0), the impact significance is expected to decrease to minor,

primarily because the magnitude could become negligible, although the sensitivity of the receptor will remain the same (Table 16).

Impacts to the survival and reproduction of population of Eastern Chimpanzee in Bugoma Central Forest Reserve could be adverse. The geographical extent of physical and sensory disturbances will be local because effects are restricted to those areas immediately adjacent to the R5 Road corridor in the CHAA, with approximately 504 ha, or 1.2%, of potential habitat affected. Impact duration will be short-term (that is, limited to the road upgrade and construction phase of ~3 years) because physical and sensory disturbances arising from construction activities are expected to dissipate within a short time after cessation of activities. Indications are that the chimpanzees in Bugoma Central Forest Reserve nest away from the current road, and therefore, it can be expected that effects to their survival and reproduction due to physical and sensory disturbances will be minimal.

However, in the event that the chimpanzees do need to cross the upgraded road, the increased traffic associated with the Project's construction could present an unacceptable collision risk and subsequent injuries/mortality of chimpanzees. Therefore, in the short-term, the survival and reproduction of chimpanzees within the forest could be detrimentally affected by the increased vehicular traffic that will be present during the construction phase of the Project. A threshold of 10% for this species' survival and reproduction in the CHAA is reasonable, and it is expected that this number of individuals in the local population within Bugoma Central Forest Reserve will not be affected through direct mortality or severe sensory disturbance; nevertheless, a single incidence of mortality or injury to any individual of this Endangered species is considered unacceptable. The magnitude of the impact of increased traffic on the P1 associated with the construction of the Project on the survival and reproduction of the Eastern Chimpanzee is medium. Therefore, the magnitude and sensitivity combine to produce a major overall impact level during the road upgrade and construction phase of the Project, pre-mitigation (Table 16). Following the successful application of the recommended mitigation measures for control of Project-related traffic, the impact significance is expected to decrease to minor, primarily because the magnitude could become negligible, although the sensitivity of the receptor will remain the same.

Table 16: Potential impacts in the construction phase to the Eastern Chimpanzee

Indicator of potential impact	Pre-mitigation			Post-mitigation (pre-offsets)		
	Magnitude	Sensitivity of the Receptor	Significance	Magnitude	Sensitivity of the Receptor	Significance
Habitat quality and quantity	Low – 2	High – 4	Moderate – 8	Negligible – 1	High – 4	Minor – 4
Habitat connectivity	Medium - 3	High – 4	Major – 12	Negligible – 1	High – 4	Minor – 4
Abundance and distribution	Low – 2	High – 4	Moderate – 8	Negligible – 1	High – 4	Minor – 4
Survival and reproduction	Medium - 3	High – 4	Major – 12	Negligible – 1	High – 4	Minor – 4

Prediction Confidence

Given the information available, there is a reasonable understanding of the potential effects that the upgrade works associated with the R5 and P1 Roads, and traffic associated with the construction of the Project, could have on the Eastern Chimpanzees and their habitat in the CHAA.

The spatial extent of the dense forest habitat in the CHAA was broadly mapped based on knowledge of the site, baseline studies, literature and reports (see Section 6.1). The actual extent of possible habitat may have been over-estimated.

10.2   Operation Phase Impacts

For the assessment of impacts during the operations phase, the key questions were divided into sub-questions that focused on individual valued components within the CHAA and LSA. In answering each question, the individual components of the Project were considered with regards to their potential to affect a valued component. These questions are presented below.

10.2.1   What impact could the operation of the Project have on habitats and ecosystem integrity?

This section presents the assessment of impacts that the operation of the Project could have on the habitat and ecosystem integrity within the CHAA and the LSA. These habitats either do, or could, support populations of species of concern. Therefore, the assessment of potential impacts to those species, and others, occurring in the CHAA has been assessed in this section through the determination of the impacts to potential habitat for those species.

The impacts of the Project on critical habitat, as triggered by species of concern, are covered under the individual assessment of those species in Section 7.2. Other triggers of critical habitat are discussed as relevant in the appropriate sections, and in APPENDIX F.

10.2.1.1   What impact could the operation of the Project have on the near-shore environment of Lake Albert?

Impact Indicators

Indicators used to assess impacts of the Project on the habitat and ecosystem integrity of the near-shore environment of Lake Albert were changes in: regional representativeness; topography (geomorphology), sediments, water quality; ecosystem composition; ecosystem configuration.

Additional, indirect impacts to habitat were estimated by applying a 1 km buffer to the Project footprint, forming the LSA. Specifically, the buffer was selected to account for changes in habitat quantity and/or quality that could be caused by sensory disturbance, changes in water quality, and air emissions and dust.

Changes in habitat composition and ecosystem configuration were assessed by identifying potential succession changes in species composition that could occur. This was accomplished by examining available literature about the ecology of Lake Albert, and scientific literature about the impacts of human activities on aquatic environments.

Impact Assessment

■   Representativeness

The operation of the Kingfisher camps/parking lots/materials yards, airstrip, CPF, pipeline, in-field roads, crusher plant/spoil area A, new well pads, and associated infrastructure will not cause the loss of additional near-shore aquatic habitat beyond that already removed during the construction phase.

The potential for influx and in-migration of people onto the Buhuka Flats seeking opportunities from the Project, and because of the easier access provided by the escarpment road, could place increased pressure on the near-shore habitats. This increased pressure could arise from increased fishing activities and pollution (such as, fuels, human and livestock waste, fish waste, and litter). The resultant increased pressures could lead to a change in the current drivers of change to the near-shore aquatic habitats, although it is doubtful that these changes would lead to a change in the representativeness of habitats.

Impacts from the changes to representativeness are predicted to be within the expected range of natural disturbance perturbations.

- Topography (geomorphology) and sediment transport

The operation of the Kingfisher camps/parking lots/materials yards, airstrip, CPF, pipeline, in-field roads, crusher plant/spoil area A, new well pads, and associated infrastructure could cause increased sedimentation of near-shore habitats on the Buhuka Flats. The soils of the Buhuka Flats are dispersive (Golder Associates 2014d), and active soil erosion is evident in the LSA; which could be exacerbated by increased areas of bare ground and deterioration of land capability (due to overgrazing and more extensive presence of hardstanding areas) in the LSA. Erosion around cleared areas around the site could lead to the accumulation of sediment upstream of the points where the infrastructure crosses the drainage paths (ref. Surface Water). It is expected that most areas that were cleared of vegetation during the construction phase and where no infrastructure is located, will have been revegetated by the operations phase (see Section 10.1.1). Dust generation, erosion and sedimentation is, therefore, likely to be limited to the drainage associated with the main access road. Sediment-laden stormwater runoff from this road will enter the near-shore environment of the Lake via the Kamansinig River, to the north of the lagoon.

If adequate erosion and sediment control structures are not maintained as part of the prescribed stormwater management system during the operation of the Project, there is a potential that sediment loads within the watercourses draining the Project footprint could increase. These sediment-laden watercourses report to Lake Albert, and, hence, there is a potential for increased sediment loads in the near-shore environments. Near-shore habitats particularly at risk include the lagoon, and to a lesser extent, the shallow river-associated habitats. Nevertheless, the watercourses draining the LSA support dense emergent vegetation (see Section 6.2). Such vegetation forms an impactive filter for most sediment (IECA 2008), therefore, it can be expected that sediment loads reporting to the near-shore habitats, at least, via the Kamansinig River, River 1 and Masika River, could be minimal. Sediment loads from overland flows may not be retarded by vegetation, and hence may report to the near-shore habitats, contributing to measurable increased turbidity during and after storms, where River 1 discharges to the Lake.

Impacts from the changes to topography (geomorphology) and sediment are predicted to be beyond the expected range of natural disturbance perturbations if the mitigation measures fail or are inadequate.

- Water quality

Impacts from the changes to water quality are predicted to be beyond the expected range of natural disturbance perturbations, if the mitigation measures fail or are inadequate. Contributing factors to potential changes in water quality are discussed below:

Discharge of poor quality sewerage effluent

The discharge of treated sewerage effluent from the plant to Lake Albert presents an increased risk of eutrophication of the near-shore habitats on the Buhuka Flats. Sewage from the CPF will be routed via conservancy tanks to a regulating tank at the permanent camp, from where it will be treated in a Membrane Bioreactor sewage treatment works (Project Description). Options for final disposal of treated sewage effluent include the base case (discharge into perimeter drains around the CPF, which discharge into small drainage lines leading to Lake Albert), irrigation onto land in the buffer area around the CPF and at the personnel camp lawns and gardens, and/or discharge into an artificial wetland or sustainably managed plantation.

Oil and Chemical Pollution

Accidental, minor spillage of fuels and chemicals during the day-to-day operation of the Project components (other than catastrophic spillages, which are addressed in the chapter on unplanned events) could report to the near-shore habitats of the CHAA, via stormwater drainage into River 1, and subsequently Lake Albert, south west of Well Pad 2.   In this way, minor spillages during operation could ultimately report to the near-shore habitats of the CHAA. Further sources of contamination could occur around the jetty when barges are being loaded and unloaded. This Project component is located right on the lake shore, and the impact of an accidental spill would be more obvious than a land-based spill; it would also be harder to contain and clean up.

These risks must be assessed in the context of the high sensitivity of the near-shore environment to oil and chemical spills. Certain invertebrate species (for example, aquatic snails (Araujo et al. 2012), mayflies (Savić et al. 2011)) and juvenile fish (for example, Agamy 2013) are highly sensitive to chemical pollutants, particularly hydrocarbons. Currently, the concentrations of hydrocarbons and other pollutants in the lake water are below levels that could cause harm to the environment (Golder Associates 2014b); this is supported by the healthy aquatic communities observed in the lake's near-shore habitats (see Section 6.2). As such, without adequate spill prevention and clean-up measures in place, a chemical spill could, depending on the volume spilt, have a detrimental impact on the near-shore habitats of the CHAA through the introduction of toxic compounds and pollutants. Such a spill could have a detrimental impact on the aquatic invertebrate community and juvenile fish occurring in these habitats; including the Critically Endangered Mud Snail (*G. candida*) (if it does occur in the area).

Discharge of poor quality storm water

Potentially Oil Contaminated (POC) stormwater generated in the defined hazardous areas of the plant will be collected in the open drain system for delivery to an API oil separator. These API separators are designed to separate gross amounts of oil and suspended solids from the water. The first 15 minutes of any storm will be captured and routed through the API separator, before being delivered to the secondary treatment section of the produced water treatment system for further treatment and disposal with produced water. A maximum 15-minute stormwater runoff value of 120 m^3 (equivalent to runoff of 478 m^3/hr) is provided for. The balance of any stormwater will be captured in a stormwater pond, tested and released into the environment, if it meets the discharge specification. All stormwater from designated non-hazardous areas of the plant will be released directly from the open drains, without testing.

While control systems are proposed to manage contaminated stormwater and wash water from the well pads, the absence of a buffer between the well pads and the lake (or, in the case of well pad 1, the seasonally-flooded grassland wetland); makes it likely that occasionally-contaminated drainage could reach the near-shore habitats of the lake, unless there is a very high level of control of day-to-day activities.

Population increases

The potential for influx and in-migration of people onto the Buhuka Flats seeking opportunities from the Project, and because of the easier access provided by the escarpment road, could place increased pressure on the near-shore habitats. This increased pressure could arise from increased pollution (such as fuels, human and livestock waste, fish waste, and litter), particularly nutrient enrichment from sewerage and livestock. The resultant increase in pollution levels could lead to a dramatic change in the current drivers of change to the near-shore aquatic habitats, especially the Bugoma Lagoon which is already nutrient-enriched to a degree.

■ Ecosystem composition

The operation of the jetty, Kingfisher camps/parking lots/materials yards, airstrip, CPF, pipeline, in-field roads, crusher plant/spoil area A, new well pads, and associated infrastructure is not expected to result any noticeable alternation of the ecosystem composition of the aquatic communities.

As mentioned above, pollution and erosion and sedimentation derived from the Project's footprint could alter the composition of the communities if that pollution is toxic to aquatic life, or sediment loads smother aquatic organisms if mitigation measures fail. This notwithstanding (with the exception of catastrophic pollution events) it is considered unlikely that operation activities would alter the ecosystem composition of the near-shore aquatic communities during the expected ~25-year operation period for the Project.

The potential for influx and in-migration of people onto the Buhuka Flats seeking opportunities from the Project, and because of the easier access provided by the escarpment road, could place increased pressure on the near-shore habitats. This increased pressure could arise from increased fishing activities, as well as additional sources of pollution (such as, fuels, human and livestock waste, fish waste, and litter). The resultant increase in the population on the Buhuka Flats could lead to a dramatic change in the current drivers of change to the near-shore aquatic habitats. These pressures could alter the ecosystem composition of these habitats.

Provided that the appropriate management measures are in place, in line with CNOOC's in-house alien invasive species management policy, increases in populations of invasive and exotic species are not expected to result directly from the operation of the project. The increased population of people on the Buhuka Flats could alter ecosystem processes and functions and lead to an increased susceptibility of the natural ecosystems to invasion by exotic species. However, certainly for the near-shore aquatic environment, this is not expected.

Impacts from the changes to ecosystem composition are predicted to be beyond the expected range of natural disturbance perturbations, if the mitigation measures fail or are inadequate.

■   Ecosystem configuration

The operation of the Project is expected to last for 25 years. The operation of the jetty, Kingfisher camps/parking lots/materials yards, airstrip, CPF, pipeline, in-field roads, crusher plant/spoil area A, new well pads, and associated infrastructure is not expected to result any noticeable alteration of the ecosystem configuration of the aquatic ecosystems and habitats in the CHAA. It is expected that the connectivity amongst the aquatic habitats will remain the same during operation as they were during baseline.

The potential for influx and in-migration of people onto the Buhuka Flats seeking opportunities from the Project, and because of the easier access provided by the escarpment road, could place increased pressure on the near-shore habitats. This increased pressure could arise from increased fishing activities, as well as additional sources of pollution (such as, fuels, human and livestock waste, fish waste, and litter), and introduction/spread of invasive plant species. The resultant increase in the population on the Buhuka Flats could lead to a dramatic change in the current drivers of change to the near-shore aquatic habitats. These pressures could alter the ecosystem composition of these habitats.

Impacts from the changes to ecosystem configuration are predicted to be within the expected range of natural disturbance perturbations.

Impact Classification

The near-shore aquatic habitat's sensitivity is high because these habitats potentially support populations of the Critically Endangered Mud Snail (*Gabbiella candida*), and the range restricted and Near Threatened Snail (*Bellamya rubicunda*).

Impacts to the representativeness of near-shore habitats will be neutral. The geographical extent of impacts will still be local because impacts are restricted to the LSA. Impact duration will be into the far future (that is, ~25 years) because the jetty and water intake and pump station will remain in place for the duration of the operation phase, and natural ecosystem processes (i.e. longshore sediment drift) are expected to become re-established in the vicinity of the water intake and pump station (assuming that the recommended construction-phase mitigation measures were successfully applied). Although increased human populations and activity (fishing activity – wastes, fuels, litter; increased cattle grazing) on the Buhuka Flats could contribute to increased pressure on Lake Albert, no changes to the representativeness of the near-shore habitats during operations are expected. The magnitude of operation phase impacts of on representativeness of the near-shore aquatic habitats is therefore considered negligible. Therefore, the negligible magnitude of impact and high sensitivity of the receptor combine to produce a minor overall impact level to representativeness during the operations phase of the Project, pre-mitigation (Table 17). Following the application of appropriate mitigation measures (Section 11.0), the impact significance is expected to remain the same, that is, minor, primarily because the magnitude will remain negligible, and the sensitivity of the receptor will remain the same.

Impacts to the topography (geomorphology) and sediment transport in the near-shore habitats during operation will be adverse. The geographical extent of impacts will be local, because impacts are restricted to the LSA. Impact duration will be medium-term (that is, ~25 years operation duration). The magnitude of the impact on topography (geomorphology) and sediment transport is expected to be low prior to mitigation, because wetland vegetation within the Kamansinig River, Masika River and River 1 are expected to provide efficient attenuation of sediment, and a significant increase in sediment concentrations in the lake or in Bugoma Lagoon as a result of Project operations are unlikely. However, sediment loads from overland (stormwater) flows may not be

retarded by vegetation (particularly in a scenario where human-induced pressures such as cattle overgrazing and land deterioration occurs over the lifetime of the Project), and hence may report to the near-shore habitats, contributing to measurable increased turbidity during and after storms, where River 1 discharges to the Lake; potentially resulting in impacts of low magnitude. Therefore, the magnitude and sensitivity combine to produce a moderate overall impact significance to topography (geomorphology), sediment, and water quality during the operational phase of the Project, pre-mitigation (Table 17). Following the application of appropriate mitigation measures, the impact significance is expected to be reduced to minor, primarily because the magnitude will become minor, and the sensitivity of the receptor will remain the same.

Impacts to the water quality as a result of discharge of treated sewerage effluent, and stormwater that could contain oil and chemical pollution will be adverse. The geographical extent of impacts will be local, because impacts are restricted to the LSA, in the immediate vicinity of the discharge points to the Lake. Impact duration will be medium-term (that is, ~25 years). The baseline concentration of hydrocarbons and other pollutants in the lake water is currently below levels that could cause harm in the lake environment (ref. Surface Water). The magnitude of the potential impacts on water quality varies; with high magnitude assigned to any impacts associated with stormwater contaminated with oil and potentially-hazardous/toxic chemicals, and medium magnitude impacts predicted for potential discharge of treated sewerage. Combined with the high sensitivity of the near-shore habitats, both impacts on water quality could be of major significance, prior to mitigation (Table 17). Following the application of appropriate mitigation measures, the impact significance associated with contaminated stormwater reaching the Lake is expected to be reduced to moderate, primarily because the magnitude will become low, and the sensitivity of the receptor will remain the same. Consideration of other options for final disposal of treated sewage effluent, such as irrigation onto land in the buffer area around the CPF and at the personnel camp lawns and gardens, or discharge into an artificial wetland or sustainably managed plantation (ref. Section 11.0), could further reduce the magnitude of effects on water quality associated with disposal of treated sewerage effluence to negligible, resulting in overall impacts of minor significance on water quality.

Impacts to the water quality as a result of increased numbers of people and livestock on the Buhuka Flats are likely, and will be adverse. The geographical extent of impacts will be local, because impacts will be restricted to the LSA. Impact duration will be medium-term (that is, ~25 years). In the context of existing nutrient enrichment in the Bugoma Lagoon, the magnitude of additional nutrient input is predicted to be medium, which combined with the high sensitivity of the habitat, results in an overall impact of major significance, prior to mitigation. Following the application of appropriate mitigation measures, the impact significance could be reduced to moderate, primarily because the magnitude will become low, but the sensitivity of the receptor will remain the same (Table 17).

Impacts to the ecosystem composition will be adverse. The geographical extent of any impacts will be local because impacts are restricted to the LSA. Impact duration will be long-term (that is, ~25 years). The magnitude of the impact on ecosystem composition is low because, prior to any mitigation, the potential for changes to ecosystem composition potentially brought about by increased fishing intensity, pollution and smothering is possible. Therefore, the magnitude and sensitivity combine to produce a moderate overall impact level to ecosystem composition during the operational phase of the Project, pre-mitigation (Table 17). Following the application of appropriate mitigation measures, the impact significance is expected to remain minor, because the magnitude will remain negligible, and the sensitivity of the receptor will remain the same.

Impacts to the ecosystem configuration will be neutral. The geographical extent of impacts will be local because impacts are restricted to the LSA. Impact duration will be long-term (that is, ~25 years). The magnitude of the impact on ecosystem configuration is negligible because, prior to any mitigation, the potential for changes to ecosystem configuration is very remote. Consequently, even post-mitigation, the significance of the impact will remain minor (Table 17).

Table 17: Potential impacts in the operation phase to near-shore habitats

Indicator of potential impact	Pre-mitigation			Post-mitigation		
	Magnitude (the expected size of the impact)	Sensitivity of the Receptor	Significance	Magnitude (the expected size of the impact)	Sensitivity of the Receptor	Significance
Representativeness	Negligible – 1	High - 4	Minor – 4	Negligible – 1	High - 4	Minor – 4
Topography (geomorphology) and sediment	Low – 2	High - 4	Moderate – 8	Negligible – 1	High - 4	Minor – 4
Water quality – sewerage effluent	Medium - 3	High - 4	Major - 12	Negligible – 1	High – 4	Minor - 4
Water quality – contaminated stormwater	High - 4	High - 4	Major - 16	Low – 2	High - 4	Moderate – 8
Water quality – increased population and livestock	Medium - 3	High - 4	Major - 12	Low – 2	High - 4	Moderate – 8
Ecosystem composition	Low – 2	High - 4	Moderate – 8	Negligible – 1	High - 4	Minor – 4
Ecosystem configuration	Negligible – 1	High - 4	Minor – 4	Negligible – 1	High - 4	Minor – 4

Prediction Confidence

Given the information available, there is a reasonable understanding of the potential Project impacts to the near-shore habitats of the CHAA. However, there is some uncertainty in regard to the irreplaceability and vulnerability of those habitats in the CHAA. Given the current uncertainty in relation to climate change and possible scenarios with the level of Lake Albert, which has, in the recent and not so recent past varied quite dramatically (Talbot et al. 2006), it is conceivable that level of the lake may increase or decrease thereby altering near-shore habitats.

The extent of influx and in-migration of people onto the Buhuka Flats specifically seeking opportunities is uncertain. Indications are that additional large numbers of people have moved onto the flats, or are present daily in large numbers, primarily because access is now easier (Social Impact Assessment). This increase in population is expected to exacerbate existing anthropogenic pressures on the Buhuka Flats and the near-shore habitats of Lake Albert.

The spatial extent of the near-shore habitats in the CHAA was broadly mapped based on knowledge of the site, baseline studies, literature and reports (see Section 6.0). The actual extent of possible habitat may have been over-estimated.

10.2.1.2 What impact could the operation of the Project have on the wetlands in the Buhuka Flats region of the CHAA?

Impact Indicators

Indicators used to assess impacts of the Project on the habitat and ecosystem integrity of the wetlands of the CHAA were changes in: regional representativeness; ecosystem composition; and ecosystem configuration.

Indirect affects to habitat were estimated by applying a 0.50 km buffer to the Project infrastructure. Specifically, the buffer was selected to account for changes in habitat quantity and/or quality that could be caused by edge impacts, fragmentation, sensory disturbance, changes in water quantity and quality, air emissions and dust, and population increases.

Changes in habitat composition and ecosystem configuration were assessed by identifying potential changes in species composition that could occur, and the disruption of known corridors. This was accomplished by examining available scientific literature about the ecology of wetlands (permanent and seasonally flooded grasslands).

Impact Assessment

■ Representativeness

Operation of the Project infrastructure is unlikely to cause ongoing loss of representativeness of wetlands in the CHAA, or ongoing impacts to the permanent wetlands and the seasonally flooded grasslands of the CHAA, assuming the mitigation measures devised for the construction phase are impactive.

Impacts to representativeness of wetlands during the operation of the Project are predicted to be within the expected range of natural disturbance perturbations.

■ Ecosystem composition

The operation of the Project infrastructure is unlikely to cause changes to the composition of wetlands in the CHAA, or ongoing impacts to the permanent wetlands and the seasonally flooded grasslands of the CHAA, assuming the mitigation measures devised for the construction phase are impactive. Similarly, during the operation phase, noise and sensory disturbances created by the equipment is not expected to alter the behaviour of species frequenting the wetlands. For example, wading birds and Grey Crowned Cranes could become accustomed to the ongoing operational noises.

It is assumed, as part of standard operational methods, that appropriate drainage-line crossings will be maintained as part of the in-field road and airstrip management. Nevertheless, even with such measures in place, there is still a potential for long-term changes to the wetland character to occur. For example, there is the potential for erosion downstream of the crossings, backwater upstream of the crossings, and erosion at the entrance to the crossing structures. The airstrip is one area in particular where construction across a drainage line might lead to decreased flows and erosion downstream of the airstrip in the long-term (Golder Associates 2014b). This could lead to changes in the ecosystem functions and processes in the downstream wetlands, if not maintained during the operational phase.

The operation of the Kingfisher camps/parking lots/materials yards, airstrip extension, CPF, in-field roads, crusher plant/spoil area A, well pads, and associated infrastructure could cause increased erosion and sediment-laden run-off to report to the wetlands surrounding the Project footprint. The soils of the Buhuka Flats are dispersive (Golder Associates 2014d), and active soil erosion is evident in the LSA. There is a potential that, without adequate erosion and sediment control measures in place during operations, sediment loads within the watercourses draining the Project footprint could increase. Hence, there is a potential for increased sediment loads in the wetland habitats. The watercourses and associated wetlands draining the LSA support dense emergent vegetation (see Section 6.1.1). Such vegetation can form an impactive filter for most sediment (IECA 2008); therefore, it can be expected that sediment loads reporting to downstream wetland habitats could be minimal. Nevertheless, if sediment loads are substantial, there is a potential for that sediment to smother wetland vegetation and interfere with aquatic invertebrates. If this occurs, it could

detrimentally affect the wetland processes and functions, which, in turn, could alter wetland composition, albeit on a localised scale.

It is assumed that the potential acid sulphate soils in the permanent wetlands in the CHAA were adequately managed during construction, and no lasting impacts occur.

All of the above direct impacts to ecosystem composition of the wetlands in the CHAA are predicted to be within the expected range of natural disturbance perturbations during operations.

However, indirect impacts on wetlands will occur as a result of the migration of people into the CHAA both as a result of easier access provided by the operation of the newly constructed escarpment road, and in search of work opportunities, and associated increase in head of livestock grazing in the Buhuka Flats. Increased stocking is likely to result in greater pressure on vegetation communities supplying wood and fibre resources, overgrazing, and expansion of subsistence crops, causing greater runoff, channel incision, heightened fire risk and the loss of wetland function over large areas. In the dispersive soils of the Buhuka Flats, the risk of catastrophic soil loss and subsequent effects on wetland ecosystem composition will be high.

Indirect effects on the ecosystem composition of wetland communities are also likely, as a result of ongoing discharge of treated sewage effluent and stormwater in excess of the first 15 minutes of rainfall, to the receiving surface water systems (primarily River 1 and the Kamansinig River). Long-term discharges of this nature are likely to affect the vegetation species composition as a result of nutrient enrichment from the sewerage discharge, as well as the fluctuations in wetness regimes brought about by both the sewerage discharge and occasional (seasonal) stormwater peak flow inputs.

In addition, minor spillages of fuels and chemicals during the day-to-day operation of the Project components (other than catastrophic spillages, which are addressed in Surface Water) could end up in the wetlands of the LSA; potentially affecting some invertebrate species (for example, aquatic snails (Araujo et al. 2012), mayflies (Savić et al. 2011)) and juvenile fish (for example, Agamy 2013) which are highly sensitive to chemical pollutants, particularly hydrocarbons. Currently, the concentrations of hydrocarbons and other pollutants in the water of the Bugoma Lagoon are below levels that could cause harm to the environment (Golder Associates 2014b); this is supported by the healthy aquatic communities observed in the lagoon's and Masika River wetland habitats (see Section 5.2). The entrainment of small quantities of oil and potentially hazardous chemicals in stormwater runoff from the Project infrastructure and subsequent entry to wetlands (particularly the seasonally flooded grassland adjacent to well pad 1) is considered possible as the proximity of well pad 1 to the wetlands provides little buffer for potential contamination.

■ Ecosystem configuration

The long-term impacts of the construction of roads, the airstrip and the flowlines through the wetlands of the CHAA are unknown. Although the roads could potentially act as barriers to certain wetland species, they are only expected to be 5 m wide and unsealed, and, during operations, they will convey reduced Project-related traffic volumes; however, they are likely to be preferentially used by members of the increased local communities of the Buhuka Flats. Therefore, they could become barriers to species movement, particularly for species such as Grey Crowned Crane, should that species become accustomed to the increased human disturbance brought about by the population influx to the Buhuka Flats during operation.

The operation and management of the in-field roads and airstrip should not affect ecosystem processes driving the wetlands, assuming the installation of appropriate drainage connections was successful during construction. What the long-term impact of the edge impacts, and fragmentation of the wetland habitats, in the CHAA caused by the construction of roads, is unknown. As already discussed, vegetation clearing creates edges or boundaries where habitat meets a disturbance. These edges open up habitat in areas where it was previously continuous, and this generally changes the abiotic conditions (for example, temperature, light, and moisture regimes) (Porensky and Young 2013). Edges also often result in changes in species composition along the edge, with the edges typically becoming dominated by pioneer and weedy species adapted to the particular microclimate experienced on the edge (Porensky and Young 2013). Fragmentation of wetland habitat is known to reduce the viability of many species and the wetland as a whole, with the viability of the

particular fragment dependent on its size, proximity and, hence, connectivity to other wetland habitats (Uzarski et al. 2009).

What long-term impacts that the operation these roads and the airstrip could have on the wetland communities' configuration are unknown; in particular their resilience. What is known is that these wetland communities are already under pressure from livestock grazing, and harvesting of fibre for house construction.

The operation of the Kingfisher camps/parking lots/materials yards, CPF, crusher plant/spoil area A, well pads, and associated infrastructure will not directly lead to changes in the ecosystem configuration of wetlands in the CHAA.

The long-term impacts to ecosystem configuration of the wetlands in the CHAA are predicted to be beyond the expected range of natural disturbance perturbations during operations, if mitigation measures are inadequate or fail.

Impact Classification

Wetland sensitivity is high because these habitats, particularly the permanent wetlands, are potential breeding habitat for Grey Crowned Cranes (a species of concern). The wetlands are also already under stress from fires, livestock grazing and harvesting of fibre.

Impacts to the representativeness of the habitat may be adverse during operations. The geographical extent of impacts will be local because impacts are restricted to the LSA. Impact duration will be into the far future (that is, ~25 years) because the roads (which may affect the hydrological character of the wetlands, and subsequently wetland extent and condition) will be permanent features, and will remain in place even after the project is decommissioned. The magnitude of the impacts of operation of the Project on representativeness of the wetland communities is low. Therefore, the magnitude and high sensitivity of the wetlands combine to produce a moderate overall impact level to representativeness during the operations phase of the Project, prioir to the implementation of site-specific mitigation measures (Section 11.2). Following the application of appropriate mitigation measures, the impact significance is expected to be reduced minor because the magnitude will be negligible, while the sensitivity of the receptor will remain the same.

Impacts to the ecosystem composition as a result of the operation of Project infrastructure, and presence of wetlands crossings, will be adverse. The geographical extent of impacts will be local because impacts are restricted to the LSA. Impact duration will be into the far future (that is, ~25 years) because impacts are expected last as long as the in-field roads and airstrip are in place, and the potential changes to ecosystem composition are unknown. The magnitude of the impact on ecosystem composition is high because, prior to any mitigation, the potential for changes to ecosystem composition potentially brought about by edge impacts, changed flow regimes, and sedimentation, is possible, as evidenced by desiccation occurring downstream of existing crossings (Figure 19). Therefore, the magnitude and sensitivity combine to produce a major overall impact level to ecosystem composition during the operation phase of the Project, pre-mitigation (Table 18). Following the application of appropriate mitigation measures, the impact significance is expected to become minor because the magnitude will become negligible, yet the sensitivity of the receptor will remain the same.

Impacts to the ecosystem composition as a result of the increased human population living on the flats, and the associated increase in head of livestock grazing in the Buhuka Flats, will be adverse. The geographical extent of impacts will be local because impacts are restricted to the LSA. Impact duration will be into the far future (that is, ~25 years) because impacts are expected to be permanent, and the potential changes to ecosystem composition are unknown. The magnitude of the impact on ecosystem composition is medium because, prior to mitigation, changes to ecosystem composition potentially brought about by overgrazing, cattle trampling and subsequent effects on wetlands soils could be near the limits of wetland capacity to adapt. Therefore, the magnitude and sensitivity combine to produce a major overall impact level to ecosystem composition during the operation phase of the Project, pre-mitigation (Table 18). Following the application of appropriate mitigation measures, the impact significance is expected to become moderate because the magnitude will become low, yet the sensitivity of the receptor will remain the same.

The entrainment of small quantities of oil and potentially hazardous chemicals in stormwater runoff from the Project infrastructure and subsequent entry to wetlands (particularly the seasonally flooded grassland adjacent to well pad 1) will result in adverse impacts of local extent, that could occur intermittently throughout the lifetime of the Project. The magnitude of the potential impacts on wetland water quality is high, as pollution events could significantly alter aquatic species communities, and therefore ecosystem composition. Combined with the high sensitivity of the wetland habitats, impacts on wetland water quality could be of major significance prior to mitigation (Table 18). Following the application of appropriate mitigation measures, the impact significance is expected to be reduced to minor, primarily because the magnitude will become negligible, and the sensitivity of the receptor will remain the same.

Impacts to the ecosystem configuration will be adverse. The geographical extent of impacts will be local because impacts are restricted to the LSA. Impact duration will extend into the far future (that is, ~25 years) because impacts are expected to continue as long as the in-field roads, flowlines and airstrip are in place. The magnitude of the impact on ecosystem configuration is low because, prior to any mitigation, the potential for changes to ecosystem configuration is possible, especially from fragmentation. Therefore, the magnitude and sensitivity combine to produce a moderate overall impact level to ecosystem configuration during the operation phase of the Project, pre-mitigation (Table 18). Following the application of appropriate mitigation measures, the impact significance is expected to become minor because the magnitude will become negligible, yet the sensitivity of the receptor will remain the same.

Table 18: Potential impacts in the operation phase to the wetlands of the CHAA

Indicator of potential impact	Pre-mitigation			Post-mitigation		
	Magnitude	Sensitivity of the Receptor	Significance	Magnitude	Sensitivity of the Receptor	Significance
Representativeness	Low – 2	High – 4	Moderate – 8	Negligible – 1	High – 4	Minor – 4
Ecosystem composition – project infrastructure, wetland crossings	Medium - 3	High – 4	Major – 12	Negligible – 1	High – 4	Minor – 4
Ecosystem composition – increased population	Medium - 3	High – 4	Major – 12	Low - 2	High – 4	Moderate – 8
Ecosystem composition – contaminated stormwater	High – 4	High – 4	Major - 16	Negligible – 1	High – 4	Minor – 4
Ecosystem configuration	Low – 2	High – 4	Moderate – 8	Negligible – 1	High – 4	Minor – 4

Prediction Confidence

Given the information available, there is a reasonable understanding of the potential Project impacts to the wetlands of the CHAA. However, there is some uncertainty in regard to the irreplaceability and vulnerability of those habitats in the CHAA. Given the current uncertainty in relation to climate change and possible scenarios, as well as increasing human pressures, how important these habitats will become in the future is uncertain.

The spatial extent of habitats in the CHAA was broadly mapped based on knowledge of the site, baseline studies, literature and reports (see Section 6.0). The actual extent of possible habitat may have been over-estimated.

10.2.1.3 What impact could the operation of the Project have on the escarpment vegetation corridors?

Impact Indicators

Indicators used to assess impacts of the Project on the habitat and ecosystem integrity of the vegetation corridors on the escarpment were changes in: regional representativeness; ecosystem composition; and ecosystem configuration.

It is recognised that the escarpment road has already been permitted and is currently operational, and was covered by a separate ESIA process, see AWE (2014c); however, the inclusion of this road in this assessment is important because of its induced (and cumulative – Cumulative Impact Assessment) impacts on the vegetation of the escarpment. Literature was reviewed to understand the long-term impacts of roads through natural habitats, during operation.

Additional, indirect affects to habitat were estimated by applying a 0.50 km buffer to the temporary camp and quarry at the top of the escarpment, and the footprint of the escarpment road. Specifically, the buffer was selected to account for changes in habitat quantity and/or quality that could be caused by edge impacts, fragmentation, sensory disturbance, changes in water quantity and quality, and air emissions and dust.

Changes in habitat composition and ecosystem configuration were assessed by identifying potential changes in species composition that could occur over the life of the Project, and the disruption of known corridors. This was accomplished by examining available literature about the ecology of the vegetation communities on the escarpment, and scientific literature about the impacts of human activities on corridors in the long-term.

Impact Assessment

■ Representativeness

The CHAA supports approximately 2443 ha of vegetation communities on the escarpment (see Section 7.1.2), which are bounded on the east by agriculturally modified landscapes, and the Buhuka Flats on the west. As mentioned, these vegetation communities form part of a contiguous vegetation corridor that is part of the wider Murchison Falls National Park-Budongo-Bugoma-Kagombe-Itwara Forest Reserves-Semliki/Toro Wildlife Reserve corridor (Plumptre et al. 2003). Therefore, their continuous extent represents an important landscape feature in the CHAA.

The initial loss of habitat from the construction of the temporary camp on top of the escarpment is expected to be reverted during operation, because the camp site will have been rehabilitated. Rehabilitation measures should return the site to a vegetation cover similar to that that was there before the camp was constructed, that is, open wooded bushland. The loss of approximately 12.8 ha of vegetation communities, because of the construction of the escarpment road, will persist during the operational phase.

The operation of the Kingfisher camps/parking lots/materials yards, airstrip extension, CPF, pipeline, new in-field roads, crusher plant/spoil area A, new well pads, and associated infrastructure will not directly lead to the loss of vegetation communities on the escarpment.

Impacts from the changes to representativeness are predicted to be the less than those experienced during the construction phase because temporary construction areas should have been rehabilitated. Nevertheless, the loss of vegetation to the escarpment road footprint will remain for operation, representing a change in representativeness is predicted to be beyond the expected range of natural disturbance perturbations.

■ Ecosystem composition

What the long-term impact of the escarpment road on the ecosystem composition of the escarpment in the CHAA is unknown. The long-term consequences of a linear corridor through an area of relatively intact

vegetation, like that on the escarpment, create edge impacts that could, in the long-term, alter the composition of the ecosystem through which the road traverses (Findlay and Bourdages 2000). Edges associated with roads tend to be abrupt, with a high degree of contrast between the two areas (for example, road and open wooded grassland). The edges open up habitat in areas where it was previously continuous, and this generally changes the abiotic conditions (for example, temperature, light, and moisture regimes) (Porensky and Young 2013). Edges often result in changes in plant species composition along the edge, with the edges typically becoming dominated by pioneer species adapted to the particular microclimate experienced on the edge (Porensky and Young 2013). Often, these microclimates are favoured by weed species. However, certainly for fauna species, and depending on the species, edges can have either a positive or negative impact on habitat quality and quantity (Prevedello et al. 2013, Wellicome et al. 2014).

Apart from the possible changes brought about by the edge impacts, the road may also: restrict movement of certain less mobile faunal species between populations; increase mortality of individuals due to collision with vehicles; fragment habitat; present a possible path for invasive species to enter the area; or increase human and livestock access to otherwise less accessible habitats (Findlay and Bourdages 2000). All these predicted impacts, combined, could be expected to increase the potential for local extinction rates or decrease local recolonisation rates.

The escarpment road is sealed for its length down the escarpment. Sealing of the road presents other aspects that may affect the ecosystem composition of the communities on either side of the road in the long-term. For example, concentrating water run-off from the sealed surface, which could carry contaminants such as fuel, heavy metals and polycyclic-aromatic hydrocarbons, to watercourses not otherwise influenced by such run-off, and possibly lead to changes in water quality and erosion regimes. Polluted run-off could lead to detrimental impacts on aquatic species downstream from the escarpment road.

What long-term effects that these edge impacts could have on the vegetation communities' composition throughout the lifetime of the road operation are unknown; in particular their resilience[4]. The most significant project-related impact on the ecosystem composition of the escarpment is likely to be the indirect effect of migration into the area, facilitated by the escarpment road. Without mitigation, it is likely that both the project and the new ease of access to the Flats will cause significant additional in-migration (refer to Social Impact Assessment for detail), with people settling both on the Flats and in the villages above the escarpment. The escarpment vegetation communities are already under pressure from harvesting of fuel wood and charcoal manufacture, and livestock grazing. Cattle have been shown to substantially increase the edge impacts in savannah habitats (Porensky et al. 2013). It is conceivable that the road could afford people, cattle and other livestock easier access to resources and grazing on the escarpment, and facilitate the spread of weed and invasive plant species, which could place increased pressure on these communities in the long-term. It is likely that these communities may change in the long-term as grazing pressure increases, and large trees are removed for charcoal manufacture. These changes could substantially alter the habitat structure and composition, which, in turn, could affect its utilisation by the current species guild. To some extent, this may already be occurring. For example, very few medium sized mammals were recorded in the CHAA, and those that were recorded tended to be thicket and dense bushland specialists, such as bushbuck and duiker. The low populations and diversity of these species could also be a reflection of increased pressure for bush meat from the local human population, which has increased markedly over the last ten years (AECOM 2012).

The operation of the Kingfisher camps/parking lots/materials yards, airstrip extension, CPF, pipeline, new in-field roads, crusher plant/spoil area A, new well pads, and associated infrastructure will not directly lead to changes in the composition of vegetation communities on the escarpment.

Impacts from the long-term changes to ecosystem composition are predicted to be well beyond the expected range of natural disturbance perturbations if mitigation measures fail or are inadequate.

■   Ecosystem configuration

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[4] For this study, indirect effects, such as increased harvesting pressures due to migration into the area, either because of better access to existing resources or because of opportunities provided by the oil industry, are considered to be operational impacts which are driven by the access provided by the road

Roads, and especially sealed roads are known to be significant barriers, or alter behaviours, of a range of wildlife, from: small ground-dwelling mammals, insects, reptiles and amphibians (for example, Brehme et al. 2013, Pontoppidan et al. 2013, Rotholz and Mandelik 2013); to bats (for example, Berthinussen and Altringham 2012); to birds (for example, Kociolek et al. 2011); to primates (for example, Mammides et al. 2009); to large ungulates (for example, Leblond et al. 2013, Meisingset et al. 2013). Depending on the species, the presence of roads may affect individuals in many direct and indirect ways. For example, roads may inhibit seasonal migration and may cause an impactive loss of habitat due to avoidance.

The wider Murchison Falls National Park-Budongo-Bugoma-Kagombe-Itwara Forest Reserves-Semliki/Toro Wildlife Reserve corridor is recognised as being important for threatened species in the face of climate change adaptation (Ayebare et al. 2013), and as part of a much broader set of corridors running the length of the Albertine Rift. This corridor in the southern portion of the eastern shores of Lake Albert, in the vicinity of the Project, is very narrow compared to its extent elsewhere, and is recognised as being important for savannah species (Plumptre et al. 2010). The escarpment road to the Buhuka Flats is the only major road on the south-eastern portion of Lake Albert from the southern end of the lake to the Kabwoya Wildlife Reserve, that is, the only major road within the identified wildlife corridor. This area is otherwise devoid of notable roads and tracks, adding to its value as a wildlife movement corridor.

Indications are that populations of highly mobile wildlife within the area, which may depend on the corridor, are not substantial, and potentially severely depleted (see Section 7.1.2). In particular, most of those species that could utilise this corridor, such as large ungulates, predators, and primates are very rare in the escarpment area surrounding the Buhuka Flats, with the exception of birds. However, the road is not expected to be a barrier for birds; for example, White-backed Vultures were seen moving south down the escarpment corridor during the surveys (see Section 6.1.4). What impact the road could have on the movement on those terrestrial individuals and species that may utilise this corridor in the long-term is unknown. The corridor is recognised as an important climate change refugium for a range of threatened species, which may become increasingly important for those species in the future (Ayebare et al. 2013), that is, within the life time of the Project.

Impacts from the changes to ecosystem configuration on the escarpment as a result of the long-term operation of the road are predicted to be beyond the expected range of natural disturbance perturbations, if mitigation measures fail or are inadequate.

Impact Classification

The vegetation community of the escarpment's sensitivity is medium because, although the integrity of these habitats is already under stress from livestock grazing and harvesting of fuel wood and non-timber forest products, they do form part of the wider Murchison Falls National Park-Budongo-Bugoma-Kagombe-Itwara Forest Reserves-Semliki/Toro Wildlife Reserve corridor.

During operation, the impacts to the representativeness of the habitat will be neutral, because areas used temporarily during construction will be rehabilitated and the vegetation on those areas will be establishing. The geographical extent of impacts will be local because impacts are still restricted to the LSA, and the loss of vegetation communities because of the road's construction will persist. Impact duration will be into the far future (that is, ~25 years) because the road down the escarpment will remain in place even after the project is decommissioned. The magnitude of the impacts of operation on representativeness of the vegetation communities of the escarpment is negligible. Therefore, the magnitude and sensitivity combine to produce a minor overall impact level to representativeness during the operational phase of the Project, pre-mitigation (Table 19). Following the application of appropriate mitigation measures during operation, including the assumption that offset mechanisms for the initial losses during construction of the escarpment road are in place and working, the impact significance is expected to remain minor, primarily because it is assumed that offsets will be achievable, while the sensitivity of the receptor will remain the same.

Impacts to the ecosystem composition will be adverse in the long-term. The geographical extent of impacts will be local because impacts are restricted to the LSA. Impact duration will be into the far future (that is, ~25 years) because impacts are expected last as long as the road is in place. The magnitude of the impact on ecosystem composition is medium because, prior to any mitigation, the potential for changes to ecosystem

composition potentially brought about by edge impacts, and the consequences of easier access to the adjacent escarpment areas for livestock grazing and natural resource harvest, is possible. Therefore, the magnitude and sensitivity combine to produce a moderate overall impact level to ecosystem composition during the operational phase of the Project, pre-mitigation (Table 19). Following the application of appropriate mitigation measures, including the assumption that offset mechanisms for the losses suffered during construction are in place and working, the impact significance is expected to remain moderate, although the magnitude will become low, yet the sensitivity of the receptor will remain the same.

Impacts to the ecosystem configuration will be adverse. The geographical extent of impacts will be regional because impacts are restricted to the CHAA. Impact duration will extend into the far future (that is, ~25 years) because impacts are expected to continue as long as the road is in place. The magnitude of the impact on ecosystem configuration is medium because, prior to any mitigation, the potential for changes to ecosystem configuration is possible, especially inference with wildlife movement corridors. Therefore, the magnitude and sensitivity combine to produce a moderate overall impact level to ecosystem composition during the operational phase of the Project, pre-mitigation (Table 19).

Following the application of appropriate mitigation measures, the impact significance is expected to remain moderate; although the magnitude will become low, the sensitivity of the receptor will remain the same.

Table 19: Potential impacts in the operation phase to the vegetation communities of the escarpment

Indicator of potential impact	Pre-mitigation			Post-mitigation		
	Magnitude	Sensitivity of the Receptor	Significance	Magnitude	Sensitivity of the Receptor	Significance
Representativeness	Negligible - 1	Medium – 3	Minor - 4	Negligible - 1	Medium – 3	Minor - 4
Ecosystem composition	Medium – 3	Medium – 3	Moderate – 9	Low – 2	Medium – 3	Moderate – 6
Ecosystem configuration	Medium – 3	Medium – 3	Moderate – 9	Low – 2	Medium – 3	Moderate – 6

Prediction Confidence

Given the information available, there is a reasonable understanding of the potential Project impacts to the vegetation communities of the escarpment, and the wildlife corridors of which they form part. However, there is some uncertainty with regard to the irreplaceability and vulnerability of those habitats in the CHAA. Given the current uncertainty in relation to climate change and possible scenarios, as well as increasing human pressures, how important these habitats will become in the future is uncertain. Indications are that they will increase in importance (Ayebare et al. 2013), provided human pressures associated with the presence of the escarpment road do not overwhelm them.

The spatial extent of habitats in the CHAA was broadly mapped based on knowledge of the site, baseline studies, literature and reports (see Section 6.0). The actual extent of possible habitat may have been over-estimated.

10.2.1.4   *What impact could the operation of the Project have on the Bugoma Central Forest Reserve?*

Impact Analysis – Methods

As discussed in Section 6.1.6, it is recognised that CNOOC will not be responsible for the management of the R5 and P1 Roads during the operation of the Project. It is expected that the Ugandan Government will be responsible for that management and upkeep. Nevertheless, as discussed, the road will have been upgraded

during the construction phase, and will remain in place throughout the operational phase and beyond. Therefore, any effects associated with, and stemming from the existence of the upgraded road can be seen to be induced impacts arising as a result of the Project's development.

A formal impact classification based on indicators was developed for induced and cumulative impacts to the Bugoma Central Forest Reserve; the impacts are discussed, and their significance assessed through a **reasoned narrative**. An overall impact significance classification is then developed. This was accomplished by examining available literature about the ecology of the Bugoma Central Forest Reserve, and scientific literature regarding the effects of migration and human population pressure on forests in Africa.

The impacts were assessed in light of the guidance provided by IFC (2013), and in consideration of other known projects being developed in the wider area. In particular, the development of the oil processing facility at Kabaale, the oil developments around the Kaiso-Tonya area (AECOM 2012), the Hoima-Mputa-Fort Portal-Nkenda power line, and the potential for regional population increases in the wider area.

Impact Analysis Results

As discussed, the Bugoma Central Forest Reserve is identified as a valued component for this impact assessment, in terms of biodiversity (see Section 6.3.1.1.4). As identified in that section, apart from being one of the last stands of tropical semi-deciduous forests in the region, it also supports known populations of the range-restricted Nahan's Francolin and Endangered Eastern Chimpanzee (Plumptre et al. 2011), potential non-breeding habitat for the Endangered Madagascar Pond Heron (see Section 6.3.3.1), as well as elephants and a host of other threatened and irreplaceable species.

The Bugoma Central Forest Reserve is under severe pressure from the human population surrounding it. Only recently were more than 1,500 people evicted illegally after settling within the forest (Mugerwa 2013). The land cover study (see APPENDIX C and Figure 14) clearly shows that the areas surrounding the forest have largely been transformed for agricultural and subsistence purposes. This trend of encroachment of protected areas, like the Bugoma Central Forest Reserve, is not unique. Protected areas are known to be particularly vulnerable to changes in human demographics and deforestation; and Wittemyer et al. (2008) identified that human population growth and encroachment around protected areas is significantly higher than the average population growth in rural areas. This difference was largely due to the immigration of people into these areas because of the perceived increased availability of opportunities, natural resources and potential jobs (Wittemyer et al. 2008). This is supported by research conducted in the forests of the Albertine Graben, and the wider CHAA. For example, in a study of Budongo Central Forest Reserve, Zommers and MacDonald (2012), identified that of the local communities that hunted bush meat in the forest, nearly 73% were immigrants to the area. Furthermore, these workers identified that the households of immigrants were also more likely to be involved with deforestation.

The upgrade and improvement of roads in rural areas can influence immigration rates into those areas (Wennergren and Whitaker 1976, Godar et al. 2012). It is highly likely that the upgraded R5 and P1 roads could induce population influx into the Bugoma Central Forest Reserve, as well as areas adjacent to the road itself throughout its operational lifetime, because access would be made easier. Furthermore, the proximity of the Bugoma Central Forest Reserve in the area could also make the area more attractive to immigrants seeking opportunities (*viz.*, Wittemyer et al. 2008). The current influx of refugees into the CHAA is also not expected to dissipate with the continued instability in the DRC (UNHCR 2014). Therefore, there is a potential that the upgrade of the road could place increased pressure on the Bugoma Central Forest Reserve, the natural resources it offers (such as, timber, non-timber forest products), and bush meat.

An Influx Management Strategy and Framework Plan (Golder Associates 2014) has been developed to manage the potential influx of people into the LSA. However, this plan can only focus on those measures over which CNOOC has control, and to support the range of government and donor projects in Uganda aimed at socio-economic development and environmental conservation. How this translates to the potential influx of people along the improved R5 and P1 roads is unknown.

The improved road could also allow for an increase in vehicular traffic into the area, and faster speeds associated with those vehicles. Therefore, there is also the potential that direct mortality of wildlife along the road could increase. The Bugoma Central Forest Reserve is home to populations of threatened species and an array of other species (see Plumptre et al. 2010, 2011). Many of these species will move within the forest and between sections of the forest. Although the negative effects of roads on wildlife in tropical rainforests, like Bugoma Central Forest Reserve, are poorly understood, indications are that: (1) many species avoid roads altogether (especially, medium-sized mammals, diurnal, solitary and group living animals, and ungulates); and (2) high vegetation cover on the road verges (see Figure 20) increases crossing probability substantially (van der Hoeven et al. 2010). Currently, the roadside vegetation on the P1 road would encourage wildlife to cross (Figure 22); presumably this is also the case for the R5 road. This could place them in the direct paths of traffic during the operational phase of the Project.

Impact Classification

Impacts from the presence of the R5 and P1 roads, and the resultant increased traffic and ease of forest access along that road during the operation of the Project will be adverse. The geographical extent of impacts will be regional because effects are restricted to the R5 and P1 Road corridor in the CHAA. Impact duration will be long-term (extending for the lifetime of the Project, and beyond, as the roads are government-managed and will remain in place). The magnitude of the effects of operation on the Bugoma Central Forest Reserve is low.

The sensitivity of the Bugoma Central Forest Reserve is high because it is a threatened ecosystem that is already under pressure. Therefore, the magnitude and sensitivity combine to produce a moderate overall impact level during the operation phase of the Project, pre-mitigation (Table 20).

The mitigation hierarchy is an important process that has been used to minimise impacts to the Bugoma Forest Reserve. The focus for the continued use of the mitigation hierarchy during the road upgrade and construction will be continued development and implementation of mitigation measures through monitoring and adaptive management; including suggested measures for the Ugandan Government to apply in the management of the upgrade of the P1 Road, and recommendations regarding the intended use of the R5 road running north to south through Bugoma CFR (see Section 11.0).

Following the application of appropriate mitigation measures, including management support of the forest to limit influx of people, the impact significance is expected to remain major, although the intensity could become medium, yet the sensitivity of the receptor will remain the same (Table 20).

Table 20: Potential impacts in the operation phase to the Bugoma Central Forest Reserve

	Pre-mitigation			Post-mitigation (pre-offsets)		
	Magnitude (the expected size of the impact)	Sensitivity of the Receptor	Significance	Magnitude (the expected size of the impact)	Sensitivity of the Receptor	Significance
Habitat and ecosystem integrity	High – 4	High – 4	Major – 16	Medium – 3	High – 4	Major – 12

As noted above, the focus for reducing impacts to the Bugoma Central Forest Reserve is mitigation to lessen various types of disturbance that may occur (Section 12.0). Optimising mitigation will reduce the need for offsetting. However, offsetting options to compensate for impacts to the forest have been identified and are discussed in Section 13.0.

Prediction Confidence

Given the information available, there is a reasonable understanding of the potential effects that the operation of the upgraded R5 and P1 roads, could have on the Bugoma Central Forest Reserve.

The spatial extent of the forest reserve in the CHAA was broadly mapped based on knowledge of the site, baseline studies, literature and reports (see Section 6.0). The actual extent of possible habitat may have been over-estimated.

10.2.2 What impact could the operation of the Project have on species of concern?

This section presents the assessment of the impacts that the operation of the Project could have only on those species of concern that trigger critical habitat, as identified in Section 9.2, and other species of concern that were included as valued components for the impact assessment (Table 5). Potential impacts to other species of concern are assessed at the habitat level (see Section 3.3.2).

10.2.2.1 *What impact could the operation of the Project have on the Mud Snail?*

As previously discussed, the Mud Snail (*Gabbiella candida*) is a Critically Endangered and range restricted species, which could occur in the CHAA.

Impact Indicators

Indicators used to assess impacts of the operation of the Project on the Mud Snail were: habitat quantity and quality, and habitat connectivity.

Habitat loss due to indirect disturbance was assessed by calculating the area of disturbance of suitable habitat from the CHAA as a result of the operation of the Project. Changes to habitat quality were assessed by the prediction of sediment loads and changes to water quality in the water column from operational activities.

Changes in habitat connectivity were assessed by identifying potential barriers to genetic movement, and source populations. This was accomplished by visually examining the spatial distribution of critical habitat in relation to the Project footprint to qualitatively identify areas where critical habitat becomes fragmented.

Impact Assessment

■ Habitat Quality and Quantity

Very little information is available for this species. The two Mud Snail species recorded from the CHAA were collected from bottom substrates in the open sandy shore habitats. These habitats are characterised by a gently sloping lake bed extending from the shore line to deeper water.

The operation of the Project, and, in particular, the jetty, could affect the open sandy shoreline habitat within the vicinity of this infrastructure. However, the operation of the jetty itself is unlikely to change the physical structure of the open sandy shoreline habitat. Rather, the wash created by berthing and departing barges could affect the habitat quality through the disturbance of bed sediments. It is expected that these increased sediment loads will dissipate reasonably quickly. The sediment loads in the vicinity of the jetty are not expected to exceed those that would normally be expected during windy periods on the lake (see Golder Associates 2014g), and the consequent turbid conditions caused by those winds. In addition, with the opening of the escarpment road, the use of the jetty is expected to be minimised.

Accidental spillages of small quantities of fuels and chemicals during the operation of the Project components, such as loading and unloading barges, or refuelling vehicles, and drilling fluids, could end up directly in the lake, or in a watercourse, which, ultimately, report to the near-shore habitats of the CHAA. There is a real potential for this to occur as part of the jetty operation, and as a component of stormwater discharge beyond the first 15 minute rainfall events. The jetty and stormwater discharge points are located right on the lake shore, and the impact of an accidental spill would be more obvious than a land-based spill; it would also be harder to contain and clean up. Aquatic snails like *G. candida* are highly sensitive to chemical pollutants, particularly hydrocarbons (Araujo et al. 2012). Currently, the concentrations of hydrocarbons and other pollutants in the lake waters of the near-shore habitats are below levels that could cause harm to the

environment (Golder Associates 2014b); this is supported by the healthy aquatic communities observed in the lake's near-shore habitats (see Section 6.2).   As such, without adequate spill prevention and clean-up measures in place during operation, a chemical spill could, depending on the volume spilt, have a detrimental impact on the near-shore habitats of the CHAA through the introduction of toxic compounds and pollutants. Such a spill could have a detrimental impact on the Mud Snail *G. candida*.

The operation of the Kingfisher camps/parking lots/materials yards, airstrip extension, CPF, in-field roads, crusher plant/spoil area A, well pads, and associated infrastructure could cause increased sedimentation of near-shore habitats on the Buhuka Flats. The soils of the Buhuka Flats are dispersive (Golder Associates 2014d), and active soil erosion is evident in the LSA. With the operation of the Project's components, there is a potential that, without adequate and maintained erosion and sediment control measures in place, sediment loads within the watercourses draining the Project footprint could increase.   These sediment-laden watercourses report to Lake Albert (particularly River 1, which will receive stormwater runoff from the CPF and the airstrip; and the Kamansinig, which will receive stormwater runoff from the escarpment road, part of the airstrip and Well Pad 1), and, hence, there is a potential for increased sediment loads in near-shore habitats in the vicinity of the drainage discharge points south of Well Pad 2 and north of Bugoma Lagoon. Near-shore habitats particularly at risk include the Bugoma Lagoon, and to a lesser extent, the shallow river-associated habitats of the Kamansinig and River 1, both potential habitat for the Mud Snail.   Nevertheless, the watercourses draining the CHAA support dense emergent vegetation (see Section 6.1.1.1). Such vegetation forms an impactive filter for most sediment (IECA 2008), therefore, it can be expected that sediment loads reporting to the near-shore habitats, at least, via the Kamansinig River, River 1 and Masika River, could be minimal. Sediment loads from overland flows may not be retarded by vegetation, and hence may report to the near-shore habitats and affect them detrimentally.

The potential for influx and in-migration of people onto the Buhuka Flats seeking opportunities from the Project, and because of the easier access provided by the escarpment road, could place increased pressure on the near-shore habitats. This increased pressure could arise from increased pollution (such as, fuels, human and livestock waste, fish waste, and litter), as well as physical disturbance from drinking cattle. The resultant increase in pollution levels could lead to a dramatic change in the current drivers of change to the near-shore aquatic habitats, and, ultimately affect the Mud Snail.

Impacts from the alteration quality of, or loss of, habitat are predicted to be beyond the expected range of natural disturbance perturbations.

■   Habitat Connectivity

The operation of the Project is expected to last for ~25 years. Besides the operation of the jetty, it is unlikely that operational activities could substantially alter the habitat connectivity of the near-shore habitats in the CHAA. No structures are being put in place that will alter the natural connectivity of the aquatic habitats of the lake. It is expected that the connectivity amongst the aquatic habitats will remain the same during operations as they were during baseline.

Impact Classification

The Mud Snail's sensitivity is high because this species is Critically Endangered.

Impacts to the Mud Snail's habitat quantity and quality could be adverse during operations. The geographical extent of impacts will be local because impacts are restricted to the LSA. Impact duration will be long-term (that is, 25 years). The magnitude of the impacts during operation - particularly long-term effects of trampling by drinking cattle and changes influenced by the jetty - on the habitat quantity and quality of the Mud Snail is predicted to be moderate. Therefore, the moderate magnitude and high sensitivity combine to produce a major overall impact level during the operation phase of the Project, pre-mitigation (Table 24). Following the application of appropriate mitigation measures, the impact significance is may be reduced to moderate, primarily because the magnitude of habitat disturbance arising from human and livestock will at best be reduced to low during operation, and the sensitivity of the receptor will remain the same (Table 21).

Impacts to the Mud Snail's habitat connectivity will be neutral. The geographical extent of impacts will be local because impacts are restricted to the LSA. Impact duration will be long-term, and no barrier to habitat connectivity will be constructed. The magnitude of the impacts of operation on the habitat connectivity of the Mud Snail is negligible, therefore the magnitude and sensitivity combine to produce a minor overall impact level during the operation phase of the Project, pre-mitigation (Table 21). Following the application of appropriate mitigation measures, the impact significance is expected to remain the same, that is, minor, primarily because the magnitude will still remain the same during operation, and the sensitivity of the receptor will remain the same (Table 21).

Table 21: Potential impacts in the operation phase to the Mud Snail

Indicator of potential impact	Pre-mitigation			Post-mitigation		
	Magnitude (the expected size of the impact)	Sensitivity of the Receptor	Significance	Magnitude (the expected size of the impact)	Sensitivity of the Receptor	Significance
Habitat quality and quantity	Medium - 3	High – 4	Major - 12	Low – 2	High – 4	Moderate – 8
Habitat connectivity	Negligible – 1	High – 4	Minor – 4	Negligible – 1	High – 4	Minor – 4

Prediction Confidence

Given the information available, there is a reasonable understanding of the potential Project impacts to the near-shore habitats of the CHAA, and hence potential local populations of Mud Snail. However, there is some uncertainty in regard to this species actually occurring in the CHAA. As such, the above assessment has been undertaken based on a precautionary approach.

The spatial extent of the near-shore habitats in the CHAA was broadly mapped based on knowledge of the site, baseline studies, literature and reports (see Section 6.0). The actual extent of possible habitat may have been over-estimated.

10.2.2.2 *What impact could the operation of the Project have on Grey Crowned Crane?*

Grey Crowned Crane is an Endangered species. In the CHAA, it is associated with permanent and seasonal wetlands habitats.

The operation of the Production Facility could indirectly impact Grey Crowned Crane breeding and foraging habitat, given that operational impacts on wetlands in the Buhuka Flats are expected (Section 9.1.1.2); largely as a result of the induced impacts brought about by the escarpment road on the Buhuka Flats wetland habitats used by this species.

The potential direct, indirect and induced impacts to this species due to the operation of the Production Facility are presented below.

Impact Indicators

Indicators used to assess effects of the operation of the Production Facility on Grey Crowned Crane were: habitat quantity and quality, habitat connectivity, abundance and distribution, and survival and reproduction.

Habitat loss due to indirect disturbance and edge effects was estimated by applying a 200 m buffer to the Project infrastructure. Specifically, the buffer was selected to account for changes in habitat quantity and/or quality caused by indirect disturbance like light, noise, vibration, and edge effects.

Changes in habitat connectivity were assessed by identifying potential barriers to movement and loss of corridors. This was accomplished by visually examining the spatial distribution of critical habitat for Grey Crowned Crane (permanent and seasonal wetlands) in relation to the Project infrastructure to qualitatively identify areas where habitat remains fragmented during operation.

Potential changes in abundance and distribution, and survival and reproduction were assessed qualitatively by considering changes in disturbances (that is, vehicle traffic, light, noise, vibration). These disturbances were considered in light of known or inferred effects to the survival and reproduction of Grey Crowned Crane for which data on these types of effects are available.

Impact Assessment

■   Habitat Quality and Quantity

No direct losses of wetland habitat are expected during the Production Facility's operation, however, additional indirect losses of suitable foraging habitat (seasonally flooded grassland) may occur in the event that wetlands being crossed or encroached by Project infrastructure incur changes in hydrological flow patterns if construction design mitigation is not successful, potentially resulting in desiccated or permanently flooded habitats.

Although Grey Crowned Crane can tolerate a low degree of anthropogenic disturbance (e.g. agricultural cultivation), in Ugandan wetlands it has been observed to be intolerant of human proximity within 100-200m (Olupot, 2014), flying away on approach; a factor which also affects breeding success as breeding birds flush from nests on approach, causing increased rates of predation, reduced time at the nest, either incubating or feeding, and ultimately nest abandonment. How tolerant foraging/roosting/breeding Grey Crowned Crane may be to indirect disturbances, such as noise, light, vibration and edge effects, is not known. The application of a 200m buffer around the Project infrastructure footprint indicates that approximately 4.64 ha of seasonally flooded wetland habitat will be reduced in quality as a result of sensory disturbance, throughout the operational lifetime of the Project.

The escarpment road to the Project is expected to facilitate an influx of people into the area, seeking opportunities. It can reasonably be expected that the increased human population in the Buhuka Flats will exacerbate existing pressures on the wetlands of the area. These pressures are likely to manifest in increased rates of habitat loss and degradation, resulting in long-term reduction of habitat quality and quantity for Grey Crowned Crane.

Impacts from loss of habitat and reduction of habitat quality are predicted to be beyond the expected range of natural disturbance perturbations.

■   Habitat Connectivity

The effect of the Project operation as a barrier to the movement of Grey Crowned Crane is likely to be adverse. The operation activity is likely to create noise and visual sensory disturbances, which could elicit reduced use or complete avoidance of affected areas, thereby creating movement barriers. The presence of power lines between the CPF and development wells will present a significant barrier to movement for Grey Crowned Crane, as this species is susceptible to in-flight collisions with overhead powerlines (BirdLife International, 2018). The presence of roads crossing the wetlands has the potential to create barriers to movement as a result of the associated disturbance due to human presence and traffic in the area. The increased human population, and the associated increase in head of livestock grazing in the Buhuka Flats, is expected to further degrade wetland habitats and reduce habitat connectivity for Grey Crowned Crane.

Effects from disruption of habitat connectivity are predicted to be well beyond the expected range of natural disturbance perturbations.

■   Abundance and Distribution

Grey Crowned Crane was relatively common in the Buhuka Flats during baseline surveys, with up to 14 individuals frequently observed. Given the extent to which they reportedly tolerate human presence (approx.

100m – 200m; Olupot, 2014), the large-scale changes in the human population on the Flats that have occurred with the operation of the escarpment road are likely to have affected Grey Crowned Crane occurrence on the Buhuka Flats. The ongoing population influx to the Flats following development of the escarpment road is likely to exacerbate existing levels of sensory disturbance in the locality, which in combination with anthropogenic degradation of suitable foraging, roosting and breeding habitat is expected to adversely affect the abundance and distribution of the species.

Effects on the abundance and distribution of Grey Crowned Crane are predicted to be well beyond the expected range of natural disturbance perturbations.

■   Survival and Reproduction

Although Grey Crowned Crane were observed forming breeding pairs during the baseline fieldwork, the widespread degradation of suitable breeding habitat (permanent wetlands) is expected to become exacerbated throughout the operational lifetime of the Project, largely due to the population increase on the Buhuka Flats. This habitat degradation and increased human presence is expected to significantly reduce the likelihood of Grey Crowned Crane continuing to select these areas for breeding.

As mentioned above, direct disturbance via human proximity within 100-200m causes breeding birds to flush from nests on approach (Olupot, 2014), which may result in increased rates of predation, reduced time at the nest, either incubating or feeding, and ultimately nest abandonment, affecting reproductive success. The increased human population on the flats is also expected to result in increased hunting of cranes for bush meat and capture for domestication, and taking of eggs for food.

It is assumed that indirect disturbances arising from noise, light, and vibration would continue to affect the breeding success of Grey Crowned Crane on the Buhuka Flats, should they nest there during operation.

Removal of large trees which have importance as night-time roosts and day-time shelter from the midday sun has been indicated in localised declines in Grey Crowned Crane in Uganda (Olupot, 2014); the absence of such trees during the operational phase is therefore expected to have implications for the survival of flocks and individuals in the area.

These effects to the survival and reproductive success of Grey Crowned Crane are predicted to be well beyond the expected range of natural disturbance perturbations.

Impact Classification

The Grey Crowned Crane's sensitivity is high because it is an Endangered species and it triggers Tier 2 critical habitat.

Impacts to Grey Crowned Crane habitat quantity and quality may be adverse during operation. The geographical extent of impacts will be local because effects will be restricted to the LSA, with approximately 4.64 ha (6.72 %) of potential habitat on the Buhuka Flats indirectly affected. Impact duration will be into the far future (that is, ~25 years) because changes to the habitat quality and quantity from sensory disturbances are expected to continue throughout the operational lifetime of the Production Facility. The magnitude of the effects of operation on Grey Crowned Crane habitat quantity and quality is considered high (ref. Section 9.2.1.2). Therefore, the magnitude and sensitivity combine to produce a major overall impact level during the operation phase of the Project, pre-mitigation. Following the application of appropriate mitigation measures, the impact significance is expected to remain major, because the magnitude of effects can at best be reduced to medium as the pressures on wetland integrity associated with human influx are expected to be difficult to mitigate, and the sensitivity of the receptor will remain the same (Table 22).

Impacts to Grey Crowned Crane habitat connectivity will be adverse. The geographical extent of impacts will be local because effects are restricted to those areas where wetlands will be crossed by access roads. Impact duration will be long-term, as the presence of the access roads will remain in place throughout the operational lifetime of the Project, with ongoing sensory disturbances arising from traffic and the increased human

population using the access roads continuing into the far-future; the increased human population living on the flats, and the associated increase in head of livestock grazing in the Buhuka Flats is likely to further compromise habitat connectivity for Grey Crowned Crane. The magnitude of the effects of operation on Grey Crowned Crane habitat connectivity is considered high. Therefore, the magnitude and sensitivity combine to produce a major overall impact level during the operation phase of the Project, pre-mitigation. Following the application of mitigation measures, the impact significance is expected to remain major, because the magnitude of effects is likely to remain medium as the pressures on wetland integrity associated with human influx are expected to be difficult to mitigate, and the sensitivity of the receptor will remain the same (Table 22).

Impacts to Grey Crowned Crane abundance and distribution will be adverse. The geographical extent of impacts will be local, as impacts will be restricted to wetlands in the Buhuka Flats. Impact duration will be will be into the far future (that is, ~25 years) as the sensory disturbance and habitat degradation associated with the ongoing population influx to the Flats is likely to remain ongoing throughout the lifetime of the Production Facility. The magnitude of the effects of operation on Grey Crowned Crane abundance and distribution is thus considered high. Therefore, the magnitude and sensitivity combine to produce a major overall impact level during the construction phase of the Project, pre-mitigation. Following the application of appropriate mitigation measures, the impact significance is expected to remain major, because the magnitude of effects can at best be reduced to moderate as the pressures on Grey Crowned Crane (wetland) habitat integrity associated with human influx are expected to be difficult to mitigate. The sensitivity of the receptor will remain the same (Table 22).

Impacts to the survival and reproduction of Grey Crowned Crane will be adverse. The geographical extent of impacts will be local because effects are restricted to wetlands on the Buhuka Flats. Impact duration will be will be into the far future (that is, ~25 years) as the sensory disturbance and habitat degradation associated with the ongoing population influx to the Flats is likely to remain ongoing throughout the lifetime of the Production Facility. A threshold of 10% for this species' survival and reproduction in the CHAA is reasonable, and it is considered probable that at least this percentage of individuals in the local population within the Buhuka Flats will be affected. The magnitude of the effects of construction on the survival and reproduction of the Grey Crowned Crane is therefore high. Therefore, the magnitude and sensitivity combine to produce a major overall impact level during the construction phase of the Project, pre-mitigation. Following the application of appropriate mitigation measures, the impact significance is expected to remain major, because the magnitude of effects can at best be reduced to moderate as the pressures on Grey Crowned Crane habitat integrity associated with human influx are expected to be difficult to mitigate. The sensitivity of the receptor will remain the same (Table 22).

Table 22: Potential Production Facility operation phase impacts to Grey Crowned Crane

Indicator of potential impact	Pre-mitigation			Post-mitigation		
	Magnitude	Sensitivity of the Receptor	Significance	Magnitude	Sensitivity of the Receptor	Significance
Habitat quantity and quality	High – 4	High – 4	Major - 16	Medium - 3	High – 4	Major – 12
Habitat connectivity	Medium - 3	High – 4	Major – 12	Medium - 3	High – 4	Major – 12
Abundance and distribution	High – 4	High – 4	Major – 16	Medium - 3	High – 4	Major – 12
Survival and reproduction	High – 4	High – 4	Major - 16	Medium - 3	High – 4	Major – 12

Prediction Confidence

Given the information available, there is a reasonable understanding of the potential direct, indirect and induced (the upgraded R5 and P1 roads) impacts that the operation of the Production Facility could have on Grey Crowned Crane and its habitat in the CHAA.

The spatial extent of the wetland habitat in the CHAA was broadly mapped based on knowledge of the study area, baseline studies, literature and reports (see Section 6.0). The actual extent of possible habitat may have been over-estimated.

10.2.2.3 What impact could the operation of the Project have on Nahan's Francolin?

Nahan's Francolin is a Vulnerable and range-restricted species. In the CHAA, it is restricted to the Bugoma Central Forest Reserve. It triggers Tier 2 critical habitat under Criterion 2 (Section 6.3.2.2, APPENDIX F).

The potential induced and cumulative effects to this species due to the operation of the upgraded R5 and P1 roads are presented below.

Impact Indicators

Indicators used to assess effects of the operation of the upgrade of the R5 and P1 roads on Nahan's Francolin were: habitat quantity and quality, habitat connectivity, abundance and distribution, and survival and reproduction.

Habitat loss due to indirect disturbance and edge effects was estimated by applying a 200 m buffer to the road corridors. Specifically, the buffer was selected to account for changes in habitat quantity and/or quality caused by indirect disturbance like light, noise, vibration, and edge effects.

Changes in habitat connectivity were assessed by identifying potential barriers to movement and loss of corridors. This was accomplished by visually examining the spatial distribution of critical habitat in relation to the road corridor to qualitatively identify areas where habitat becomes fragmented.

Potential changes in abundance and distribution, and survival and reproduction were assessed qualitatively by considering changes in disturbances (that is, vehicle traffic, light, noise, vibration). These disturbances were considered in light of known or inferred effects to the survival and reproduction of buttonquail species for which data on these types of effects are available.

Impact Assessment

■   Habitat Quality and Quantity

The Nahan's Francolin's degree of vulnerability to disturbance is unknown. Birds are known to be sensitive to land use and habitat alteration (Lussier et al. 2006). The behavioural response of species to disturbance will depend on species-specific tolerance levels, disturbance type and frequency, group size for socially-foraging animals, and local conditions, such as the availability of alternative foraging sites (Madsen 1998). Many studies have reported a reduction in breeding success attributable to human disturbance (for a review, see Hill et al. 1992). Mechanisms include: increased rates of predation, nest abandonment and reduced time at the nest, either incubating or feeding. Clearly, a reduction in breeding output may have conservation implications and consequences for the population of this species in Bugoma CFR.

How tolerant the Nahan's Francolin may be to indirect disturbances, such as noise, light, vibration and edge effects, is not known. However, assuming it is sensitive to such disturbance because it is a shy, forest-dependent species (Sande et al. 2009a), then potential Nahan's Francolin habitat will be lost or reduced in quality as a result of edge effects, and possibly sensory disturbance.

The improved R5 and P1 roads could result in an influx of people into the area seeking opportunities. It can reasonably be expected that an increased human population in the area surrounding the Bugoma Central Forest Reserve will put pressure on the forest. These pressures could manifest in increased rates of habitat

alteration and deforestation, as well as increased bush meat hunting. These factors could combine to reduce the habitat quality and quantity for Nahan's Francolin.

Effects from loss of habitat are predicted to be well beyond the expected range of natural disturbance perturbations.

■ Habitat Connectivity

The upgraded R5 and P1 roads will not directly remove suitable habitat for the Nahan's Francolin. However, may affect that habitat within the 200 m buffer through indirect impacts like edge effects and sensory disturbance. As such, the road may become and effective barrier to the movement of Nahan's Francolin if the levels of traffic on the road substantially increase over the life of the Project. Roads are recognised as creating sensory disturbances, which can elicit reduced use or complete avoidance of affected areas, thereby creating movement barriers (for example, see Kolowski and Alonso 2009, Gleeson and Gleeson 2012). However, given that the Hoima-to-Ikamiro Road already exists, if the Nahan's Francolin is sensitive to such effects, then it is reasonable to assume the existing road is already a barrier to a greater or lesser degree.

The improved R5 and P1 roads could result in an influx of people into the area seeking opportunities. It can reasonably be expected that an increased human population in the area surrounding the Bugoma Central Forest Reserve will put pressure on the forest. These pressures could manifest in increased rates of habitat alteration and deforestation. These factors could reduce the habitat connectivity for Nahan's Francolin.

Effects from loss of habitat connectivity are predicted to be well beyond the expected range of natural disturbance perturbations.

■ Abundance and Distribution

Nahan's Francolin is reported to be relatively common in the Bugoma Central Forest Reserve (Plumptre et al. 2011). What effects the upgrade of the road, and the predicted increased traffic levels along the road during the operation of the Project, could have on the abundance and distribution of this species is unknown.

With the operation of the upgraded road, and the increased traffic along the road, it is reasonable to assume that the local abundance and distribution of this species may be altered. Individuals may avoid the resultant sub-optimal habitat brought about by the upgraded road and increased traffic volumes. Additionally, the increased traffic on the road could lead to an increase in direct mortality of individuals.

The improved R5 and P1 roads could result in an influx of people into the area seeking opportunities. It can reasonably be expected that an increased human population in the area surrounding the Bugoma Central Forest Reserve will put pressure on the forest. These pressures could manifest in increased rates of bush meat hunting and habitat alteration. These factors could reduce the abundance and distribution of Nahan's Francolin.

Effects from the upgraded road are predicted to be well beyond the expected range of natural disturbance perturbations.

■ Survival and Reproduction

The Nahan's Francolin's degree of vulnerability to direct disturbance, particularly during the breeding season, is not well understood. Generally, for birds, the behavioural response of species to disturbance will depend on species-specific tolerance levels, disturbance type and frequency, group size for socially-foraging animals, and local conditions such as the availability of alternative breeding sites (Madsen 1998). Many studies have reported a reduction in breeding success attributable to human disturbance (for a review, see Hill et al. 1992). Mechanisms include: increased rates of predation, nest abandonment and reduced time at the nest, either incubating or feeding. Clearly, a reduction in breeding output may have conservation implications and consequences for the local population of Nahan's Francolin.

How tolerant the Nahan's Francolin may be to indirect disturbances, such as noise, light, vibration and edge effects, during the breeding season, are also not completely understood. What is known is that disturbance

of mature forest generally appears to reduce the home range of this species (Sande et al. 2009b), and hence its potential to find suitable mates. Assuming it is sensitive to sensory disturbance because it is a shy, forest-dependent species (Sande et al. 2009a), the operation of the upgraded roads, and the increased traffic levels on the road could affect the breeding success of those individuals living in close proximity to the road.

The improved R5 and P1 roads could result in an influx of people into the area seeking opportunities. It can reasonably be expected that an increased human population in the area surrounding the Bugoma Central Forest Reserve will put pressure on the forest. These pressures could manifest in increased rates of bush meat hunting and habitat alteration. These factors could reduce the survival and reproduction of Nahan's Francolin.

These effects to the survival and reproductive success of Nahan's Francolin are predicted to be well beyond the expected range of natural disturbance perturbations.

Impact Classification

The Nahan's Francolin's sensitivity is high because it is range-restricted, and triggers Tier 2 critical habitat.

Impacts to the Nahan's Francolin's habitat quantity and quality will be adverse. The geographical extent of impacts will be local because effects are restricted to those areas immediately adjacent to the R5 and P1 road corridors in the CHAA. Impact duration will be long-term. The magnitude of the effects of operation on the habitat quantity and quality of the Nahan's Francolin is low. Therefore, the magnitude and sensitivity combine to produce a moderate overall impact level during the operational phase of the Project, pre-mitigation (Table 25).

Following the application of appropriate mitigation measures, the impact significance is expected to remain moderate, primarily because the effectiveness of mitigation measures in the long-term are unknown and beyond the control of CNOOC, although the sensitivity of the receptor will remain the same (Table 23).

Impacts to the Nahan's Francolin's habitat connectivity will be adverse. The geographical extent of impacts will be local because effects are restricted to those areas immediately adjacent to the R5 and P1 road corridors in the CHAA. Impact duration will be long-term. The magnitude of the effects of operation on the habitat connectivity of the Nahan's Francolin is Low. Therefore, the magnitude and sensitivity combine to produce a moderate overall impact level during the operational phase of the Project, pre-mitigation.

Following the application of appropriate mitigation measures, the impact significance is expected to remain moderate, primarily because the effectiveness of mitigation measures in the long-term are unknown and beyond the control of CNOOC, although the sensitivity of the receptor will remain the same (Table 23).

Impacts to the Nahan's Francolin's abundance and distribution could be adverse. The geographical extent of impacts will be local because effects are restricted to those areas immediately adjacent to the R5 and P1 road corridors in the CHAA. Impact duration will be long-term. There is a possibility that individuals could be killed or severely disturbed during the operation phase. The magnitude of the effects of operation on the abundance and distribution of the Nahan's Francolin is Low. Therefore, the magnitude and sensitivity combine to produce a moderate overall impact level during the operation phase of the Project, pre-mitigation.

Following the application of appropriate mitigation measures, the impact significance is expected to remain moderate, primarily because the effectiveness of mitigation measures in the long-term are unknown and beyond the control of CNOOC, although the sensitivity of the receptor will remain the same (Table 23).

Impacts to the survival and reproduction of Nahan's Francolin could be adverse. The geographical extent of impacts will be local because effects are restricted to those areas immediately adjacent to the R5 and P1 road corridors in the CHAA. Impact duration will be long-term. There is a possibility that individuals could be killed or severely disturbed during the operation phase. A threshold of 10% for this species' survival and reproduction in the CHAA is reasonable, and it is expected that this number of individuals in the local population within Bugoma Central Forest Reserve will not be affected. The magnitude of the effects of operation on the survival and reproduction of the Nahan's Francolin is therefore low. Therefore, the magnitude and sensitivity combine

to produce a moderate overall impact level during the operational phase of the Project, pre-mitigation (Table 23).

Following the application of appropriate mitigation measures, the impact significance is expected to remain moderate, primarily because the effectiveness of mitigation measures in the long-term are unknown and beyond the control of CNOOC, and the sensitivity of the receptor will remain the same (Table 23).

Table 23: Potential impacts in the operational phase to the Nahan's Francolin

Indicator of potential impact	Pre-mitigation			Post-mitigation		
	Magnitude	Sensitivity of the Receptor	Significance	Magnitude	Sensitivity of the Receptor	Significance
Habitat quality and quantity	Low – 2	High – 4	Moderate – 8	Low – 2	High – 4	Moderate – 8
Habitat connectivity	Low – 2	High – 4	Moderate – 8	Low – 2	High – 4	Moderate – 8
Abundance and distribution	Low – 2	High – 4	Moderate – 8	Low – 2	High – 4	Moderate – 8
Survival and reproduction	Low – 2	High – 4	Moderate – 8	Low – 2	High – 4	Moderate – 8

Prediction Confidence

Given the information available, there is a reasonable understanding of the potential direct, indirect and induced (the upgraded R5 and P1 roads) impacts that the operation of the Project could have on the Nahan's Francolin and its habitat in the CHAA.

The spatial extent of the dense forest habitat in the CHAA was broadly mapped based on knowledge of the site, baseline studies, literature and reports (see Section 6.0). The actual extent of possible habitat may have been over-estimated.

10.2.2.4 What impact could the operation of the Project have on Eastern Chimpanzee?

Eastern Chimpanzee is an Endangered species. A population occurs in the Bugoma Central Forest Reserve. This species triggers Tier 1 critical habitat.

The potential induced effects of the upgraded R5 and P1 roads on Eastern Chimpanzee are presented below.

Impact Indicators

Indicators used to assess effects of the upgraded R5 and P1 roads on Eastern Chimpanzee were: habitat quantity and quality, habitat connectivity, abundance and distribution, and survival and reproduction.

Habitat loss due to indirect disturbance and edge effects during operation was estimated by applying a 500 m buffer to the road corridor. Specifically, the buffer was selected to account for changes in habitat quantity and/or quality caused by indirect disturbance like noise, vibration and traffic. The buffer width was determined based known chimpanzee sensitivities to noise disturbance (Parren and Byler 2003, Rabanal et al. 2010). The amount of loss or degradation of habitats within the buffer was evaluated across a range of possibilities, including that habitats become completely unavailable to chimpanzees during the operation phase. Evaluating the potential for complete avoidance of the buffer area is a conservative approach, which addresses uncertainty about the attenuation distance of sensory disturbances for chimpanzees, even though the likelihood of strict avoidance throughout the entire buffer may be low.

Changes in habitat connectivity were assessed by identifying potential barriers to movement and loss of corridors. This was accomplished by visually examining the spatial distribution of critical habitat in relation to the road corridor to qualitatively identify areas where habitat becomes fragmented.

Potential changes in abundance and distribution were assessed qualitatively by considering changes in disturbances (that is, vehicle traffic, light, noise, vibration). These disturbances were considered in light of known or inferred effects to the survival and reproduction of other populations of chimpanzees for which data on these types of effects are available.

To assess effects to survival and reproduction as a result of in-migration and potential associated increases in poaching and disease spread, in-migration rates were predicted based on the predictions in Golder Associates (2014h). A literature review of the impact of contact with humans was also conducted

Impact Assessment

■   Habitat Quality and Quantity

Based on the data presented in Plumptre et al. (2010), the distribution of nesting sites appears to be widely distributed through the forest; the exception being within the vicinity of the Hoima-to-Ikamiro Road. Here the frequency of nests encountered by those workers was a lot lower than elsewhere in the forest. This suggests that the Eastern Chimpanzees within the Bugoma Central Forest Reserve are actively avoiding the road, preferring to sleep some distance away from the disturbances arising from the road. The observation supports the findings of Parren and Byler (2003) that chimpanzees actively avoid environments where they will be disturbed at night.

The degree of vulnerability to disturbance experienced by chimpanzees is reasonably well known (for example, see Parren and Byler 2003, Rabanal et al. 2010, Thompson and Wrangham 2013). The chimpanzees living in and around the Bugoma Central Forest Reserve most likely experience sensory disturbances at present from human activities, given the high human populations living around the reserve. Indeed, groups are known to forage in the agricultural fields surrounding the forest, and hence, would more than likely be used to human noises and disturbances (McLennan 2008). As such, the potential sensory disturbances arising from the operation of the upgraded road are likely to be minimal. Nevertheless, the magnitude of noise may not be the most important determinant of chimpanzee response. Instead, chimpanzees may respond to 'new' noises or may associate particular noises with other occurrences (for example, machine noise may be associated with human presence, which chimpanzees may, in turn, associate with the presence of danger). Where humans pose a threat, chimpanzees generally avoid them (Hockings and Humle 2009, Parren and Byler 2003). Therefore, the degree of avoidance may depend on the behaviour of people, highlighting the importance of managing contractor activity.

The improved R5 and P1 roads could result in an influx of people into the area seeking opportunities. It can reasonably be expected that an increased human population in the area surrounding the Bugoma Central Forest Reserve will put pressure on the forest. These pressures could manifest in increased rates of bush meat hunting and habitat alteration. These factors could reduce the survival and reproduction of Eastern Chimpanzee.

Effects from the loss of habitat are predicted to be well beyond the expected range of natural disturbance perturbations.

■   Habitat Connectivity

Although the operation of the upgraded R5 and P1 roads will not cause direct losses of suitable habitat for the Eastern Chimpanzees; it may affect suitable habitat within the 500 m buffer through indirect impacts like edge effects and sensory disturbance.

However, the chimpanzees within Bugoma Central Forest Reserve are assumed to be accustomed to human activity, and they may, more than likely, regularly cross roads within their range. Therefore, it is possible that they will not completely avoid the road corridor when the road is operational.

As such, the effect of the operation of the upgraded roads and associated traffic volumes within Bugoma CFR as a barrier to chimpanzee movements is predicted to be negligible – assuming that the mitigation recommendation of restricted access on the R5 intersecting the reserve has been applied.

Effects from loss of habitat connectivity are predicted to be beyond the expected range of natural disturbance perturbations.

■   Abundance and Distribution

The Bugoma Central Forest Reserve supports one of the top four Eastern Chimpanzee populations in Uganda, with a population of between 450 and 850 individuals (Plumptre et al. 2010). Although the increased traffic volumes expected on these roads during operation has the potential to cause direct mortality of individuals, should such individuals cross the road, the operation of the upgraded roads is not expected to detrimentally affect the abundance of chimpanzees in the forest directly. What effect the loss of individuals from the population could have is unknown. It is doubtful though that the population could be reduced by 10% and hence, reach that critical population threshold due to road mortalities alone.

The long-term presence of the improved R5 and P1 roads could continue to facilitate influx of people into the area seeking opportunities. It can reasonably be expected that an increased human population in the area surrounding the Bugoma Central Forest Reserve will put pressure on the forest. These pressures could manifest in increased rates of bush meat hunting and habitat alteration. These factors could reduce the abundance and distribution of Eastern Chimpanzee.

Effects from the upgraded road are predicted to be well beyond the expected range of natural disturbance perturbations, although not beyond the disturbance from the human-induced deforestation rate and habitat loss, and bush meat hunting in Bugoma Central Forest Reserve.

■   Survival and Reproduction

In-migration associated with upgrade of the R5 and P1 roads may adversely affect survival and reproduction of chimpanzees through poaching and disease transfer. Hunting and poaching is a recognised threat to chimpanzees in Bugoma Central Forest Reserve (Plumptre et al. 2003), and this pressure could increase as in-migration of people from other areas occurs.   Mitigation and management of in-migration (see Golder Associates 2014h) will be very important to minimise potential effects on chimpanzees and other fauna species.

Disease is one of the major threats to Eastern Chimpanzees (Oates et al. 2008); increased abundance of people and competition for land and food resources between humans and chimpanzees could lead to higher rates of disease spread from humans to chimpanzees. Chimpanzees are closely related to humans; therefore, many diseases are transferrable between chimpanzees and humans (Formenty et al. 2003; Isabirye-Basulta and Lwanga 2008). Either direct or indirect contact with humans can spread disease. For example, there is evidence to suggest that respiratory illnesses have been transferred directly to chimpanzees from humans as a result of researcher and tourist contacts, often leading to outbreaks and death (Formenty et al. 2003). Human defecation in forest undergrowth can indirectly lead to spread of intestinal diseases, such as *Clostridium perfringens*, which can be fatal to chimpanzees (Fujita 2011). As forest fragments decrease in size, risks of contact with, and transmission of, disease from humans increases (Isabirye-Basulta and Lwanga 2008). Factors that lead to increased crop raiding or sharing of water resources can also increase the risk of disease spread (Hockings and Hulme 2009). As identified in Golder Associates (2014e), communicable respiratory diseases are a significant concern in the LSA.

An increasing human population, facilitated by an improved road, could lead to an increase in the demand for agricultural resources, which, in turn could further fragment, change, and degrade the Bugoma Central Forest Reserve and surrounding habitat. With the upgrade of the road, and the potential for the Project to be attractive for people seeking opportunities, could see a substantial increase the current population around the Bugoma Central Forest Reserve.

Effects from the upgraded road are predicted to be well beyond the expected range of natural disturbance perturbations.

Impact Classification

The Eastern Chimpanzee's sensitivity is high because it is Endangered.

Impacts to the Eastern Chimpanzee's habitat quantity and quality will be adverse. The geographical extent of impacts will be local because effects are restricted to those areas immediately adjacent to the Hoima-to-Ikamiro Road corridor in the CHAA. Impact duration will be long-term. The magnitude of the effects of construction on the habitat quantity and quality of the Eastern Chimpanzee is low. Therefore, the magnitude and sensitivity combine to produce a moderate overall impact level during the operation phase of the Project, pre-mitigation (Table 20). Following the application of appropriate mitigation measures, the impact significance is expected to remain moderate, primarily because the effectiveness of mitigation measures in the long-term are unknown and beyond the control of CNOOC, although the sensitivity of the receptor will remain the same (Table 24).

Impacts to the Eastern Chimpanzee's habitat connectivity will be neutral. The geographical extent of impacts will be local because effects are restricted to those areas immediately adjacent to the Hoima-to-Ikamiro Road corridor in the CHAA. Impact duration will be long-term. The magnitude of the effects of construction on the habitat connectivity of the Eastern Chimpanzee is negligible. Therefore, the magnitude and sensitivity combine to produce a minor overall impact level during the operational phase of the Project (Table 24).

Impacts to the Eastern Chimpanzee's abundance and distribution could be adverse. The geographical extent of impacts will be regional because, although effects are restricted to those areas immediately adjacent to the Hoima-to-Ikamiro Road corridor in the CHAA, there is the potential to extend beyond that area. Impact duration will be long-term. There is a possibility that individuals could be killed or severely disturbed during the operational phase. The magnitude of the effects of operation on the abundance and distribution of the Eastern Chimpanzee is medium. Therefore, the magnitude and sensitivity combine to produce a major overall impact level during the operation phase of the Project, pre-mitigation (Table 24). Following the application of appropriate mitigation measures, the impact significance is expected to become moderate, primarily because the effectiveness of mitigation measures in the long-term are unknown and beyond the control of CNOOC, although the sensitivity of the receptor will remain the same (Table 24).

Impacts to the survival and reproduction of the population of Eastern Chimpanzee in Bugoma Central Forest Reserve could be adverse. The geographical extent of impacts will be national because effects could extend well beyond the CHAA. Impact duration will be long-term. There is a possibility that individuals could be killed or severely disturbed during the operation phase. A threshold of 10% for this species' survival and reproduction in the CHAA is reasonable, and it is expected that this number of individuals in the local population within Bugoma Central Forest Reserve could be affected through direct mortality from bush meat hunting or other disturbance. Therefore, the magnitude of the effects of operations on the survival and reproduction of the Eastern Chimpanzee high. Therefore, the magnitude and sensitivity combine to produce a major overall impact level during the road upgrade and construction phase of the Project, pre-mitigation (Table 24).

Following the application of appropriate mitigation measures, the impact significance is expected to become moderate, primarily because the effectiveness of mitigation measures in the long-term are unknown and beyond the control of CNOOC, although the sensitivity of the receptor will remain the same (Table 24).

Table 24: Potential impacts in the operation phase to the Eastern Chimpanzee

Indicator of potential impact	Pre-mitigation			Post-mitigation		
	Magnitude (the expected size of the impact)	Sensitivity of the Receptor	Significance	Magnitude (the expected size of the impact)	Sensitivity of the Receptor	Significance
Habitat quality and quantity	Low – 2	High – 4	Moderate – 8	Low – 2	High – 4	Moderate – 8
Habitat connectivity	Negligible – 1	High – 4	Minor – 4	Negligible – 1	High – 4	Minor – 4
Abundance and distribution	Medium – 3	High – 4	Major – 12	Low – 2	High – 4	Moderate – 8
Survival and reproduction	High – 4	High – 4	Major – 12	Low – 2	High – 4	Moderate – 8

Prediction Confidence

Given the information available, there is a reasonable understanding of the potential direct, indirect and induced (the upgraded R5 and P1 roads) impacts that the operation of the Project could have on the Eastern Chimpanzees and their habitat in the CHAA.

The spatial extent of the dense forest habitat in the CHAA was broadly mapped based on knowledge of the site, baseline studies, literature and reports (see Section 6.0). The actual extent of possible habitat may have been over-estimated.

11.0 IMPACT ASSESSMENT – FEEDER LINE

This section presents an assessment of the possible interactions of biodiversity valued components with the feeder line infrastructure and activities, and the resulting impacts during the construction and operation phases.

The biodiversity valued components for the feeder line impact assessment are listed in Table 5 below. They include all of the species and habitats that trigger critical habitat designation within the CHAA. In addition, ecosystems of concern that will be potentially affected by the Project, and Grey Crowned Crane, were also included as valued components for impact assessment, for reasons outlined in the Table below. As mentioned in Section 10.1.2, potential impacts to other species of concern are assessed at the habitat level (ecosystems of concern).

Table 25: Biodiversity Valued Components for Feeder line Impact Assessment

Valued Component	Confirmed CH Trigger? (see Table 4)	Reasoning (see Table 4)
Near-shore aquatic habitats of Lake Albert	■ Yes – Criterion 13 ■ Possibly Criterion 1 and Criterion	■ The near-shore habitats are important fishing grounds that support 11 fishing villages on the Buhuka Flats and surrounds (see Ecosystem Services Review) ■ May support the CR and range-restricted species Gabbiella candida

Valued Component	Confirmed CH Trigger? (see Table 4)	Reasoning (see Table 4)
	2 (G. candida)	
Wetlands	No	■ Natural habitat – priority habitat according to IFC (2012) ■ Supports Endangered Grey Crowned Crane ■ Important in supply of ecosystem services to local communities (see Ecosystem Services Review)
Escarpment vegetation corridor	No	■ Natural habitat – priority habitat according to IFC (2012) ■ Forms part of a contiguous vegetation corridor that is part of the wider Murchison Falls National Park-Budongo-Bugoma-Kagombe-Itwara Forest Reserves-Semliki/Toro Wildlife Reserve corridor ■ The location of caves and cavities along the escarpment that could be important for cavity-roosting bats
Bugoma Central Forest Reserve	■ Yes – ■ Criterion 4 ■ Criterion 1 ■ Criterion 2	■ Triggers CH on the basis of being a highly threatened and unique ecosystem (Criterion 4) ■ Triggers Criterion 1 Tier 1 CH on the basis of support of a population of Eastern Chimpanzee, that is recognised as being one for the four largest in the region; apart from being an Endangered species, chimpanzees are also recognised as key stone species and ecosystem engineers ■ Triggers Criterion 2 Tier 2 CH on the basis of support of range-restricted Nahan's Francolin ■ Recognised area of old growth forest ■ The forest is recognised for its unique biodiversity values, including biome restricted species ■ Is an important ecosystem service supply area for local people who harvest timber, fibre, fuel wood and charcoal, and non-timber forest products from the forest ■ Bugoma Central Forest Reserve is recognised as an Important Bird Area ■ Nationally recognised as a high conservation priority area (NEMA 2010)
Mud Snail (*Gabbiella candida*)	Possibly Criterion 1 and Criterion 2	■ Could occur on near-shore aquatic habitats (Bugoma Lagoon, large bays, open sandy shores, shallow river-associated water) ■ Has not been confirmed in LSA to date and is included on basis of precautionary principle
Grey Crowned Crane	No	■ Although Grey Crowned Crane is not present in numbers that would trigger CH designation, it is an Endangered

Valued Component	Confirmed CH Trigger? (see Table 4)	Reasoning (see Table 4)
		species and has been confirmed present on the Buhuka Flats during baseline fieldwork in 2014 and 2017 ■ Any potential Project impacts on a globally-recognised and nationally-protected Endangered species are unacceptable and warrant addressing via the impact assessment process
Nahan's Francolin (*Ptilopachus nahani*)	Yes – Criterion 2	■ Occurs in Bugoma Central Forest Reserve, possibly one of less than 10 DMUs globally (including DRC) ■ Potential for CHAA to support >10% of this species' known global population
Eastern Chimpanzee (*Pan troglodytes schweinfurthii*)	Yes – Criterion 1	■ Occurs in Bugoma Central Forest Reserve ■ Great apes are an iconic species of anthropological and evolutionary significance ■ They generally immediately trigger CH designation (see GN 74 and footnotes in PS6, IFC 2012a and b)

It should be noted that there is limited potential for decommissioning phase impacts for the feeder line, as typically pipelines are left in situ following decommissioning. In any case, the decommissioning activity will be the subject of a separate ESIA process, to be conducted towards the end of the operational phase.

11.1 Construction Phase Impacts

The construction of the feeder line will occur over 10-12 months, and is expected to present direct impacts to valued components including sensory disturbances, the potential for pollution and erosion and sedimentation, and direct mortality from vehicle movements and entrapment in open trenches. Indirect impacts on valued components are also anticipated as a result of population influx, due to expectations of work on the construction contract.

For the assessment of impacts during the construction phase, the key questions were divided into sub-questions that focused on individual valued components within the CHAA and LSA. In answering each question, the individual components of the pipeline were considered with regards to their potential to affect a valued component. These questions are presented below.

11.1.1 What impact could the construction of the Feeder line have on habitats and ecosystem integrity?

This section presents the assessment of impacts that the construction and decommissioning of the Feeder line could have on the habitat and ecosystem integrity within the CHAA and the LSA. These habitats either do, or could, support populations of species of concern. Therefore, the assessment of potential impacts to those species, and others, occurring in the CHAA has been assessed in this section through the determination of the impacts to potential habitat for those species.

The impacts of the Feeder line on critical habitat, as triggered by species of concern, are covered under the individual assessment of those species in Section 11.1.2. Other triggers of critical habitat are discussed, as relevant, in the appropriate sections.

11.1.1.1 What impact could the construction of the Feeder line have on the near-shore aquatic habitats of Lake Albert?

Impact Indicators

The feeder line will not be constructed in the vicinity of the near-shore aquatic habitats of Lake Albert and thus is not expected to directly impact these habitats in terms of direct or indirect habitat loss as a result of disturbances and clearing during construction. However, changes in water quality as a result of the proposed discharge of hydrotest water to Lake Albert could affect the habitat and ecosystem integrity of the near-shore environment of Lake Albert.

Indicators used to assess impacts of the Project on the habitat and ecosystem integrity of the near-shore environment of Lake Albert were changes in: regional representativeness; topography (geomorphology) and sediments; water quality; ecosystem composition; ecosystem configuration.

Potential losses of habitat due to direct disturbance and clearing associated with the Project was quantified by overlaying the current, baseline extent of the habitat with the Project footprint.

Additional, indirect impacts to habitat were estimated by applying a 1 km buffer to the Project footprint, forming the LSA. Specifically, the buffer was selected to account for changes in habitat quantity and/or quality that could be caused by sensory disturbance, changes in water quality, and air emissions and dust.

Changes in habitat composition and ecosystem configuration were assessed by identifying potential succession changes in species composition that could occur. This was accomplished by examining available literature about the ecology of Lake Albert, and scientific literature about the impacts of human activities on aquatic environments.

Impact Assessment

■   Representativeness

The CHAA supports 16.2 km of near-shore aquatic habitats, equating to about 810 ha (based on the near-shore habitat extending 0.50 km into the lake, see Section 7.1.1).

The feeder line will not be constructed in the vicinity of the near-shore aquatic habitats of Lake Albert and thus is not expected to directly impact these habitats in terms of direct or indirect habitat loss as a result of disturbances and clearing during construction. Therefore, no effects on regional representativeness are predicted.

■   Topography (geomorphology) and sediment transport

The feeder line will not be constructed in the vicinity of the near-shore aquatic habitats of Lake Albert and thus is not expected to directly impact these habitats in terms of direct or indirect habitat loss as a result of disturbances and clearing during construction. Therefore, no pipeline-related impacts on the topography (geomorphology) and/or sediment transport in the near-shore habitats are predicted.

■   Water Quality

The commissioning of the feeder line will involve hydrotesting, in which the vessels are filled with water and pressurised to verify their integrity. On occasions, chemical additives such as biocides, oxygen scavengers, dyes and/or corrosion inhibitors are added to the water, depending on the residence time, before it is discharged. This water is proposed to be discharged directly to Lake Albert. Without management, its release can present a severe risk to the aquatic environment, resulting in possible mortality and degradation of downstream ecosystems and species.

■   Ecosystem composition

All six of the main habitat types in Lake Albert, as identified for fishes by Wandera and Balirwa (2010) (that is, shallow river-associated waters, open sandy shores, lagoons, large bays, rocky escarpments, and, open-water habitats), occur within the near-shore areas of the CHAA (see Section 7.1.1, Figure 5). Similarly, the species

guilds associated with the near-shore habitats of the CHAA, in particular fish, are well represented throughout those regions of the lake that have been investigated (for example, see Wandera and Balirwa 2010, Taabu-Munyaho et al. 2012). Consequently, at baseline, the composition of these ecosystems can be said to be in good condition and reflective of the aquatic diversity of Lake Albert. Similarly, these aquatic habitats have a well-developed structure, that is, well-defined aquatic plant layers associated with underwater features and substrates.

If not correctly treated, the discharge of hydrotest fluids directly to Lake Albert during pipeline construction is likely to result in high-intensity, temporary and localised alteration of the ecosystem composition of the aquatic communities; particularly those inhabiting the near-shore habitats in the vicinity of the discharge outfall.

The point source discharge, and the quantity of hydrotest fluid involved, presents a risk of localised toxicity, which could cause mortality of fish and aquatic invertebrates, algae and plants, thereby changing diversity and complexity of the aquatic habitats and their ability to support associated aquatic faunal communities. Impacts from the changes to ecosystem composition as a result of this contamination are predicted to be beyond the expected range of natural disturbance perturbations.

Since the near-shore habitats of Lake Albert within the CHAA potentially support species that trigger critical habitat including the Critically Endangered mud snail (*G. candida*); any negative impacts on the ecosystem composition of this habitat have the potential to be of major significance.

■ Ecosystem configuration

The feeder line will not be constructed in the vicinity of the near-shore aquatic habitats of Lake Albert and thus is not expected to directly impact these habitats in terms of direct or indirect habitat loss as a result of disturbances and clearing during construction. Therefore, no pipeline-related impacts on the connectivity, or ecosystem configuration of the near-shore habitats are predicted.

Impact Classification

The near-shore aquatic habitat's sensitivity is high because these habitats potentially support populations of the Critically Endangered Mud Snail (*G. candida*), the Vulnerable African Soft-shelled Turtle (*T. triunguis*), and the range-restricted and Near Threatened Snail (*Bellamya rubicunda*). Near-shore aquatic habitat within the CHAA potentially constitutes Tier 1 Critical Habitat for the Mud Snail (*G. candida)* (Table 4). Impacts on this habitat are therefore classified on the basis of high sensitivity to potential effects of the proposed development.

■ Representativeness

Impacts to the representativeness of the habitat will be neutral, as the feeder line will not be constructed in the vicinity of the near-shore aquatic habitats of Lake Albert, and thus is not expected to directly impact these habitats in terms of direct or indirect habitat loss as a result of disturbances and clearing during construction. Therefore, no effects on regional representativeness are predicted.

■ Topography (geomorphology) and sediment transport

Impacts to the topography (geomorphology) and sediment transport in the near-shore aquatic habitats of Lake Albert will be neutral, as the feeder line will not be constructed in the vicinity of these habitats, and thus is not expected to directly impact them in terms of direct or indirect habitat loss as a result of disturbances and clearing during construction. Therefore, no pipeline-related impacts on the topography (geomorphology) and/or sediment transport in the near-shore habitats are predicted

■ Ecosystem composition – water quality

Impacts to the water quality, and subsequently the ecosystem composition of near-shore habitats will be adverse. The geographical extent of impacts is expected to be localised, around the Lake Albert discharge point. The duration will be temporary (that is, over the course of several weeks), and will only occur once the construction of the full pipeline has been completed i.e. at the end of the construction phase.

The magnitude of the potential impacts of the direct discharge of hydrotest effluent from the pipeline on the water quality is medium. This is because, prior to mitigation, the potential for hydrotest discharge to alter the baseline water quality is substantial, resulting localised changes to ecosystem composition as a result of toxic effects on aquatic invertebrate, fish and plant communities (i.e. the diversity and complexity of the habitat) around the discharge point. As mentioned previously, the near-shore aquatic habitat's sensitivity is high, therefore, the magnitude and sensitivity combine to produce a major overall impact level to water quality as a result of potential contamination with potentially toxic chemicals during the hydrotesting of the feeder line, prior to the application of the recommended mitigation (Table 7). Following the application of appropriate mitigation measures, the impact significance is expected to be reduced to minor, primarily because the magnitude will become negligible.

Following the application of the mitigation measures (Section 12.2), the impact significance is expected to be reduced to minor, primarily because the magnitude will become negligible, and the sensitivity of the receptor will remain the same.

■ Ecosystem configuration

Impacts to the ecosystem configuration of the near-shore aquatic habitats of Lake Albert will be neutral, as the feeder line will not be constructed in the vicinity of these habitats, and thus is not expected to directly impact them in terms of direct or indirect habitat loss as a result of disturbances and clearing during construction. Therefore, no pipeline-related impacts on the ecosystem configuration of the near-shore habitats are predicted.

Table 26: Potential impacts in the construction phase to near-shore habitats

Indicator of potential impact	Pre-mitigation			Post-mitigation (pre-offsets)		
	Magnitude	Sensitivity of the Receptor	Significance	Magnitude	Sensitivity of the Receptor	Significance
Ecosystem composition - Water quality	Medium - 3	High - 4	Major – 12	Negligible - 1	High - 4	Minor – 4

Prediction Confidence

Given the information available, there is a reasonable understanding of the potential Project impacts to the near-shore habitats of the CHAA. However, there is some uncertainty in regard to the irreplaceability and vulnerability of those habitats in the CHAA. Given the current uncertainty in relation to climate change and possible scenarios with the level of Lake Albert, which has, in the recent and not so recent past, varied quite dramatically (Talbot et al. 2006), it is conceivable that level of the lake may increase or decrease thereby altering near-shore habitats.

The spatial extent of the near-shore habitats in the CHAA was broadly mapped based on knowledge of the site, baseline studies, literature and reports (see Section 7.1.1). The actual extent of possible habitat may have been over-estimated.

11.1.1.2 What impact could the construction of the Feeder line have on the escarpment vegetation corridors?

Impact Indicators

Indicators used to assess impacts of the Project on the habitat and ecosystem integrity of the vegetation corridors on the escarpment were changes in: regional representativeness; ecosystem composition; and ecosystem configuration.

Loss of habitat due to direct disturbance and clearing associated with the feeder line was quantified by overlaying the current, baseline extent of the escarpment vegetation communities with the feeder line footprint.

Additional, indirect affects to habitat were estimated by applying a 0.50 km buffer to the footprint of the feeder line. Specifically, the buffer was selected to account for changes in habitat quantity and/or quality that could be caused by edge effects, fragmentation, sensory disturbance, changes in water quantity and quality, and air emissions and dust.

Changes in habitat composition and ecosystem configuration were assessed by identifying potential changes in species composition that could occur, and the disruption of known corridors. This was accomplished by examining available literature about the ecology of the vegetation communities on the escarpment, and scientific literature about the impacts of human activities on corridors.

Impact Assessment

■ Representativeness

The CHAA supports approximately 2443 ha of escarpment corridor vegetation communities (see Section 6.3.1.1.2), which are bounded on the east by agriculturally modified landscapes, and the Buhuka Flats on the west. As mentioned, these vegetation communities form part of a contiguous vegetation corridor that is part of the wider Murchison Falls National Park-Budongo-Bugoma-Kagombe-Itwara Forest Reserves-Semliki/Toro Wildlife Reserve corridor (Plumptre et al. 2003) (see Section 7.1.2). Therefore, their continuous extent represents an important landscape feature in the CHAA.

The proposed feeder line will traverse approximately 0.8 km through escarpment vegetation communities before it enters agriculturally-modified habitats on the plateau above the escarpment. The total area of escarpment habitat that will be lost and disturbed as a result of the construction of the feeder line is 4.1 ha. All these vegetation communities are widely represented on the escarpment, and the CHAA.

The total loss of escarpment vegetation communities within the CHAA due to the construction of the feeder line is outlined in Table 27).

Table 27: Permanent loss of escarpment corridor vegetation due to construction of feeder line

Vegetation Type	Total area in the CHAA (ha)	Total area in Escarpment vegetation corridor (ha)	Area of escarpment vegetation corridor affected by the pipeline (ha)	% loss of vegetation corridor within CHAA
Cultivation and settlement	31860.9	0.1	-	-
Dense bushland	1097.6	337.7	1.6	0.5%
Dense wooded grassland	613.2	589.0	1.7	0.3%
Open grassland	568.5	31.5	-	-
Open wooded bushland	523.0	214.0	0.8	0.4%
Open wooded grassland	1900.9	552.2	-	-
Riverine woodland	74.8	69.8	-	-

The loss of this quantity of vegetation in relation to the amount in the CHAA is not substantial. Nevertheless, the loss of this vegetation does open up a previously contiguous tract of vegetation with a linear corridor that introduces edge effects and the concomitant aspects associated with those, as discussed below.

Impacts from the changes to representativeness are predicted to be beyond the expected range of natural disturbance perturbations.

■ Ecosystem composition

The construction of the feeder line may result in loss of biodiversity at both local and regional scales due to restricting movement between populations, increased mortality, habitat fragmentation and edge effects, invasion by exotic species, or increased human access to wildlife habitats, all of which are expected to increase local extinction rates or decrease local recolonisation rates (Findlay and Bourdages 2000). Indeed, the construction of a linear corridor (such as the feeder line) through an area of relatively intact vegetation, like that on the escarpment, creates edge effects that could, in the long-term, alter the composition of the ecosystem through which the pipeline traverses. Vegetation clearing creates edges or boundaries where habitat (for example, riverine woodland) meets a disturbance (for example, the pipeline corridor). Edges associated with disturbance are different than transition areas, or ecotones, amongst vegetation communities, because disturbance edges tend to be abrupt with a high degree of contrast between two areas (for example, pipeline corridor and open wooded grassland). Edges open up habitat in areas where it was previously continuous, and this generally changes the abiotic conditions (for example, temperature, light, and moisture regimes) (Porensky and Young 2013). Edges often result in changes in species composition along the edge, with the edges typically becoming dominated by pioneer species adapted to the particular microclimate experienced on the edge (Porensky and Young 2013). Often, these microclimates are favoured by weed and/or invasive plant species. However, certainly for fauna species, and depending on the species, edges can have either a positive or negative impact on habitat quality and quantity (Prevedello et al. 2013, Wellicome et al. 2014). Given the length of the feeder line (approximately 0.8 km) traversing the escarpment vegetation communities, this equates to approximately 1.6 km of edges in the escarpment vegetation corridor, which would have otherwise not existed.

What long-term impacts that these edge impacts could have on the vegetation communities' composition are unknown; in particular their resilience. The escarpment vegetation communities are already under pressure from harvesting of fuel wood and charcoal manufacture, and livestock grazing. Cattle have been shown to substantially increase the edge impacts in savannah habitats (Porensky et al. 2013). Vegetation clearing for the feeder line could facilitate the introduction and spread of invasive plant species throughout the escarpment vegetation communities, as well as create a nick point for erosion and subsequent degradation of adjacent vegetation. These changes could substantially alter the habitat structure and composition, which, in turn, could affect its utilisation by the current species guild. To some extent this may already be occurring. For example, very few medium sized mammals were recorded in the CHAA, and those that were recorded tended to be thicket and dense bushland specialists, such as bushbuck and duiker. The low populations and diversity of these species could also be a reflection of increased pressure for bush meat from the local human population, which has increased markedly over the last ten years (AECOM 2012). It is expected that the existing trends in this regard will increase markedly once people become aware that project construction is imminent.

The 800 m section of the feeder line that will intercept the escarpment vegetation corridor will be routed straight up a 76% (40º) slope. The trench for the pipeline will probably need to be drilled and blasted to achieve the minimum 0.8m depth of cover for rocky ground. During construction, the trenches present a risk of injury and mortality to fauna, in particular smaller mammal and reptile species, which could affect ecosystem composition, albeit in a temporary and localised manner.

If properly managed during construction, including rolling rehabilitation of the buried pipeline once construction is complete, impacts on the ecosystem composition could be minor, nevertheless the potential construction impacts are predicted to be beyond the expected range of natural disturbance perturbations.

■ Ecosystem configuration

The wider Murchison Falls National Park-Budongo-Bugoma-Kagombe-Itwara Forest Reserves-Semliki/Toro Wildlife Reserve corridor is recognised as being important for threatened species in the face of climate change adaptation (Ayebare et al. 2013), and as part of a much broader set of corridors running the length of the Albertine Rift. This corridor in the southern portion of the eastern shores of Lake Albert, in the vicinity of the Project, is very narrow compared to its extent elsewhere, and is recognised as being important for savannah species (Plumptre et al. 2010).

The construction of the pipeline generally requires a 30 m wide construction right-of-way[5] and will involve digging/blasting of a trench for the pipeline, which will then be buried. The construction activity and concomitant environmental disturbances (visual, noise, lighting, physical barrier) are likely to temporarily reduce its value as a wildlife movement corridor.

Indications are that populations of highly mobile wildlife within the area, which may depend on the corridor, are not substantial, and potentially severely depleted (see Section 6.1). In particular, those species that could utilise this corridor, such as large ungulates, predators, primates and birds, are very rare in the area, apart from birds. Nevertheless, during the construction phase, the trenches for the pipeline could present a barrier to movement for fauna, in particular smaller mammal and reptile species. However, the feeder line is not expected to be a barrier for birds; for example, White-backed Vultures were seen moving south down the escarpment corridor during the surveys (see Section 6.1.4). What impact the feeder line could have on the movement of those terrestrial individuals and species that may utilise this corridor is unknown. The corridor is recognised as an important climate change refugium for a range of threatened species, which may become increasingly important for those species in the future (Ayebare et al. 2013).

Direct impacts from the changes to ecosystem configuration on the escarpment as a result of the feeder line are, therefore, predicted to be beyond the expected range of natural disturbance perturbations.

Impact Classification

The vegetation community of the escarpment's sensitivity is medium because these habitats are already under stress from livestock grazing and harvesting of fuel wood and non-timber forest products. However, these communities do form part of a wider, regionally-important wildlife corridor.

Impacts to the representativeness of the habitat will be adverse. The geographical extent of impacts will be local because impacts are restricted to the LSA, and will only constitute a loss of 4.1 ha, in a total area of escarpment vegetation in the CHAA of 2233.8 ha (Table 27). This amounts to 0.18% of the vegetation in the escarpment corridor in the CHAA. The impact is expected to be medium to long term; while rehabilitation of the affected pipeline corridor will occur immediately after construction is completed, the steep and rocky slopes make it unlikely that habitat recovery by plants other than pioneer species will occur in the short-term. Whether there is relatively complete habitat recovery will depend largely on the effectiveness of the rehabilitation strategy. If normal construction management methods are used (without a high degree of specialist rehabilitation intervention), full recovery is unlikely. Nevertheless, the small area affected is not expected to materially impact on the representativeness of the escarpment vegetation corridor, either within the CHAA or at regional scale, and the magnitude of the impacts of the feeder line on representativeness of the vegetation communities of the escarpment is rated as low. Therefore, the magnitude and sensitivity combine to produce a moderate overall impact level to representativeness during the construction phase of the Project, pre-mitigation (Table 28). Following the application of appropriate mitigation measures, the impact significance is expected to be reduced to low, providing that the recommended mitigation measures (rehabilitation of the soil and vegetation cover on top of the buried pipeline) are implemented, with a high degree of management intervention necessary both during and after construction.

Impacts to the ecosystem composition will be adverse. The geographical extent of impacts will be local because impacts are restricted to the LSA. The impact is expected to be medium to long term; while rehabilitation of the affected pipeline corridor will occur immediately after construction is completed, the steep and rocky slopes make it unlikely that habitat recovery by plants other than pioneer species will occur in the short-term. There is also potential for changes to the vegetation community composition to occur through the introduction or spread of invasive plant species, often themselves pioneer-type species. The magnitude of the impact on ecosystem composition is medium because, prior to any mitigation, the potential for changes to ecosystem composition potentially brought about by edge effects is possible. Therefore, the magnitude and sensitivity combine to produce a moderate overall impact level to ecosystem composition during the construction phase of the Project, pre-mitigation (Table 28). Following the application of appropriate mitigation

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[5] The construction right-of-way (ROW) has been set at 30 m for the purposes of impact assessment; however typically the ROW will vary according to site circumstances – e.g. for straight sections of pipeline the ROW will be approx. 24 m, whereas for rivers and road crossings, the ROW may need to be 50 m wide.

measures (rehabilitation of the soil and vegetation), vegetation recovery to primary levels of succession would be expected in the short term, with further recovery in the medium and long-term (dependent on a high degree of management and specialist intervention both during and after construction); therefore the impact significance is expected to be reduced to minor, as the magnitude will become negligible, and the sensitivity of the receptor will remain the same.

Impacts to the ecosystem configuration will be adverse. The geographical extent of impacts will be regional because impacts are restricted to the CHAA. Impact duration will be medium-term (that is ~25 years) because impacts are expected to continue through the Project operations. The magnitude of the impact on ecosystem configuration is medium because, prior to any mitigation, the potential for changes to ecosystem configuration is possible, especially interference with wildlife movement corridors. Therefore, the magnitude and sensitivity combine to produce a moderate overall impact level to ecosystem composition during the construction phase of the Project, pre-mitigation (Table 28). Following the application of appropriate mitigation measures, the impact significance is expected to be reduced to minor, because the burial and rehabilitation of the pipeline will restore habitat connectivity for fauna using the escarpment corridor.

Table 28: Potential impacts in the construction phase to the vegetation communities of the escarpment

Indicator of potential impact	Pre-mitigation			Post-mitigation (pre-offsets)		
	Magnitude	Sensitivity of the Receptor	Significance	Magnitude	Sensitivity of the Receptor	Significance
Representativeness	Low - 2	Medium – 3	Moderate – 6	Negligible – 1	Medium – 3	Minor - 3
Ecosystem composition	Medium – 3	Medium – 3	Moderate – 9	Negligible – 1	Medium – 3	Minor - 3
Ecosystem configuration	Negligible – 1	Medium – 3	Minor - 3	Negligible – 1	Medium – 3	Minor - 3

Prediction Confidence

Given the information available, there is a reasonable understanding of the potential impacts of the feeder line to the vegetation communities of the escarpment, and the wildlife corridors of which they form part. However, there is some uncertainty in regard to the irreplaceability and vulnerability of those habitats in the CHAA. Given the current uncertainty in relation to climate change and possible scenarios, as well as increasing human pressures, how important these habitats will become in the future is uncertain. Indications are that they will increase in importance (Ayebare et al. 2013), provided human pressures do not overwhelm them.

The spatial extent of habitats in the CHAA was broadly mapped based on knowledge of the site, baseline studies, literature and reports (see Section 7.1.2). The actual extent of possible habitat may have been over-estimated.

11.1.1.3 What impact could the construction of the Feeder line have on wetlands and riparian habitat in the CHAA?

Impact Indicators

Indicators used to assess impacts of the Feeder line on the habitat and ecosystem integrity of the wetlands of the CHAA were changes in: regional representativeness; ecosystem composition; and ecosystem configuration.

Loss of habitat due to direct disturbance and clearing associated with the Feeder line was quantified by overlaying the current, baseline extent of the vegetation communities with the Feeder line footprint, plus a 30m construction right of way.

Additional, indirect impacts to habitat were estimated by applying a 0.50 km buffer to the Feeder line footprint. Specifically, the buffer was selected to account for changes in habitat quantity and/or quality that could be caused by edge effects, fragmentation, sensory disturbance, changes in water quantity and quality (drivers of ecosystem processes and functions), and air emissions and dust.

Changes in habitat composition and ecosystem configuration were assessed by identifying potential changes in species composition that could occur, and the disruption of known corridors. This was accomplished by examining available scientific literature about the ecology of wetlands (permanent and seasonally flooded grasslands).

Impact Assessment

■   Representativeness

The CHAA supports approximately 1157.9 ha of wetlands, of which 85.3 ha are classified as seasonal. In addition, 840 ha of riparian vegetation communities associated with drainage lines and riparian systems occur within the CHAA. Table 29 quantifies the impact of the pipeline on the CHAA wetlands and riparian habitats, based on the area of physical disturbance during construction.

Table 29: Area of wetland and riparian habitat impacted along the 30m wide pipeline construction right of way

Habitat	Area in the CHAA (ha)	Area in the 30m-wide pipeline corridor (ha)
Cultivation and Settlement	31860.9	108.9
Dense Bushland	1097.6	1.6
Dense Wooded Grassland	613.2	1.7
Open Bushland and Shrubland	2896.3	14.9
Open Grassland	568.5	3.1
Wooded Grassland	184,3	3.9
Open Wooded Grassland	1900.9	0.8
Riverine Woodland and Bushland (riparian habitat along drainage lines)	74.8	0.0
Riverine Bushland (riparian habitat along drainage lines)	640.3	1.6
Seasonal Wetland	85.3	0.6
Permanent Wetland	83.8	0.0
Wetland	1072.6	0.4

Approximately 2.6 ha of wetlands, seasonal wetlands and riparian habitat along drainage lines will be directly affected, which is 0.13% of the total area of similar wetland and riparian habitat in the CHAA. Further indirect impacts could result from edge effects and channel incision, affecting downstream wetland function. The loss of this quantity of wetlands in relation to their representation in the wider CHAA is not substantial; however, because this loss is brought about by the construction of a linear feature, there is a potential for the downstream wetland habitat to be affected if proper management controls are not implemented.

Impacts from the changes to representation of the wetlands in the CHAA are predicted to be beyond the expected range of natural disturbance perturbations.

■   Wetland and Riparian Habitat Structure and Ecosystem Composition

The construction of linear infrastructure, such as pipelines, through wetland communities is known to have detrimental impacts on the functioning, processes and species composition of these communities (Roise et al. 2004). Pipeline construction may result in significant loss of biodiversity at both local and regional scales due to restricted movement between populations, increased mortality, habitat fragmentation and edge effects, invasion by exotic species, or increased human access to wildlife habitats, all of which are expected to increase local extinction rates or decrease local recolonisation rates (Findlay and Bourdages 2000). Consequently, it could be expected that the construction of the pipeline through wetlands and riparian habitats, could alter the ecosystem processes and functions driving these wetlands, especially downstream.

Buried pipelines crossing rivers and wetlands will not (of themselves) obstruct surface water flow. The risk to wetland function is mainly due to the disruption of wetland vegetation and soils by heavy machinery, particularly when tracked vehicles are used that have greater impact on soil structure and the soil profile is overturned due to careless construction management. Disruption of flows and ecosystem composition may also occur if fill material is imported into the wetland to provide stability for excavators and pipe layers, and is not completely removed and replaced with the natural soils after construction.

Alteration of wetland and riparian vegetation community composition could occur if flow paths for water, both surface and sub-surface, are not maintained. If these flow paths are not maintained, there is a potential that wetland vegetation community composition downstream of the obstruction could become altered – typically via flow concentration and channel incision in downstream wetlands that were previously supplied by diffuse, dispersed flows. The risk of incised drainage and associated loss of wetland function due to concentration of water flows is high. The vegetation within the seasonally flooded grasslands and riparian habitats is adapted to seasonal inundation, and, therefore, is dependent upon that cycle of wet and dry for survival. Additional, associated impacts that could occur in tandem with channel incision and wetland desiccation include exotic species invasion.

As part of standard construction methods, culverted wetland/drainage line crossings have been installed as part of the in-field road and airstrip construction. Nevertheless, even with such measures in place, there is still a potential for changes to the structure and ecosystem composition of wetland and riparian habitats to occur.

The wetland and riparian vegetation communities on the escarpment are already under pressure from livestock grazing, and harvesting of fibre for house construction. It is possible that these communities may change in the long-term as grazing pressure increases, and the human population of the region increases (Golder Associates 2014e). These changes could alter the habitat structure and composition, which, in turn, could affect the utilisation of these habitats by the currently resident species guilds.

Impacts on wetland and riparian fauna will depend on the changes in vegetation communities as a result of construction; in addition, the noise and sensory disturbances created by the construction equipment could alter the behaviour of species frequenting the wetlands during construction/decommissioning. For example, wading birds and Grey Crowned Cranes are unlikely to tolerate construction nuisance within 500 m and could avoid these areas entirely during the construction period. If construction occurs during the breeding season of the Grey Crowned Crane (that is, the dry season (Archibald et al. 2013)), which could occur in wetlands on the escarpment, then disturbance from the construction activities could cause nest abandonment (Strasser et al. 2013).

Impacts to ecosystem composition of the wetlands in the CHAA are predicted to be beyond the expected range of natural disturbance perturbations.

■   Water Quality and Ecosystem Composition

Impacts to ecosystem composition of the wetlands in the CHAA are predicted to be beyond the expected range of natural disturbance perturbations.

Erosion and Sedimentation

The construction of the feeder line could cause increased erosion and sediment-laden run-off to report to the wetlands and riparian habitats being crossed by the pipeline. With the construction of the pipeline, and the

consequent exposure of areas of soil, there is a potential that, without adequate erosion and sediment control measures in place, sediment loads within the watercourses draining the pipeline footprint could increase. Hence, there is a potential for increased sediment loads in the wetland and riparian habitats. The watercourses and associated wetlands draining the LSA support dense emergent vegetation (see Section 6.1.1). Such vegetation can form an impactive filter for most sediment (IECA 2008); therefore, it can be expected that sediment loads reporting to downstream wetland and riparian habitats could be minimal. Nevertheless, if sediment loads are substantial, there is a potential for that sediment to smother wetland vegetation and interfere with aquatic invertebrates. If this occurs, it could detrimentally affect the wetland and riparian processes and functions, which, in turn, could alter wetland and riparian community composition, albeit on a localised scale.

Hydrocarbon and Chemical Spills

Accidental spillage of fuels and chemicals during the construction of the feeder line are probable, where most construction activities will take place over a period of 10-12 months. Certain invertebrate species (for example, aquatic snails (Araujo et al. 2012), mayflies (Savić et al. 2011)) and juvenile fish (for example, Agamy 2013) are highly sensitive to chemical pollutants, particularly hydrocarbons; therefore, accidental spillages during construction could detrimentally affect aquatic species as well as the wetland and riparian habitat processes and functions, which, in turn, could alter ecosystem composition, albeit on a localised scale.

Sewage Disposal

Sewage at the personnel camp will be treated by a package sewage treatment plant, designed to comply with the Ugandan requirements for effluent disposal and the IFC guidelines for domestic wastewater. Treated effluent will be discharged into a soakaway. The personnel construction camp is situated more than 500 m from the nearest drainage line/riparian habitat, and since the discharge will be to a soakaway, potential impacts are discussed under Groundwater.

Increase in Population

Indirect impacts on wetlands and riparian habitats as a result of water quality impacts could occur as a result of the migration of people into the CHAA in search of work. Existing sanitary conditions in the CHAA are poor, with all of the streams being contaminated with faecal waste from both animals and humans (Social Impact Assessment). Increasing population pressures will exacerbate these conditions. Increased grazing pressure and erosion from denuded areas around expanding settlements will increase erosion and sedimentation in the wetlands.

■ Ecosystem configuration

Linear infrastructure such as pipelines can present significant barriers to, or can alter behaviours of, a range of wetland and riparian wildlife, from: amphibians (for example, Pontoppidan et al. 2013); to turtles (for example, Langen et al. 2012). The construction of the pipeline through the wetlands and riparian habitats of the CHAA could present a barrier to movement for those species inhabiting them, during those project phases. However, the pipeline will be buried, therefore once construction is complete, they are not expected to be major barriers.

The pipeline will cut currently contiguous wetlands in the LSA. If not managed correctly during the construction process, that is, the installation of appropriate drainage connections, the pipeline could cause permanent barriers between the two newly separated wetland habitats. The process of clearing the wetlands for the construction of pipeline will create edge impacts, and result in the fragmentation of the wetland habitats. As already discussed, vegetation clearing creates edges or boundaries where habitat meets a disturbance. These edges open up habitat in areas where it was previously continuous, and this generally changes the abiotic conditions (for example, temperature, light, and moisture regimes) (Porensky and Young 2013). Edges also often result in changes in species composition along the edge, with the edges typically becoming dominated by pioneer and weedy species adapted to the particular microclimate experienced on the edge (Porensky and Young 2013). Fragmentation of wetland habitat is known to reduce the viability of many species and the wetland as a whole, with the viability of the particular fragment dependent on its size, proximity and, hence,

connectivity to other wetland habitats (Uzarski et al. 2009). These wetland communities are already under pressure from livestock grazing, and harvesting of fibre for house construction.

Impacts to ecosystem configuration of the wetlands and riparian habitats in the CHAA are therefore predicted to be beyond the expected range of natural disturbance perturbations.

Impact Classification

The sensitivity of wetlands and riparian habitats is high, because permanent and seasonal wetlands are important breeding and foraging habitat for Grey Crowned Crane, a species of concern; and wetlands are susceptible to degradation as a result of changes in water flow patterns brought about by infrastructural developments. The habitats are also already under stress from livestock grazing and harvesting of fibre. This high sensitivity is weighed against the magnitude of each of the impacted indicators as described in the paragraphs below, in order to derive the overall impact level for each indicator.

- Representativeness

Impacts to the representativeness of the habitat will be adverse. The geographical extent of impacts will be local because impacts are restricted to the feeder line construction right of way on the escarpment, and will only constitute loss of approximately 0.13% of wetland and riparian habitat in relation to the CHAA. The magnitude of the impacts of the feeder line on representativeness is therefore considered to be low. In the context of high wetland sensitivity, this results in impacts of moderate significance.

Following the application of appropriate mitigation measures, the impact significance is expected to be reduced to minor, as rehabilitated wetlands re-establish following completion of construction activities.

- Wetland Structure and Ecosystem Composition

Impacts to the ecosystem composition will be adverse. The geographical extent of impacts will be local because impacts are restricted to the LSA. Impact duration will be medium-term, because impacts are expected last as long as it takes the wetland rehabilitation to become established post-construction. The magnitude of the impact on ecosystem composition is low because, although changes to wetland structure and ecosystem composition in wetland areas crossed by the feeder line are likely, which could result in edge effects, changed flow regimes, and erosion and sedimentation of affected wetlands, the extent of the area affected is relatively small. Therefore, the magnitude and high sensitivity of the wetlands combine to produce a moderate overall impact level to ecosystem composition during construction of the feeder line, pre-mitigation (Table 30).

Following the application of site-specific mitigation measures (Section 12.2), including appropriate construction management methods, the impact significance is expected to be reduced to minor, because, as the magnitude will become negligible, the sensitivity of the receptor will remain the same.

- Water Quality and Ecosystem Composition

Impacts to the ecosystem composition will be adverse. The geographical extent of impacts will be local because impacts are restricted to the LSA. Impact duration will be for the duration of construction, which is expected to take approximately 3 years. The magnitude of the different project-specific impacts on ecosystem composition varies, as discussed under each of the subheadings below.

Erosion and Sedimentation

Clearing of vegetation will result in increased sediment loads in stormwater flows. These impacts will be of short duration, most likely occurring as a result of significant rain events, and will be most frequent in the early stages of construction when bulk earthworks are in progress and large areas of exposed earth are available. Impacts will be local (mainly in the catchment of wetlands that will be crossed by the pipeline). They will generally be reversible, and, consequently, have a low magnitude in the context of the feeder line construction. Wetland and riparian plant species are generally tolerant of occasional increases in sediment load in stormwater flows, and can serve as an effective sediment filter. In cases of severe and/or ongoing sediment

loading, detrimental impacts on wetland and riparian vegetation and macro-invertebrates could be likely, which could detrimentally affect wetland processes and functions and, in turn, wetland composition at a localised scale. The high wetland and riparian habitat sensitivity, in combination with the low magnitude of predicted effects, will result in a moderate overall impact level to ecosystem composition during construction of the Project, pre-mitigation (Table 30).

Following the application of appropriate mitigation measures, the impact significance is expected to reduce to minor.

Hydrocarbon and Chemical Spills

The baseline concentrations of hydrocarbons and other industrial pollutants in the wetlands and riparian habitats of the LSA were below levels that cause harm in the aquatic environment (Golder Associates 2014b). Some invertebrate species (such as aquatic snails, described in Araujo et al. 2012), mayflies (Savić et al. 2011)) and juvenile fish (Agamy 2013) are particularly sensitive to these pollutants.

Equipment working in the wetlands could contribute small quantities of oil into the aquatic environment as a result of leakages or spills. Hydrocarbon spills will only occur if insufficient care is taken during construction to prevent them, and will have a low probability of occurrence. In the absence of daily monitoring and management of site activities by competent personnel, an impact of low magnitude could occur, resulting in an overall impact of moderate significance (Table 30).

Following the application of appropriate mitigation measures, the impact magnitude is expected to reduce to negligible, which in combination with the high sensitivity of the wetland habitat, results in an overall impact of minor significance.

Increase in Population

In the absence of project interventions, the impact of increased population density (and associated increases in grazing livestock) on the Buhuka Flats is expected to be long-term, and to have a material effect on water quality in the wetlands across the Flats through reductions in sanitary water quality, exacerbation of wetland erosion, increased harvest of plant species used for traditional home construction, increased fire frequency and increased grazing pressure. The effects will be irreversible, and of medium magnitude. In the context of the high wetland sensitivity, the predicted impact significance is major, prior to mitigation (Table 30).

Following the application of appropriate mitigation measures, including appropriate construction management methods, the impact significance associated with population increase is expected to remain moderate, as although the magnitude will become low, the sensitivity of the receptor will remain the same.

■ **Ecosystem Configuration**

Impacts to the ecosystem configuration will be adverse. The geographical extent of impacts will be local because impacts are restricted to the LSA. Impact duration will be short-term and reversible, subject to the avoidance of permanent structural damage at the crossing points and the length of time that the rehabilitated crossing points (wetlands and riparian bank vegetation) takes to successfully re-establish. Taking into consideration the very localised geographic extent of construction through the wetlands and small drainage lines and the intensive cultivation in all of the surrounding areas, as well as the fact that the pipeline will be buried, the magnitude of impact is considered to be low.

Combined with the high sensitivity of wetland and aquatic environments, the overall impact on wetland and drainage line configuration, without mitigation, is expected to be of moderate significance. This suggests that project-specific measures will be necessary to minimize the impacts of construction equipment operating in the wetlands and drainage lines.

Following the application of project-specific mitigation measures (Section 11.2), the impact significance is expected to be reduced to minor (Table 30).

Impact Significance Rating

Table 30: Potential impacts of construction of the feeder line on the wetlands of the CHAA

Indicator of potential impact	Pre-mitigation			Post-mitigation (pre-offsets)		
	Magnitude	Sensitivity of the Receptor	Significance	Magnitude	Sensitivity of the Receptor	Significance
Representativeness	Low - 2	High – 4	Moderate – 8	Negligible – 1	High – 4	Minor - 4
Ecosystem composition – wetland structure	Low - 2	High – 4	Moderate – 8	Negligible – 1	High – 4	Minor - 4
Water quality						
Erosion and sedimentation	Low – 2	High – 4	Moderate – 8	Negligible - 1	High – 4	Minor - 4
Hydrocarbon and chemical spills	Low – 2	High – 4	Moderate – 8	Negligible - 1	High – 4	Minor - 4
Population increase	Medium – 3	High – 4	Major – 12	Low – 2	High – 4	Moderate – 8
Ecosystem configuration	Low – 2	High – 4	Moderate – 8	Negligible - 1	High – 4	Minor - 4

Prediction Confidence

Given the information available, there is a reasonable understanding of the potential feeder line impacts to the wetlands of the CHAA. However, there is some uncertainty in regard to the irreplaceability and vulnerability of those habitats in the CHAA. Given the current uncertainty in relation to climate change and possible scenarios, as well as increasing human pressures, how important these habitats will become in the future is uncertain.

The spatial extent of habitats in the CHAA was broadly mapped based on knowledge of the site, baseline studies, literature and reports (see Section 6.3.1.1.1). The actual extent of possible habitat may have been over-estimated.

11.1.1.4 What impact could the construction of the Feeder line have on Bugoma CFR?

Impact Indicators

Bugoma Central Forest reserve (Bugoma CFR) will not be directly affected by pipeline construction, which at its nearest point will be at least 1,8 km from the Bugoma CFR boundary. The indirect impacts of population influx, due to expectations of work on the construction contract, are considered since this could impact on the forest reserve.

A formal impact classification based on indicators was developed for induced and cumulative impacts to the Bugoma Central Forest Reserve; the impacts are discussed, and their significance assessed through a **reasoned narrative**. An overall impact significance classification was then developed. This was accomplished by examining available literature about the ecology of the Bugoma Central Forest Reserve (BCFR), and scientific literature regarding the effects of migration and human population pressure on forests in Africa.

The impacts were assessed in light of the guidance provided by IFC (2013), and in consideration of other known projects being developed in the wider area. In particular, the development of the oil processing facility

at Kabaale, the oil developments around the Kaiso-Tonya area (AECOM 2012), the Hoima-Mputa-Fort Portal-Nkenda power line, and the potential for regional population increases in the wider area.

Impact Analysis

Bugoma CFR is identified as a valued component for this impact assessment, certainly in terms of biodiversity (see Section 6.3.1.1.4). As identified in that section, apart from being one of the last stands of tropical semi-deciduous forests in the region, it also supports known populations of the Endangered Eastern Chimpanzee and range-restricted Nahan's Francolin (Plumptre et al. 2011), potential non-breeding habitat for the Endangered Madagascar Pond Heron (see Section 6.3.3.1), as well as elephants and a host of other threatened and irreplaceable species.

Although Bugoma CFR will not be directly affected by pipeline construction, which at its nearest point will be at least 1,8 km from the Bugoma CFR boundary, the indirect effects of project-induced migration to the pipeline construction region due to expectations of work on the construction contract have the potential to affect the ecological integrity of the habitats within the CFR, as well as the species of conservation concern that occur within it.

Bugoma CFR is under severe pressure from the human population surrounding it. In 2013, more than 1,500 people evicted illegally after settling within the forest (Mugerwa 2013), and recent (2016) reports from the area suggest that land-grab activity has resulted in the conversion of an estimated 8000 ha for sugar cane plantation development. The land cover study (see Figure 4) clearly shows that the areas surrounding the forest have largely been transformed for agricultural and subsistence purposes, and the transformation is now encroaching within the boundary of the CFR. This trend of encroachment of protected areas is not unique. Protected areas are known to be particularly vulnerable to changes in human demographics and deforestation; and Wittemyer et al. (2008) identified that human population growth and encroachment around protected areas is significantly higher than the average population growth in rural areas. This difference was largely due to the immigration of people into these areas because of the perceived increased availability of opportunities, natural resources and potential jobs (Wittemyer et al. 2008). This is supported by research conducted in the forests of the Albertine Graben, and the wider CHAA. For example, in a study of Budongo Central Forest Reserve, Zommers and MacDonald (2012), identified that of the local communities that hunted bush meat in the forest, nearly 73% were immigrants to the area. Furthermore, these workers identified that the households of immigrants were also more likely to be involved with deforestation.

The results of the recently-updated (Nov 2017) social baseline data gathering fieldwork indicated that in-migration to the CHAA has escalated significantly since the opening of the escarpment road, and commencement of preliminary construction works at the Kingfisher Development Area.

An Influx Management Strategy and Framework Plan (Golder Associates 2018) was developed to manage the potential influx of people into the LSA. However, this plan can only focus on those measures over which CNOOC has control, and to support the range of government and donor projects in Uganda aimed at socio-economic development and environmental conservation. How this translates to the potential influx of people towards the feeder line route and construction camp is unknown.

Impact Classification

Indirect impacts on Bugoma CFR due to population influx to the region during construction of the feeder line will be adverse. The geographical extent of impacts will be regional because effects are restricted to Bugoma CFR, in the CHAA. Impact duration will be short-term (that is, limited to the construction phase of the feeder line, that is, 10-12 months). The magnitude of the effects of population influx associated with pipeline construction on the Bugoma Central Forest Reserve is expected to be low, given the short duration of the construction period, and the distance of the construction activities from the Bugoma CFR boundary.

The sensitivity of the Bugoma Central Forest Reserve is high because it is a threatened ecosystem that is already under pressure. Therefore, the intensity and sensitivity combine to produce a moderate overall impact level during the construction phase of the pipeline, prior to the implementation of strict Project-specific mitigation measures (**Table 31**).

The mitigation hierarchy is an important process that has been used to minimise impacts to Bugoma CFR. The focus for the continued use of the mitigation hierarchy during the feeder line construction phase will be continued development and implementation of mitigation measures through monitoring and adaptive management (see Section 12.0).

With the implementation of such mitigation measures, the impact significance is expected to decrease to minor, primarily because the magnitude of impact could become negligible, and the sensitivity of the receptor will remain the same (**Table 31**).

Table 31: Potential impacts in the construction phase to the Bugoma Central Forest Reserve

	Pre-mitigation			Post-mitigation (pre-offsets)		
	Magnitude	**Sensitivity of the Receptor**	**Significance**	**Magnitude**	**Sensitivity of the Receptor**	**Significance**
Habitat and ecosystem integrity	Low – 2	High – 4	Moderate – 8	Negligible – 1	High – 4	Minor – 4

As noted above, the focus for reducing impacts to the Bugoma Central Forest Reserve is mitigation to lessen various types of disturbance that may occur (Section 12.0). Optimising mitigation will reduce residual impacts on the CFR to minor, and reduce the need for offsetting. However, possible offsetting options to ultimately achieve 'net gain' for the natural habitats of the forest have been identified and are discussed in Section 13.0.

11.1.2 What impact could the construction of the Feeder line have on species of concern?

This section presents the assessment of impacts that the construction of the Feeder line could have on those species of concern that trigger critical habitat, as identified in Section 8.0; that is, the Mud Snail (*G. candida*), Nahan's Francolin, and Eastern Chimpanzee; as well as Grey Crowned Crane which was also included as a valued component (see Table 25). Potential impacts to other species of concern are assessed at the habitat level (see Section 11.1.1).

Only Mud Snail and Grey Crowned Crane are potentially directly affected by construction of the feeder line. Other species, including the Eastern Chimpanzee and Nahan's Francolin, occur in the Bugoma Central Forest reserve (BCFR) but are not directly affected by pipeline construction, which at its nearest point will be at least 1,8 km from the BCFR boundary. The indirect impacts of population influx, due to expectations of work on the construction contract, are considered since this could impact on the forest reserve and the species of concern that it supports.

11.1.2.1 What impact could the construction of the Feeder line have on the Mud Snail?

The Mud Snail (*Gabbiella candida*) is a Critically Endangered and range restricted species. Currently, the only known populations occur around Butiaba (see Section 9.1.1.1), which is on the eastern shore of Lake Albert approximately 90 km north of the LSA. Although this species was not confirmed within the CHAA during the course of baseline studies, there is a potential that this species could occur in the near-shore habitats of the CHAA, based on its known habitat preferences, and those of other Mud Snail species (*Gabbiella* spp.), which have previously been recorded in both the same locality as this species at Butiaba, as well as in the LSA. Hence, a precautionary approach has been adopted, and *G. candida* is assumed to occur in the near-shore habitats of the CHAA.

Impact Indicators

No habitat loss due to direct disturbance and clearing of habitat is expected during construction of the feeder line, as these habitats lie outside that portion of the LSA. It is unlikely that construction of the feeder line could alter the habitat connectivity of the near-shore habitats in the CHAA. No structures are being put in place that will alter the natural connectivity of the aquatic habitats of the lake. It is expected that the connectivity amongst the aquatic habitats will remain the same during construction as they were during baseline.

Predicted construction phase impacts of the feeder line on the Mud Snail were therefore limited to the proposed discharge of hydrotest water to Lake Albert and subsequent effects on habitat quality.

The assessment of changes to habitat quantity and quality was focussed on the prediction of changes to water quality in the water column from construction-related activities.

Impact Assessment

■ Habitat Quality and Quantity

Very little information is available for this species. Information about the genus *Gabbiella* indicates that this group is generally found in lakes, rivers and, less commonly, in small water bodies, and rarely in habitats that dry out (Kristensen and Stensgaard 2010). Two sister species (*G. humerosa* and *G. walleri*) were recorded in the LSA (see Section 3.3.2.4, APPENDIX C). These two species have also been recorded in the same locality and habitat as *G. candida* (GBIF, 2014). Therefore, the habitat preferences of those two species were used as a model to predict the potential impacts of changes to habitat quantity and quality for this species.

The two sister Mud Snail species recorded from the CHAA were collected from bottom substrates in the open sandy shore habitats in the LSA. These habitats are characterised by a gently sloping lake bed extending from the shore line to deeper water. The substrate is typically comprised of sand and finer sediments (Wandera and Balirwa 2010). This habitat constitutes approximately linear (lake shore) 10.5 km of the CHAA; however it should be noted that the near-shore habitat is located well beyond the feeder line construction right-of-way.

Despite the large buffering capacity of Lake Albert, the proposed direct discharge of the feeder line hydrotest water to Lake Albert could ultimately report to the near-shore habitats of the CHAA, with subsequent effects on the Mud Snail.

Aquatic snails are highly sensitive to chemical pollutants, particularly hydrocarbons (Araujo et al. 2012). Currently, the concentrations of hydrocarbons and other pollutants in the lake waters of the near-shore habitats are below levels that could cause harm to the environment (Golder Associates 2014b); this is supported by the healthy aquatic communities that were observed in the lake's near-shore habitats at baseline (see Section 6.2). As such, the direct discharge of the hydrotest fluid to Lake Albert could have a detrimental impact on the near-shore habitats of the LSA through the introduction of toxic compounds and pollutants, and subsequent effects on the Mud Snail.

Impacts on habitat quality and quantity for *G. candida* arising from discharge of the feeder line hydrotest fluid following construction are predicted to be beyond the expected range of natural disturbance perturbations. Potential loss of critical habitat for the Mud Snail requires the consideration of offsets to meet IFC requirements.

Impact Classification

The Mud Snail's sensitivity is high because this species is Critically Endangered, and potentially triggers a Tier 1 critical habitat designation.

Impacts to the Mud Snail's habitat quantity and quality will be adverse. The geographical extent of impacts will be local because impacts are restricted to the LSA. Although the impact duration will be short-term, and should be reversible with time as the Lake waters dilute and disperse the contaminants, the magnitude of the impacts of a potentially-toxic discharge to *G. candida's* habitat could be high. Therefore, the magnitude and sensitivity combine to produce a major overall impact on habitat quality and quantity as a result of contamination, prior to the implementation of the recommended mitigation (Table 32).

The strict application of the recommended mitigation measures (Section 12.2) will reduce the risk, and thus the likely magnitude, of potential habitat contamination for the Mud Snail, reducing the overall impact significance to moderate.

Table 32: Potential impacts in the construction phase to the Mud Snail

Indicator of potential impact	Pre-mitigation			Post-mitigation (pre-offsets)		
	Magnitude	Sensitivity of the Receptor	Significance	Magnitude	Sensitivity of the Receptor	Significance
Habitat quality and quantity	High – 4	High – 4	Major - 16	Negligible - 1	High - 4	Minor - 4

Prediction Confidence

Given the information available, there is a reasonable understanding of the potential Project impacts to the near-shore habitats of the CHAA, and hence potential local populations of Mud Snail. However, there is some uncertainty with regard to this species actually occurring in the CHAA. As such, the above assessment has been undertaken based on a precautionary approach.

The spatial extent of the near-shore habitats in the CHAA was broadly mapped based on knowledge of the site, baseline studies, literature and reports (see Section 6.3.1.1.1). The actual extent of possible habitat may have been over-estimated.

11.1.2.2   What impact could the construction of the Feeder line have on Grey Crowned Crane?

The Grey Crowned Crane is an Endangered species. Up to 14 individuals were regularly recorded on the Buhuka flats during baseline surveys, and a pair of Grey Crowned Crane was observed on the Flats near Well Pad 1 during social baseline survey work conducted in November 2017. The local population of Grey Crowned Crane is regarded as highly sensitive, and the wetlands of the CHAA are considered an important conservation unit for the species.

The construction of the Feeder line could directly impact Grey Crowned Crane breeding and foraging habitat, given that construction impacts on wetlands above the escarpment are expected (Section 10.1.1.2).

The potential direct, indirect and induced impacts of the construction of the Feeder line on Grey Crowned Crane are presented below.

Impact Indicators

Indicators used to assess effects of the construction of the Feeder line on Grey Crowned Crane were: habitat quantity and quality, habitat connectivity, abundance and distribution, and survival and reproduction.

Habitat loss due to direct disturbance and clearing of habitat was assessed by calculating the loss of suitable habitat from the CHAA as a result of the construction of the Feeder line, consisting of a 30m construction right of way. Changes to habitat quality due to indirect disturbance were estimated by applying a 200m buffer to the pipeline footprint. Specifically, the buffer was selected to account for changes in habitat quantity and/or quality caused by indirect disturbance arising from light, noise, vibration, and edge effects.

Changes in habitat connectivity were assessed by identifying potential barriers to movement and loss of corridors. This was accomplished by visually examining the spatial distribution of critical habitat for Grey Crowned Crane in relation to the Feeder line to qualitatively identify areas where habitat becomes fragmented.

Potential changes in abundance and distribution, and survival and reproduction were assessed qualitatively by considering changes in disturbances (that is, vehicle traffic, light, noise, vibration) and site clearing activities.

These disturbances were considered in light of known or inferred effects to the survival and reproduction of Grey Crowned Crane, where data on these types of effects are available.

Impact Assessment

- Habitat Quality and Quantity

Grey Crowned Crane is distributed across eastern and southern Africa. Populations in many areas including Uganda have experienced rapid declines during the past 45 years (BirdLife International, 2018) for reasons including habitat loss to farming, human presence causing disturbance, collection of chicks for domestication, disruption of breeding activity, loss of roosting sites (large trees located remotely from areas frequented by humans) and dry-season fires in wetland habitats (Olupot, 2014). Its habitat preferences are diverse, including wetlands with tall emergent vegetation, open riverine woodland, shallowly flooded plains and temporary pools with adjacent grasslands, open savannas, croplands, pastures, fallow fields and irrigated areas (Archibald et al, 2018). It prefers short to medium height open grasslands adjacent to wetlands for foraging, which is consistent with the seasonally flooded grassland wetlands in the Buhuka Flats. For breeding, it prefers marshes with water 1 m deep and emergent vegetation 1 m above the water (Archibald et al, 2018); habitat which corresponds to the permanent wetlands of the Buhuka Flats. They are also often found foraging in agricultural land wherever available, in close proximity to the preferred mixture of wetlands and open grassland or savanna (Morrison, 2015).

Approximately 2.6 ha of wetlands, seasonal wetlands and riparian habitat along drainage lines will be directly affected by the construction of the pipeline, which is 0.13% of the total area of similar wetland and riparian habitat in the CHAA. In the context of available foraging and breeding habitat in the CHAA for Grey Crowned Crane, the direct losses are not substantial.

Although Grey Crowned Crane can tolerate a degree of anthropogenic disturbance in foraging habitat (e.g. in agricultural lands), in Ugandan wetlands it has been observed to be intolerant of human proximity within 100-200m (Olupot, 2014), flying away on approach; a factor which also affects breeding success as breeding birds flush from nests on approach, causing increased rates of predation, reduced time at the nest (either incubating or feeding), and ultimately nest abandonment. How tolerant foraging/roosting/breeding Grey Crowned Crane may be to indirect disturbances, such as noise, light, vibration and edge effects, is not known. The application of a 200m buffer around the 120 m length of the Feeder line that intercepts wetlands indicates that approximately 2.4 ha of wetland habitat will be reduced in quality as a result of sensory disturbance.

This equates to a total potential habitat loss in the CHAA from direct losses from vegetation clearing, and indirect losses from sensory disturbances and edge effects of up to 5 ha (0.43%).

Effects from loss of habitat are predicted to be beyond the expected range of natural disturbance perturbations (for example, fire), although not beyond the human-induced rate of degradation via cattle grazing pressure etc.

- Habitat Connectivity

The impact of the feeder line construction as a barrier to the movement of Grey Crowned Crane is likely to be adverse. The construction activity will create sensory disturbances in the short-term, which can elicit reduced use or complete avoidance of affected areas, thereby creating temporary movement barriers (for example, see Kolowski and Alonso 2009, Gleeson and Gleeson 2012). Construction of linear infrastructure (pipelines and service roads) through wetlands has the potential to create temporary barriers to movement as a result of the associated disturbance due to human presence in the area.

Impacts on habitat connectivity are predicted to be beyond the expected range of natural disturbance perturbations.

- Abundance and Distribution

Up to 14 individuals of Grey Crowned Crane were frequently observed on the Flats during the baseline fieldwork conducted in 2014, and a pair were observed in the same area during social baseline fieldwork

conducted in November 2017. Grey Crowned Crane has potential to nest in wetland habitats and forage in the wetland/grassland/cultivated lands mosaic that occurs throughout the CHAA.

For the purposes of this assessment, it is assumed that Grey Crowned Crane is present in suitable habitat (permanent and seasonal wetlands) in the CHAA. The construction of the Feeder line is likely to generate increased levels of sensory disturbance in the locality, with resultant effects on habitat quality and the distribution of the species. Although significant losses of preferred seasonal grassland-type foraging habitat to the Feeder line construction right-of-way could affect the abundance and distribution of Grey Crowned Crane in the CHAA; the predicted potential habitat loss amounts to 5 ha or (0.43%) of similar habitat in the CHAA, which is miniscule in the context of the available foraging habitat for cranes, which includes wetlands and agricultural lands.

Effects on the abundance and distribution of Grey Crowned Crane are predicted to be beyond the expected range of natural disturbance perturbations.

■ Survival and Reproduction

During the baseline fieldwork conducted in May 2014, the formation of breeding pairs of Grey Crowned Crane was indicated. Grey Crowned Crane nests are typically constructed within or on the edges of marshes with water of 1m depth and emergent vegetation 1m high (BirdLife International, 2018). Loss and disturbance of wetland habitat in the CHAA is expected to decrease the likelihood of Grey Crowned Crane selecting these areas for breeding.

Above the escarpment, migration into the area due to expectations about work on the construction projects could result in increased settlement in the CHAA. In the vicinity of the areas of permanent wetland, this could cause greater pressure on natural resources, including harvesting of reeds and an increased threat of discovery and removal of crane chicks for sale/domestication. Direct disturbance via human proximity within 100-200m causes breeding birds to flush from nests on approach (Olupot, 2014), which may result in increased rates of predation, reduced time at the nest, either incubating or feeding, and ultimately nest abandonment, affecting reproductive success. It is assumed for this assessment that indirect disturbances arising from mechanical noise, site lighting, vibration and edge effects during construction are also likely to affect the breeding success of Grey Crowned Crane in the CHAA.

Removal of large trees which have importance as night-time roosts and day-time shelter from the midday sun has been indicated in localised declines in Grey Crowned Crane in Uganda (Olupot, 2014); the loss of such trees during vegetation clearance for pipeline construction is therefore expected to have implications for the survival of flocks and individuals in the area.

These effects to the survival and reproductive success of Grey Crowned Crane are predicted to be well beyond the expected range of natural disturbance perturbations.

Impact Classification

The Grey Crowned Crane sensitivity is high because it is Endangered.

Impacts to Grey Crowned Crane habitat quantity and quality will be adverse. The geographical extent of impacts will be local because effects are restricted to those areas within 200 m of the Production Facility infrastructure footprint, with approximately 0.36 ha (0.5%) of potential habitat being cleared, and 2.4 ha (3.47 %) of potential habitat indirectly affected. Impact duration will be short-term (that is, limited to the construction phase of the Project, approx. 10-12 months. Changes to the habitat quality and quantity from sensory disturbances arising from construction activities are expected to be reversible after completion of the works. The magnitude of the effects of construction on Grey Crowned Crane habitat quantity and quality is considered low. Therefore, the magnitude and sensitivity combine to produce a moderate overall impact level during the construction phase of the Project, pre-mitigation. Following the application of appropriate mitigation measures, the impact significance is expected to decrease to minor, because the magnitude of effects could be reduced to negligible, and the sensitivity of the receptor will remain the same (Table 14).

Impacts to Grey Crowned Crane habitat connectivity will be adverse. The geographical extent of impacts will be local because effects are restricted to the 30m construction right-of-way within which wetlands will be crossed by the feeder line. Impact duration will be short-term, as the pipeline will be buried and vegetation rehabilitated, and sensory disturbances arising from construction activities are expected to dissipate within a short time after completion of the construction phase. The magnitude of the effects of construction on Grey Crowned Crane habitat connectivity is considered to be low. Therefore, the magnitude and sensitivity combine to produce a moderate overall impact level during the construction phase of the Feeder line, pre-mitigation. Following the application of appropriate mitigation measures, the impact significance is expected to decrease to minor, because the magnitude of effects could be reduced to negligible, and the sensitivity of the receptor will remain the same (Table 14).

Impacts to Grey Crowned Crane abundance and distribution will be adverse. The geographical extent of impacts will be local because effects are restricted to wetlands within 200m of the proposed feeder line construction right of way. Impact duration will be short-term (that is, limited to the construction phase of 10-12 months) because physical and sensory disturbances arising from construction activities are expected to dissipate within a short time after cessation of activities. There is a possibility that individuals could be killed or severely disturbed during the construction phase (e.g. chicks on nests during clearance works); however, in the context of overall species abundance, these losses or disturbances are expected to be reversible after completion of the works. The magnitude of the effects of construction on Grey Crowned Crane abundance and distribution is thus considered low. Therefore, the magnitude and sensitivity combine to produce an impact of moderate significance during the construction phase of the Project, pre-mitigation. Following the application of appropriate mitigation measures, the impact significance is expected to decrease to minor, because the magnitude of effects could be reduced to negligible, and the sensitivity of the receptor will remain the same (Table 14).

Impacts to the survival and reproduction of Grey Crowned Crane will be adverse. The geographical extent of impacts will be local because effects are restricted to wetlands within 200m of the proposed feeder line construction right of way. Although physical and sensory disturbances arising from construction activities are expected to dissipate within a short time after cessation of activities, the effects of in-migration on Grey Crowned Crane are expected to be permanent, once households/settlements are established. The likelihood of impacts is uncertain (it is not known whether there are any breeding pairs of the crane in the permanent wetlands of the CHAA above the escarpment and the extent of migration into the area cannot be determined with certainty). A threshold of 10% for this species' survival and reproduction in the CHAA is reasonable, and it is considered unlikely that this number of individuals in the CHAA will be affected. The magnitude of the effects of construction on the survival and reproduction of the Grey Crowned Crane is considered to be medium. The magnitude and sensitivity combine to produce a major overall impact level during the construction phase of the Project, pre-mitigation. Following the application of appropriate mitigation measures, the impact significance is expected to decrease to moderate, because the magnitude of impact will be reduced to low, and the sensitivity of the receptor will remain the same (Table 33).

Table 33: Potential construction phase impacts to Grey Crowned Crane

Indicator of potential impact	Pre-mitigation			Post-mitigation (pre-offsets)		
	Magnitude	Sensitivity of the Receptor	Significance	Magnitude	Sensitivity of the Receptor	Significance
Habitat quality and quantity	Low – 2	High – 4	Moderate - 8	Negligible - 1	High – 4	Minor – 4
Habitat connectivity	Negligible - 1	High – 4	Minor - 4	Negligible - 1	High – 4	Minor – 4

Indicator of potential impact	Pre-mitigation			Post-mitigation (pre-offsets)		
	Magnitude	Sensitivity of the Receptor	Significance	Magnitude	Sensitivity of the Receptor	Significance
Abundance and distribution	Negligible - 1	High – 4	Minor - 4	Negligible - 1	High – 4	Minor – 4
Survival and reproduction – direct construction effects e.g. mortality	Low – 2	High – 4	Moderate - 8	Negligible - 1	High – 4	Minor – 4
Survival and reproduction – population influx	Medium	High – 4	Major - 12	Low – 2	High – 4	Moderate - 8

Prediction Confidence

Given the information available, there is a reasonable understanding of the potential Project impacts on the Grey Crowned Crane and its habitat in the CHAA.

The spatial extent of the wetland habitats in the CHAA was broadly mapped based on knowledge of the site, baseline studies, literature and reports (see Section 6.1). The actual extent of possible habitat may have been over-estimated.

11.1.2.3 What impact could the construction of the Feeder line have on Nahan's Francolin?

Nahan's Francolin is a Vulnerable and range-restricted species. It has a very restricted distribution, being found only in north-east DRC and western and south-central Uganda; in particular, the forests of Budongo, Bugoma and Mabira (McGowan and de Juana 1994). In the CHAA, it is restricted to the Bugoma Central Forest Reserve. It triggers Tier 2 critical habitat under Criterion 2 (Section 9.0, APPENDIX F).

Tier 2 habitats are considered to be sensitive, and, therefore, if a project is located in such a habitat, the IFC considers that compliance with the provisions of paragraph 17 of PS 6 (IFC 2012a) would be difficult. In summary, a project will not be developed in Tier 2 habitat unless: no other viable alternatives exist; and, the project does not lead to measurable and irreversible adverse impacts to the valued component that triggered critical habitat; and, the project does not lead to a net reduction in the global and/or national/regional population of the triggering species (such as Nahan's Francolin) over a reasonable period of time; and, a robust, appropriately designed, and long-term biodiversity monitoring and evaluation programme is part of the project's Environmental and Social Management System (ESMS). A Biodiversity Action Plan (BAP) will then be developed to achieve net gain for the affected species.

It is expected that the construction of the Feeder line will not have direct impacts to Bugoma CFR; its nearest point will be at least 1,8 km from the pipeline, and therefore no direct impacts on Nahan's Francolin are predicted. However, the indirect impacts of population influx, due to expectations of work on the construction contract, are considered since this could impact on the forest reserve and subsequently Nahan's Francolin.

Impact Indicators

As the pipeline will be at least 1.8 km from the Bugoma CFR boundary, no effects on habitat connectivity are predicted. Therefore, the indicators used to assess effects of the population influx associated with the

construction of the feeder line on Nahan's Francolin were: habitat quantity and quality, abundance and distribution, and survival and reproduction.

Potential changes in habitat quantity and quality, abundance and distribution, and survival and reproduction were assessed qualitatively by considering changes in disturbances arising from increased human presence in the CHAA. These disturbances were considered in light of known or inferred effects to the survival and reproduction of buttonquail species for which data on these types of effects are available.

Impact Assessment

■ Habitat Quality and Quantity

This species is confined to dense, mature, moist, sometimes swampy medium-altitude forest below 1,500 m (McGowan and de Juana 1994, BirdLife International 2014i); and is reasonably common in Budongo Central Forest Reserve (Plumptre et al. 2010, 2011). Suitable habitat was predicted to cover an area of ~35,201 ha (352 km^2) in the CHAA, principally in the Bugoma Central Forest Reserve. No direct losses or impacts on the quantity of habitat suitable for Nahan's Francolin are predicted as a result of the construction of the feeder line. However, indirect effects on habitat quality and quantity may arise as a result of human-induced disturbance associated with population influx to the region,

The Nahan's Francolin's degree of vulnerability to disturbance is unknown. Birds are known to be sensitive to land use and habitat alteration (Lussier et al. 2006). The behavioural response of species to disturbance will depend on species-specific tolerance levels, disturbance type and frequency, group size for socially-foraging animals, and local conditions, such as the availability of alternative foraging sites (Madsen 1998). A reduction in habitat quality and quantity may have conservation implications and consequences for the population of this species.

The construction phase of the feeder line, as a component of the Project, could result in an influx of people into the CHAA seeking opportunities. It can reasonably be expected that an increased human population in the area surrounding the Bugoma Central Forest Reserve will put pressure on the forest. These pressures could manifest in increased rates of habitat alteration and deforestation. Nahan's Francolin is a shy, forest-dependent species (Sande et al. 2009a) and thus is also probably sensitive to disturbance arising from deforestation/human presence in the forest; individuals may avoid the resultant sub-optimal habitat. These factors could combine to reduce the habitat quality and quantity for Nahan's Francolin.

Effects from reductions in habitat quality are predicted to be beyond the expected range of natural disturbance perturbations, although not beyond the baseline rate of direct loss as a result of the human induced deforestation rate.

■ Abundance and Distribution

Although the pipeline will be at least 1.8 km from the Bugoma CFR boundary, the indirect impacts of population influx to the CHAA, due to expectations of work or opportunities generated during construction of the pipeline, could ultimately affect the abundance and distribution of Nahan's Francolin in the CHAA.

The construction of the pipeline, as a component of the overall Project, could result in an influx of people into the area seeking jobs and/or opportunities. It can reasonably be expected that an increased human population in the area surrounding the Bugoma CFR and within the CFR itself will exacerbate existing pressures on the forest. These pressures are likely to manifest in increased rates of bush meat hunting and habitat alteration, which could reduce the abundance and distribution of Nahan's Francolin in Bugoma CFR. Although this species within the forest is reported to be relatively common (*viz.*, Plumptre et al. 2011), the distribution of individuals within this habitat is unknown. For the purposes of this assessment, it is assumed that the current distribution of this species is evenly spread within suitable habitat in the Bugoma Central Forest Reserve.

Effects from the population influx to the CHAA associated with the construction of the pipeline are predicted to be beyond the expected range of natural disturbance perturbations, although not beyond the baseline disturbance levels from the human-induced deforestation rate.

■ Survival and Reproduction

The Nahan's Francolin's degree of vulnerability to direct disturbance, particularly during the breeding season, is not well understood. Nahan's Francolin is reliant upon large trees, with appropriate buttress formation, for breeding sites (Sande et al. 2009a). No direct losses or impacts on breeding habitat suitable for Nahan's Francolin are predicted as a result of the construction of the feeder line. However, indirect effects on habitat quality and quantity may arise as a result of human-induced disturbance associated with population influx to the region.

How tolerant the Nahan's Francolin may be to indirect disturbances during the breeding season, are not completely understood. What is known is that disturbance of mature forest generally appears to reduce the home range of this species (Sande et al. 2009b), and hence its potential to find suitable mates. Generally, for birds, the behavioural response of species to disturbance will depend on species-specific tolerance levels, disturbance type and frequency, group size for socially-foraging animals, and local conditions such as the availability of alternative breeding sites (Madsen 1998). Many studies have reported a reduction in breeding success attributable to human disturbance (for a review, see Hill et al. 1992). Mechanisms include: increased rates of predation, nest abandonment and reduced time at the nest, either incubating or feeding. Clearly, a reduction in breeding output may have conservation implications and consequences for the local population of Nahan's Francolin.

The construction of the pipeline, as a component of the overall Project, could result in an influx of people into the area seeking opportunities. It can reasonably be expected that an increased human population in the area surrounding the Bugoma CFR and within the CFR itself will exacerbate existing pressures on the forest. These pressures could manifest in increased rates of bush meat hunting and habitat alteration, which could reduce the survival and reproductive success of Nahan's Francolin. Assuming it is sensitive to sensory disturbance because it is a shy, forest-dependent species (Sande et al. 2009a), the disturbance generated by increased human presence in Bugoma CFR could further affect the breeding success of those individuals living in close proximity to the boundaries of Bugoma CFR in particular.

These effects to the survival and reproductive success of Nahan's Francolin are predicted to be well beyond the expected range of natural disturbance perturbations, although not beyond the current, baseline human-induced deforestation rate.

Impact Classification

The Nahan's Francolin's sensitivity is high because it is range-restricted and triggers Tier 2 critical habitat.

Impacts to the Nahan's Francolin's habitat quantity and quality will be adverse. The geographical extent of impacts will be regional because effects are restricted to Bugoma CFR. Impact duration will be long-term (that is, extending far beyond the pipeline construction period of 10-12 months), as once settlements created by migrants to the area become established, they may be difficult to reverse. The magnitude of the impact of population influx associated with the pipeline construction on the habitat quantity and quality of the Nahan's Francolin is expected to be low. Therefore, the magnitude and sensitivity combine to produce a moderate overall impact level during the construction phase of the feeder line, pre-mitigation (**Table 34**). Following the application of appropriate mitigation measures, the impact significance is expected to decrease to minor, primarily because the magnitude could become negligible, although the sensitivity of the receptor will remain the same (**Table 34**).

Impacts to the Nahan's Francolin's abundance and distribution could be adverse. The geographical extent of impacts will be regional because effects are restricted to Bugoma CFR. Impact duration will be long-term (that is, extending far beyond the pipeline construction period of 10-12 months), as once settlements created by migrants to the area become established, they may be difficult to reverse. There is a possibility that as a result of influx during the construction phase, the distribution and abundance of Nahan's Francolin in Bugoma CFR could be affected. The magnitude of the effects of population influx associated with pipeline construction on the abundance and distribution of the Nahan's Francolin is Low. Therefore, the magnitude and sensitivity combine to produce a moderate overall impact level, pre-mitigation (**Table 34**). Following the application of

site-specific mitigation measures, the impact significance is expected to decrease to minor, primarily because the magnitude could become negligible, although the sensitivity of the receptor will remain the same (**Table 34**).

Impacts to the survival and reproduction of Nahan's Francolin could be adverse. The geographical extent of impacts will be regional because effects are restricted to Bugoma CFR. Impact duration will be long-term (that is, extending far beyond the pipeline construction period of 10-12 months), as once settlements created by migrants to the area become established, they may be difficult to reverse. No direct effects on breeding habitat or direct species mortalities are anticipated as a result of pipeline construction; however indirect effects arising from sensory disturbance and poaching associated with population influx to Bugoma CFR could result in the injury, mortality and reduced breeding success of some individuals. A threshold of 10% for this species' survival and reproduction in the CHAA is reasonable, and it is expected that this number of individuals in the local population within Bugoma Central Forest Reserve will not be affected by the indirect impacts of pipeline construction. The magnitude of the effects of construction on the survival and reproduction of the Nahan's Francolin is therefore low. Therefore, the magnitude and sensitivity combine to produce a moderate overall impact level during the pipeline construction phase of the Project, pre-mitigation (**Table 34**).

Following the application of site-specific mitigation measures, the impact significance is expected to decrease to minor, primarily because the magnitude could become negligible, although the sensitivity of the receptor will remain the same (**Table 34**).

Table 34: Potential impacts in the construction phase to the Nahan's Francolin

Indicator of potential impact	Pre-mitigation			Post-mitigation (pre-offsets)		
	Magnitude	Sensitivity of the Receptor	Significance	Magnitude	Sensitivity of the Receptor	Significance
Habitat quality and quantity	Low – 2	High – 4	Moderate – 8	Negligible – 1	High – 4	Minor – 4
Abundance and distribution	Low – 2	High – 4	Moderate – 8	Negligible – 1	High – 4	Minor – 4
Survival and reproduction	Low – 2	High – 4	Moderate – 8	Negligible – 1	High – 4	Minor – 4

Prediction Confidence

Given the information available, there is a reasonable understanding of the potential direct, indirect and induced impacts that the operation of the feeder line could have on the Nahan's Francolin and its habitat in the CHAA.

The spatial extent of the dense forest habitat in the CHAA was broadly mapped based on knowledge of the site, baseline studies, literature and reports (see Section 6.1.1). The actual extent of possible habitat may have been over-estimated.

11.1.2.4 *What impact could the construction of the Feeder line have on Eastern Chimpanzee?*

The Eastern Chimpanzee is an Endangered species. The population of Eastern Chimpanzees in the Bugoma CFR is recognised as being one for the four largest in the region (Plumptre et al. 2010). Hence, the forest is recognised as an important chimpanzee conservation unit by the IUCN (Plumptre et al. 2010).

This species triggers Tier 1 critical habitat (Section 6.3.2.2, APPENDIX F). Tier 1 habitats are considered to be very sensitive, and, therefore, if a project is located in such a habitat, the IFC considers it unlikely that the client will be able to comply with the provision of PS 6, in particular paragraphs 17, 18 and 19 (IFC 2012a, as

presented in APPENDIX B). In summary, a project will not be developed in Tier 1 habitat unless: no other viable alternatives exist; <u>and</u>, the project does not lead to measurable and irreversible adverse impacts to the valued component that triggered critical habitat; <u>and</u>, the project does not lead to a net reduction in the global and/or national/regional population of the triggering species (i.e. Eastern Chimpanzee) over a reasonable period of time; <u>and</u>, a robust, appropriately designed, and long-term biodiversity monitoring and evaluation programme is part of the project's Environmental and Social Management System (ESMS). A Biodiversity Action Plan (BAP) will be developed to achieve net gain for the affected species.

Bugoma Central Forest reserve (Bugoma CFR) will not be directly affected by pipeline construction, which at its nearest point will be at least 1,8 km from the Bugoma CFR boundary. The indirect impacts of population influx, due to expectations of work on the construction contract, are considered since this could impact on the forest reserve, and the population of Eastern Chimpanzee that lives there.

Impact Indicators

As the pipeline will be at least 1.8 km from the Bugoma CFR boundary, no effects on habitat connectivity during operation are predicted. Therefore, the indicators used to assess effects of the population influx associated with the operation of the feeder line on Eastern Chimpanzee were: habitat quantity and quality, abundance and distribution, and survival and reproduction.

Potential changes in habitat quantity and quality, and abundance and distribution, were assessed qualitatively by considering changes in disturbances arising from increased human presence in the CHAA. These disturbances were considered in light of known or inferred effects to the survival and reproduction of other populations of chimpanzees for which data on these types of effects are available.

To assess effects to survival and reproduction as a result of in-migration and potential associated increases in poaching and disease spread, in-migration rates were assessed based on the data presented in the social impact assessment. A literature review of the impact of contact with humans was also conducted.

Impact Assessment

■   Habitat Quality and Quantity

The entire Bugoma Central Forest Reserve is considered suitable habitat for Eastern Chimpanzees, as well as the areas beyond the boundaries of the forest reserve (see McLennan 2008). However, for the intents of this impact assessment, the habitat within and immediately surrounding the Bugoma Central Forest Reserve was only considered.

The potential for the construction of the feeder line (as a component of the overall Project) to be attractive for people seeking opportunities could result in a substantial increase the current population around the Bugoma Central Forest Reserve. An increasing human population could lead to an increase in the demand for agricultural and timber resources, resulting in increased rates of habitat alteration and deforestation, which, in turn could further fragment, change, and degrade Bugoma CFR and surrounding habitat, resulting in reduced habitat quantity and quality for Eastern Chimpanzee.

The degree of vulnerability to disturbance experienced by chimpanzees is reasonably well known (for example, see Parren and Byler 2003, Rabanal et al. 2010, Thompson and Wrangham 2013). The chimpanzees living in and around the Bugoma Central Forest Reserve most likely experience sensory disturbances at present from human activities, given the high human populations living around the reserve. Indeed, groups are known to forage in the agricultural fields surrounding the forest, and hence, would more than likely be used to human noises and disturbances (McLennan 2008). As such, the potential sensory disturbances arising from population influx associated with the construction of the pipeline are likely to be minimal. Nevertheless, the magnitude of noise may not be the most important determinant of chimpanzee response. Instead, chimpanzees may respond to 'new' noises or may associate particular noises with other occurrences (for example, machine noise may be associated with human presence, which chimpanzees may, in turn, associate with the presence of danger). Where humans pose a threat, chimpanzees generally avoid them (Hockings and Humle 2009, Parren and Byler 2003). Therefore, the degree of avoidance may depend on the behaviour

of people, resulting in varying levels of indirect effects on the quality of available habitat for Eastern Chimpanzee, and highlighting the importance of managing contractor activity during construction.

Effects from the reduced habitat quantity and quality during construction are predicted to be beyond the expected range of natural disturbance perturbations.

- Abundance and Distribution

The Bugoma Central Forest Reserve supports one of the top four Eastern Chimpanzee populations in Uganda, with a population of between 450 and 850 individuals (Plumptre et al. 2010). Given its distance from the forest, the construction of the feeder line is not expected to detrimentally affect the abundance or distribution of chimpanzees in the forest directly.

However, the construction of the feeder line could influence influx of people into the area seeking opportunities. It can reasonably be expected that an increased human population both within and in the area surrounding Bugoma CFR, will put pressure on the forest. These pressures could manifest in increased rates of bush meat hunting, and reduced habitat availability due to human disturbance, which could affect the abundance and distribution of Eastern Chimpanzee within Bugoma CFR.

Effects are predicted to be beyond the expected range of natural disturbance perturbations.

- Survival and Reproduction

In-migration of people seeking opportunities associated with the construction of the feeder line may adversely affect survival and reproduction of chimpanzees through poaching and disease transfer. Hunting and poaching is a recognised threat to chimpanzees in Bugoma Central Forest Reserve (Plumptre et al. 2003), and this pressure could increase as in-migration of people from other areas occurs. Mitigation and management of in-migration (see Golder Associates 2018) will be very important to minimise potential effects on chimpanzees and other fauna species.

Disease is one of the major threats to Eastern Chimpanzees (Oates et al. 2008); increased abundance of people and competition for land and food resources between humans and chimpanzees could lead to higher rates of disease spread from humans to chimpanzees. Chimpanzees are closely related to humans; therefore, many diseases are transferrable between chimpanzees and humans (Formenty et al. 2003; Isabirye-Basulta and Lwanga 2008). Either direct or indirect contact with humans can spread disease. For example, there is evidence to suggest that respiratory illnesses have been transferred directly to chimpanzees from humans as a result of researcher and tourist contacts, often leading to outbreaks and death (Formenty et al. 2003). Human defecation in forest undergrowth can indirectly lead to spread of intestinal diseases, such as *Clostridium perfringens*, which can be fatal to chimpanzees (Fujita 2011). As forest fragments decrease in size, risks of contact with, and transmission of, disease from humans increases (Isabirye-Basulta and Lwanga 2008). Factors that lead to increased crop raiding or sharing of water resources can also increase the risk of disease spread (Hockings and Hulme 2009). As identified in the social impact assessment, communicable respiratory diseases are a significant concern in the LSA; as such there is a risk of loss of Eastern Chimpanzee individuals due to transmission of diseases as a result of construction-phase population influx.

What effect the loss of individuals from the population could have is unknown. It is doubtful that the population could be reduced by 10% and hence, reach that critical population threshold due to population influx associated with the pipeline alone, nevertheless the potential impacts are predicted to be beyond the expected range of natural disturbance perturbations.

Impact Classification

The Eastern Chimpanzee's sensitivity is high because it is Endangered.

Impacts to the Eastern Chimpanzee's habitat quantity and quality will be adverse. The geographical extent of impacts will be regional because effects are restricted to Bugoma CFR. Impact duration will be long-term (that is, extending far beyond the pipeline construction period of 10-12 months), as once settlements created by migrants to the area become established, they may be difficult to reverse. The amount of influx that could be

specifically attributed to the construction of the feeder line is expected to be low, therefore the magnitude of the effects of construction on the habitat quantity and quality of the of the Eastern Chimpanzee is expected to be low. Therefore, the magnitude and sensitivity combine to produce a moderate overall impact level during the operation phase of the feeder line, to the application of Project-specific mitigation measures (Table 41). Following the application of the recommended mitigation measures (Section 11.0), the impact significance is expected to decrease to minor, primarily because the magnitude could become negligible, although the sensitivity of the receptor will remain the same.

Impacts to the Eastern Chimpanzee's abundance and distribution could be adverse. The geographical extent of impacts will be regional because effects are restricted to Bugoma CFR. Impact duration will be long-term (that is, extending far beyond the pipeline construction period of 10-12 months), as once settlements created by migrants to the area become established, they may be difficult to reverse. Given its distance from the forest, the operation of the feeder line is not expected to affect the abundance and distribution of Eastern Chimpanzee in Bugoma CFR, however the Project-associated population influx has the potential to generate impacts. The amount of influx that could be specifically attributed to the construction of the feeder line is expected to be low, therefore the magnitude of the effects of construction on the abundance and distribution of the Eastern Chimpanzee in Bugoma CFR is low. Therefore, the magnitude and sensitivity combine to produce a moderate overall impact level during the operation phase of the feeder line, to the application of Project-specific mitigation measures (Table 41). Following the application of the recommended mitigation measures (Section 11.0), the impact significance is expected to decrease to minor, primarily because the magnitude could become negligible, although the sensitivity of the receptor will remain the same.

Impacts to the survival and reproduction of the population of Eastern Chimpanzee in Bugoma Central Forest Reserve could be adverse. The geographical extent of impacts will be national because effects could extend well beyond the CHAA. Impact duration will be long-term (that is, extending far beyond the pipeline construction period of 10-12 months), as once settlements created by migrants to the area become established, they may be difficult to reverse. There is a possibility that individuals could be killed or severely disturbed as a result of Project-related population influx during the operation phase. A threshold of 10% for this species' survival and reproduction in the CHAA is reasonable, and it is expected that this number of individuals in the local population within Bugoma Central Forest Reserve could be affected through direct mortality from bush meat hunting or other disturbance. However, the amount and intensity of influx that could be specifically attributed to the construction of the feeder line is expected to be low, therefore the magnitude of the effects of construction on the survival and reproduction of the Eastern Chimpanzee is expected to be low. Therefore, the magnitude and sensitivity combine to produce a moderate overall impact level during the operation phase of the feeder line, prior to the application of Project-specific mitigation measures (Table 41). Following the application of the recommended mitigation measures (Section 11.0), the impact significance is expected to decrease to minor, primarily because the magnitude could become negligible, although the sensitivity of the receptor will remain the same.

Table 35: Potential impacts in the construction phase to the Eastern Chimpanzee

Indicator of potential impact	Pre-mitigation			Post-mitigation		
	Magnitude	Sensitivity of the Receptor	Significance	Magnitude	Sensitivity of the Receptor	Significance
Habitat quality and quantity	Low - 2	High – 4	Moderate - 8	Negligible - 1	High – 4	Minor - 4
Abundance and distribution	Low - 2	High – 4	Moderate - 8	Negligible - 1	High – 4	Minor - 4
Survival and reproduction	Low - 2	High – 4	Moderate - 8	Negligible - 1	High – 4	Minor - 4

Prediction Confidence

Given the information available, there is a reasonable understanding of the potential direct, indirect and induced impacts that the construction of the feeder line could have on the Eastern Chimpanzees and their habitat in the CHAA.

The spatial extent of the dense forest habitat in the CHAA was broadly mapped based on knowledge of the site, baseline studies, literature and reports (see Section 6.3.1.1.1). The actual extent of possible habitat may have been over-estimated.

11.2 Operation Phase Impacts

For the assessment of impacts during the operations phase, the key questions were divided into sub-questions that focused on individual valued components within the CHAA and LSA. In answering each question, the individual components of the Project were considered with regards to their potential to affect a valued component. These questions are presented below.

11.2.1 What impact could the operation of the Feeder line have on habitats and ecosystem integrity?

This section presents the assessment of impacts that the operation of the Project could have on the habitat and ecosystem integrity within the CHAA and the LSA. These habitats either do, or could, support populations of species of concern. Therefore, the assessment of potential impacts to those species, and others, occurring in the CHAA has been assessed in this section through the determination of the impacts to potential habitat for those species.

The impacts of the Project on critical habitat, as triggered by species of concern, are covered under the individual assessment of those species in Section 10.2.2. Other triggers of critical habitat are discussed as relevant in the appropriate sections.

As discussed, construction-phase rehabilitation measures should return the site to a grassed, herbaceous vegetation cover similar to open grassland-type habitats that occur in the escarpment vegetation corridor at baseline. Ongoing recovery of vegetation cover from the initial construction-phase habitat losses, and associated edge effects, risk of alien invasive vegetation spread are considered in the construction phase impact assessment (Section 11.1.1). Operation phase impacts of the feeder line on habitats and ecosystem integrity are therefore limited to those caused by new components and activities, including:

- Maintenance activities particularly clearance of woody vegetation with roots that could damage the pipeline beneath;

- The presence of the heated pipeline approximately 1.0 m beneath the surface; and

- The effect of ongoing in-migration into the CHAA in response to the expectation of job opportunities.

11.2.1.1 What impact could the operation of the Feeder line have on the escarpment vegetation corridors?

Impact Indicators

Indicators used to assess impacts of the Feeder line on the habitat and ecosystem integrity of the vegetation corridors on the escarpment were changes in: regional representativeness; ecosystem composition, and ecosystem configuration.

Literature was reviewed to understand the long-term direct impacts of pipelines through natural habitats. Indirect affects to habitat were estimated by applying a 0.50 km buffer to the pipeline route. Specifically, the buffer was selected to account for changes in habitat quantity and/or quality that could be caused by edge effects, fragmentation, sensory disturbance, changes in water quantity and quality, and air emissions and dust.

Changes in habitat composition and ecosystem configuration were assessed by identifying potential changes in species composition that could occur over the life of the Project, and the disruption of known corridors. This

was accomplished by examining available literature about the ecology of the vegetation communities on the escarpment, and scientific literature about the impacts of human activities on corridors in the long-term.

Impact Assessment

■   Representativeness

The CHAA supports approximately 2443 ha of escarpment corridor vegetation communities (see Section 6.3.1.1.2), which are bounded on the east by agriculturally modified landscapes, and the Buhuka Flats on the west. As mentioned, these vegetation communities form part of a contiguous vegetation corridor that is part of the wider Murchison Falls National Park-Budongo-Bugoma-Kagombe-Itwara Forest Reserves-Semliki/Toro Wildlife Reserve corridor (Plumptre et al. 2003) (see Section 6.3.1.2.1). Therefore, their continuous extent represents an important landscape feature in the CHAA.

Indirect effects on the representativeness of the escarpment vegetation communities during operation are expected as a result of the ongoing effects of population influx to the region. The presence of a relatively-easy to navigate, grassed linear feature through the escarpment vegetation corridor is likely to facilitate access to other areas of the escarpment vegetation communities for timber harvest and livestock grazing on accessible slopes, resulting in habitat loss and degradation in the vicinity, affecting the representativeness of this section of the escarpment vegetation corridor in the landscape.

Impacts from the changes to representativeness are predicted to be less than those experienced during the construction phase because temporary construction areas will be rehabilitated. Nevertheless, the potential for renewed reduction in habitat extent and condition during operation as a result of population influx in the area is predicted to be beyond the expected range of natural disturbance perturbations.

■   Ecosystem composition

The construction phase rehabilitation measures should return the corridor to a vegetation cover similar to baseline vegetation communities that are suitable for establishment over the underground pipeline (i.e. communities that lack large trees, such as open grassland). Ongoing maintenance will be conducted throughout the operational lifetime of the pipeline to ensure that shrubs and trees, whose roots could potentially damage or penetrate the buried pipeline, do not establish on the surface directly above the pipeline, and is likely to extend to 10 m either side of the buried pipeline route, meaning that the climax vegetation community achievable for this area will be open grassland.

The pipeline will be buried to 1.0 m depth and it will be heated to 80°C. There is a potential for the heated pipeline to warm the soil overhead, which could influence the dominant type of flora species in the grass/herbaceous layer on the surface. For example, drought-tolerant or xerophytic species could dominate species that require seasonally-cold periods for dormancy, or species that require more moisture, affecting the ecosystem composition of vegetation communities and associated faunal guilds (e.g. invertebrates). However, the insulation surrounding the pipeline is expected to prevent any significant heating of the soils surrounding it, and associated potential impacts.

Ongoing migration into the CHAA are expected to increase existing pressures on escarpment vegetation communities, through harvest of woody resources for timber and fuel, overgrazing, and hunting fauna for bushmeat. Overgrazing pressures could result in shifts in vegetation community composition to more hardy species, whilst hunting pressure would further reduce the remaining mammalian fauna on the escarpment within the CHAA. Birds and other faunal community composition may also change due to hunting and a deterioration in cover.

Impacts from the long-term changes to ecosystem composition are predicted to be less than those experienced during the construction phase because temporary construction areas will be rehabilitated, but still beyond the expected range of natural disturbance perturbations.

■   Ecosystem configuration

The wider Murchison Falls National Park-Budongo-Bugoma-Kagombe-Itwara Forest Reserves-Semliki/Toro Wildlife Reserve corridor is recognised as being important for threatened species in the face of climate change adaptation (Ayebare et al. 2013), and as part of a much broader set of corridors running the length of the Albertine Rift. This corridor in the southern portion of the eastern shores of Lake Albert, in the vicinity of the Project, is very narrow compared to its extent elsewhere, and is recognised as being important for savannah species (Plumptre et al. 2010). The corridor is recognised as an important climate change refugium for a range of threatened species, which may become increasingly important for those species in the future (Ayebare et al. 2013), that is, within the life time of the Project.

The feeder line will be buried and rehabilitated following construction, and rehabilitation measures should return the site to a vegetation cover similar to baseline vegetation communities that are suitable for establishment over the underground pipeline. During operation, the pipeline is therefore not expected to be a significant barrier for species that could use the escarpment vegetation as a wildlife corridor, such as large ungulates, predators, primates (all of which are very rare in the area in any case), and birds.

Therefore, no significant changes to ecosystem configuration of the escarpment vegetation communities as a result of the long-term operation of the pipeline are predicted.

Impact Classification

The vegetation community of the escarpment's sensitivity is medium because, although these habitats are already under stress from livestock grazing and harvesting of fuel wood and non-timber forest products, they form part of the wider Murchison Falls National Park-Budongo-Bugoma-Kagombe-Itwara Forest Reserves-Semliki/Toro Wildlife Reserve corridor.

Impacts to the representativeness of the habitat will be negative because the indirect effects of population influx to the region are likely to result in further loss and degradation of escarpment vegetation communities, in particular in the vicinity of the short-stretch of easily traversed, grassed pipeline route. The geographical extent of impacts will be local because impacts are restricted to the LSA. Impact duration will be medium-long term because the pipeline will remain in place throughout the project lifetime. The magnitude of the impacts of operation on representativeness of the vegetation communities of the escarpment is low, given the extent of the area in question. Therefore, the magnitude and sensitivity combine to produce a moderate overall impact level to representativeness during the operational phase of the Project, pre-mitigation (Table 36). Following the application of appropriate mitigation measures during operation, the impact significance could remain moderate, as the effects of population influx on the escarpment vegetation community extent and condition in the vicinity of the pipeline. may be difficult to mitigate.

Impacts to the ecosystem composition will be adverse in the long-term, because any re-establishing woody vegetation species will be cleared from the pipeline, and the vegetation community may shift to more heat/drought-tolerant species. The geographical extent of impacts will be local because impacts are restricted to the LSA. Impact duration will be medium-term (that is, ~25 years) because the pipeline will remain in place throughout the project lifetime. The magnitude of the impact on ecosystem composition is low, as although the woody species will be removed, and the vegetation community may see a shift to more heat tolerant species, the re-established grass and herbaceous vegetation layer will remain. Therefore, low magnitude and medium sensitivity combine to produce a moderate overall impact level to ecosystem composition during the operational phase of the Project, pre-mitigation (Table 36). Following the application of appropriate mitigation measures, the impact significance is expected to become minor, as the magnitude will become negligible, while the sensitivity of the receptor will remain the same.

Impacts to the ecosystem configuration will be neutral, as the buried and rehabilitated pipeline will not present a significant barrier to movement for faunal species using the escarpment vegetation corridor. The geographical extent of impacts will be local because impacts are restricted to the LSA. Impact duration will be medium-term (that is, ~25 years) because the pipeline will remain in place throughout the project lifetime. The magnitude of the impact on ecosystem configuration is therefore negligible, and combines with medium sensitivity to produce a minor overall impact level to ecosystem composition during the operational phase of the Project (Table 36), and no further mitigation measures are required.

Table 36: Potential impacts in the operation phase of the Feeder line to the vegetation communities of the escarpment

Indicator of potential impact	Pre-mitigation			Post-mitigation		
	Magnitude	Sensitivity of the Receptor	Significance	Magnitude	Sensitivity of the Receptor	Significance
Representativeness	Low – 2	Medium – 3	Moderate - 6	Low – 2	Medium – 3	Moderate - 6
Ecosystem composition	Low – 2	Medium – 3	Moderate - 6	Negligible – 1	Medium – 3	Minor - 4
Ecosystem configuration	Negligible – 1	Medium – 3	Minor - 4	Negligible – 1	Medium – 3	Minor - 4

Prediction Confidence

Given the information available, there is a reasonable understanding of the potential Feeder line-related impacts to the vegetation communities of the escarpment, and the wildlife corridors of which they form part. However, there is some uncertainty with regards to the irreplaceability and vulnerability of those habitats in the CHAA. Given the current uncertainty in relation to climate change and possible scenarios, as well as increasing human pressures, how important these habitats will become in the future is uncertain. Indications are that they will increase in importance (Ayebare et al. 2013), provided human pressures do not overwhelm them.

The spatial extent of habitats in the CHAA was broadly mapped based on knowledge of the site, baseline studies, literature and reports (see Section 6.3.1.1.1). The actual extent of possible habitat may have been over-estimated.

11.2.1.2   *What impact could the operation of the Feeder line have on wetlands and riparian habitat in the CHAA?*

Impact Indicators

Indicators used to assess impacts of the Feeder line on the habitat and ecosystem integrity of the wetland and riparian habitats in the CHAA were changes in: regional representativeness; ecosystem composition; and ecosystem configuration.

Literature was reviewed to understand the long-term direct impacts of pipelines through natural habitats. Indirect affects to habitat were estimated by applying a 200 m buffer to the pipeline route. Specifically, the buffer was selected to account for changes in habitat quantity and/or quality that could be caused by edge effects, fragmentation, sensory disturbance, and changes in water quantity and quality.

Changes in habitat composition and ecosystem configuration were assessed by identifying potential changes in species composition that could occur over the life of the Project, and the disruption of wetland and riparian systems. This was accomplished by examining available literature about wetland ecology, and scientific literature about the impacts of human activities on wetland systems in the long-term.

Impact Assessment

■   Representativeness

The CHAA supports approximately 1157.9 ha of wetlands, and 840 ha of riparian vegetation communities associated with drainage lines and riparian systems, of which, approximately 2.6 ha will have been directly affected by construction activity.

During operation, no additional direct effects on the extent and/or condition of wetland and riparian habitats are predicted. However, indirect effects on the representativeness of the wetland and riparian habitats during

operation are expected, as a result of the ongoing effects of population influx to the region. Knock-on effects on the ecological integrity and resilience of the wetlands are predicted, as increased levels of livestock grazing, harvest of reeds and grasses for home construction, and conversion of wetland and riparian habitats for subsistence cropping are likely to occur.

The construction phases losses of habitat are expected to be partially recovered because the pipeline will be buried and rehabilitated following construction. Rehabilitation measures should return the affected areas to a vegetation cover similar to that that was there before the pipeline was constructed.

Impacts from the changes to representativeness are predicted to be less than those experienced during the construction phase because temporary construction areas will be rehabilitated. Nevertheless, the potential for renewed reduction in habitat extent and condition during operation as a result of population influx in the area is predicted to be beyond the expected range of natural disturbance perturbations.

- Ecosystem Composition

The presence of linear infrastructure, such as pipelines, through wetlands is known to have detrimental impacts on the functioning, processes and species composition of these communities (Roise et al. 2004). Buried pipelines passing through wetlands may result in losses of biodiversity at local and downstream scales largely due to changes in geomorphological properties and interruption in hydrological regimes, which could affect the maintenance of flow to wetland areas downstream of the crossing, or result in increased erosion potential around the buried pipeline. Alteration of wetland structure and composition could occur if flow paths for water, both surface and sub-surface, are not maintained. If these flow paths are not maintained throughout the operational lifetime of the project, there is a potential that the wetland community downstream of the obstruction could become altered – typically via flow concentration and channel incision in downstream wetlands that were previously supplied by diffuse, dispersed flows. The risk of incised drainage and associated loss of wetland function due to concentration of water flows may be relatively low, assuming that the construction mitigation measures were successfully applied.

The pipeline will be buried to 1.0 m depth and it will be heated to 80°C. The heated pipeline has the potential to warm the wetland and riparian habitat in its immediate vicinity, which could influence the moisture regime of some habitats (particularly seasonal wetlands) and associated flora and fauna community composition, albeit on a very localised basis.

Although the feeder line will have been buried and rehabilitated following construction, and rehabilitation measures should return the corridor to a vegetation cover similar to baseline vegetation communities; the likely intensification in use of the wetlands as the human population of the region increases could generate indirect impacts on wetlands. Existing sanitary conditions in the CHAA are poor, with all of the streams being contaminated with faecal waste from both animals and humans (Social Impact Assessment). The wetland communities in the CHAA are already under pressure from livestock grazing, and harvesting of fibre for house construction. It is likely that these communities will become degraded in the long-term as the human population of the region increases. Such changes would alter the habitat structure and vegetation community composition of the wetland and riparian habitats in the CHAA, which, in turn, could affect the utilisation of these habitats by the currently resident faunal species guilds (e.g. the Endangered Grey Crowned Crane).

Impacts from the changes to ecosystem composition of wetland and riparian habitats are predicted to be less than those experienced during the construction phase, because temporary construction areas will be rehabilitated. Nevertheless, the potential for renewed reduction in habitat extent and condition during operation as a result of population influx in the area is predicted to be beyond the expected range of natural disturbance perturbations.

- Ecosystem configuration

Linear infrastructure such as pipelines can present significant barriers to, or can alter behaviours of, a range of wetland wildlife, from: amphibians (for example, Pontoppidan et al. 2013); to turtles (for example, Langen et al. 2012).

Although the feeder line will cross currently contiguous wetlands and riparian habitats in the LSA, it will be buried and rehabilitated following construction, and rehabilitation measures should eventually return the affected areas to a vegetation cover similar to baseline vegetation communities. During operation, the pipeline is not expected to represent a significant barrier to movement, or break in habitat connectivity, for wetland and riparian faunal species.

Therefore, no significant changes to ecosystem configuration of the wetland and riparian habitats as a result of the long-term operation of the pipeline are predicted.

Impact Classification

The sensitivity of wetlands and riparian habitats is high, because permanent and seasonal wetlands are important breeding and foraging habitat for Grey Crowned Crane, a species of concern; and wetlands are susceptible to degradation as a result of changes in water flow patterns brought about by infrastructural developments. The habitats are also already under stress from livestock grazing and harvesting of fibre. This high sensitivity is weighed against the magnitude of each of the impacted indicators as described in the paragraphs below, in order to derive the overall impact level for each indicator.

■   Representativeness

Impacts to the representativeness of the habitat will be adverse because the indirect effects of population influx to the region are likely to result in further loss and degradation of wetland and riparian habitat. The geographical extent of impacts will be local because impacts are restricted to the LSA. Impact duration will be medium-long term because the pipeline will remain in place throughout the project lifetime. The magnitude of the impacts of operation on representativeness of the wetland and riparian habitats is low, given the extent of the potentially-affected areas in question. In the context of high wetland sensitivity, this results in impacts of moderate significance.

Following the application of appropriate mitigation measures, the impact significance could remain moderate, as the effects of population influx on the extent and condition of wetland habitats in the vicinity of the pipeline. may be difficult to mitigate.

■   Ecosystem Composition

Impacts to the ecosystem composition will be adverse. The geographical extent of impacts will be local because impacts are restricted to the LSA. Impact duration will be for the duration of operation (~25 years). The magnitude of the different project-specific impacts on ecosystem composition varies, as discussed under each of the subheadings below.

Impacts to the ecosystem composition arising from the heated pipeline could be adverse in the long term, as the wetland vegetation community in its direct vicinity may be affected. The geographical extent of impacts will be highly localised with impacts restricted to the direct vicinity of the buried pipeline. Impact duration will be medium-term, lasting throughout the operational lifetime of the project. The magnitude of the impact on ecosystem composition is negligible because, although localised changes to the floral and faunal community composition could occur, the extent of the potentially affected area is small, and the likelihood of any significant changes in the wetland or riparian community composition is considered very low. Therefore, the magnitude and high sensitivity of the wetlands combine to produce a minor overall impact level to ecosystem composition during operation of the feeder line, and no project-specific mitigation measures are required (Table 37).

The ongoing in-migration to the CHAA is likely to result in increased human use of wetlands in the CHAA. In the absence of project interventions, the impact of increased population density (and associated increases in grazing livestock) in the CHAA is expected to be long-term, and to have a material effect on both wetland structure and water quality in the wetlands across the CHAA through reductions in sanitary water quality, exacerbation of wetland erosion, increased harvest of plant species used for traditional home construction, increased fire frequency and increased grazing pressure. The impacts will be irreversible; and of medium magnitude. In the context of the high wetland sensitivity, the predicted impact significance on ecosystem composition is major, prior to mitigation. Following the application of Project-specific mitigation measures

during operation, the impact significance could remain moderate, as the effects of population influx on the ecosystem composition of wetlands and riparian habitat in the vicinity of the pipeline may be difficult to mitigate.

■ Ecosystem Configuration

Impacts to the ecosystem configuration will be neutral, as the buried and rehabilitated pipeline will not present a significant barrier to movement for faunal species using the affected wetland and riparian habitats. The magnitude of the impact on ecosystem configuration is therefore negligible, and combines with medium sensitivity to produce a minor overall impact level to ecosystem composition during the operational phase of the Project (Table 37), and no further mitigation measures are required.

Impact Significance Rating

Table 37: Potential impacts of operation of the feeder line on the wetlands of the CHAA

Indicator of potential impact	Pre-mitigation			Post-mitigation (pre-offsets)		
	Magnitude	Sensitivity of the Receptor	Significance	Magnitude	Sensitivity of the Receptor	Significance
Representativeness	Low - 2	High – 4	Moderate – 8	Low - 2	High – 4	Moderate – 8
Ecosystem composition – (heated pipeline)	Negligible – 1	High – 4	Minor - 4	Negligible – 1	High – 4	Minor - 4
Ecosystem composition – (population influx)	Medium - 3	High – 4	Major - 12	Low – 2	High – 4	Moderate – 8
Ecosystem configuration	Negligible – 1	High – 4	Minor - 4	Negligible – 1	High – 4	Minor - 4

Prediction Confidence

Given the information available, there is a reasonable understanding of the potential operational impacts that the feeder line may have on the wetlands of the CHAA. However, there is some uncertainty in regard to the irreplaceability and vulnerability of those habitats in the CHAA. Given the current uncertainty in relation to climate change and possible scenarios, as well as increasing human pressures, how important these habitats will become in the future is uncertain.

The spatial extent of habitats in the CHAA was broadly mapped based on knowledge of the site, baseline studies, literature and reports (see Section 6.3.1.1.1). The actual extent of possible habitat may have been over-estimated.

11.2.1.3 *What impact could the operation of the Feeder line have on Bugoma CFR?*

Impact Indicators

Bugoma Central Forest reserve (Bugoma CFR) will not be directly affected by pipeline operation, which at its nearest point will be at least 1,8 km from the Bugoma CFR boundary. The indirect impacts of population influx to the CHAA, due to expectations of work or opportunities generated by the Project, are considered since this could impact on the forest reserve.

An analysis of the potential impacts of such influx on the habitat and ecosystem integrity of Bugoma CFR was accomplished by examining available literature about the ecology of Bugoma CFR, and scientific literature regarding the effects of migration and human population pressure on forests in Africa. The impacts are discussed, and their significance assessed through a **reasoned narrative**.

Impact Analysis

Bugoma CFR is identified as a valued component for this impact assessment, certainly in terms of biodiversity (see Table 25). As identified in that section, apart from being one of the last stands of tropical semi-deciduous forests in the region, it also supports known populations of the Endangered Eastern Chimpanzee and range-restricted Nahan's Francolin (Plumptre et al. 2011), potential non-breeding habitat for the Endangered Madagascar Pond Heron (see Section 6.3.3.1), as well as elephants and a host of other threatened and irreplaceable species.

Although Bugoma CFR will not be directly affected by pipeline operation, which at its nearest point will be at least 1,8 km from the Bugoma CFR boundary, the indirect effects of project-induced migration to the CHAA due to expectations of work on the Project or induced opportunities, have the potential to affect the ecological integrity of the habitats within the CFR, as well as the species of conservation concern that occur within it.

Bugoma CFR is under severe pressure from the human population surrounding it. In 2013, more than 1,500 people evicted illegally after settling within the forest (Mugerwa 2013), and recent (2016) reports from the area suggest that land-grab activity has resulted in the conversion of an estimated 8000 ha for sugar cane plantation development. The land cover study (see Figure 4) clearly shows that the areas surrounding the forest have largely been transformed for agricultural and subsistence purposes, and the transformation is now encroaching within the boundary of the CFR. This trend of encroachment of protected areas is not unique. Protected areas are known to be particularly vulnerable to changes in human demographics and deforestation; and Wittemyer et al. (2008) identified that human population growth and encroachment around protected areas is significantly higher than the average population growth in rural areas. This difference was largely due to the immigration of people into these areas because of the perceived increased availability of opportunities, natural resources and potential jobs (Wittemyer et al. 2008). This is supported by research conducted in the forests of the Albertine Graben, and the wider CHAA. For example, in a study of Budongo Central Forest Reserve, Zommers and MacDonald (2012), identified that of the local communities that hunted bush meat in the forest, nearly 73% were immigrants to the area. Furthermore, these workers identified that the households of immigrants were also more likely to be involved with deforestation.

The results of the recently-updated (Nov 2017) social baseline data gathering fieldwork indicated that in-migration to the CHAA has escalated significantly since the opening of the escarpment road, and commencement of preliminary construction works at the Kingfisher Development Area; this pattern of in-migration will probably continue throughout the operational lifetime of the Project.

An Influx Management Strategy and Framework Plan (Golder Associates 2018) was developed to manage the potential influx of people into the LSA. However, this plan can only focus on those measures over which CNOOC has control, and to support the range of government and donor projects in Uganda aimed at socio-economic development and environmental conservation. How this translates to the potential influx of people to the CHAA throughout the operational lifetime of the Project is unknown.

Impact Classification

Indirect impacts on Bugoma CFR due to population influx to the region during the operation of the feeder line will be adverse. The geographical extent of impacts will be regional because effects are restricted to Bugoma CFR, in the CHAA. Impact duration will be long-term, lasting for at least as long as the Project is in operation, and may be irreversible.

However, the magnitude of the impacts of population influx specifically associated with the operation of the pipeline on Bugoma CFR is expected to be negligible, given that the pipeline will be buried, rehabilitated and will be generally remote from the main Production Facility where in-migration is expected to be concentrated, and taking into consideration the distance of the rehabilitated pipeline from the Bugoma CFR boundary.

The sensitivity of the Bugoma Central Forest Reserve is high because it is a threatened ecosystem that is already under pressure. Therefore, the intensity and sensitivity combine to produce a minor overall impact level during the operation phase of the pipeline (Table 31).

The mitigation hierarchy is an important process that has been used to minimise impacts to Bugoma CFR. The focus for the continued application of the mitigation hierarchy to Bugoma CFR during the feeder line operation phase will consist of monitoring and adaptive management, as well as implementation of the Influx Management Strategy and Framework Plan for the Project (see Section 12.0).

With the implementation of such mitigation measures, the impact significance is expected to remain minor for the operational lifetime of the Project. (**Table 31**).

Table 38: Potential impacts in the construction phase to the Bugoma Central Forest Reserve

	Pre-mitigation			Post-mitigation		
	Magnitude	**Sensitivity of the Receptor**	**Significance**	**Magnitude**	**Sensitivity of the Receptor**	**Significance**
Habitat and ecosystem integrity	Negligible – 1	High – 4	Minor – 4	Negligible – 1	High – 4	Minor – 4

As noted above, the focus for reducing impacts to the Bugoma Central Forest Reserve is mitigation to avoid and minimise various types of disturbance that may occur (Section 12.0). Optimising mitigation will reduce residual impacts on the CFR to minor, and reduce the need for offsetting. However, possible offsetting options to ultimately achieve 'net gain' for the natural habitats of the forest have been identified and are discussed in Section 12.0.

11.2.2 What impact could the operation of the Feeder line have on species of concern?

This section presents the assessment of impacts that the operation of the Feeder line could have only on those relevant species of concern identified as biodiversity valued components; that is, Grey Crowned Crane, Nahan's Francolin and Eastern Chimpanzee (see Table 25). Since the operation of the feeder line will not affect the near-shore habitats of Lake Albert, potential effects on the Mud Snail *G. candida* are not considered. Potential impacts to other species of concern are assessed at the habitat level (see Section 11.2.1).

11.2.2.1 What impact could the operation of the Feeder line have on Grey Crowned Crane?

Grey Crowned Crane is an Endangered species. In the CHAA, it is associated with permanent and seasonal wetlands habitats.

Given that operational impacts on wetlands in the CHAA are expected (Section 10.2.1.2), the operation of the Feeder line could indirectly impact Grey Crowned Crane breeding and foraging habitat.

The potential direct, indirect and induced impacts to this species due to the operation of the Production Facility are presented below.

Impact Indicators

Indicators used to assess effects of the operation of the Feeder line on Grey Crowned Crane were: habitat quantity and quality, habitat connectivity, abundance and distribution, and survival and reproduction.

Potential changes in habitat quantity and quality, abundance and distribution, and survival and reproduction were assessed qualitatively by considering changes in disturbances arising from increased human presence in the CHAA. These disturbances were considered in light of known or inferred effects to the survival and reproduction of Grey Crowned Crane for which data on these types of effects are available.

Changes in habitat connectivity were assessed by identifying potential barriers to movement and loss of corridors. This was accomplished by visually examining the spatial distribution of critical habitat for Grey Crowned Crane (permanent and seasonal wetlands) in relation to the Feeder line to qualitatively identify any areas where habitat remains/may become fragmented during operation.

Impact Assessment

■ Habitat Quality and Quantity

Construction-phase losses of wetland habitat (permanent wetland) to the 30m-wide Feeder line construction right of way, consisting of 0.36 ha (0.5%) of 69 ha available habitat in the CHAA, will be mitigated through rehabilitation of the vegetation following construction; the ongoing reduction in habitat quantity and quality for Grey Crowned Crane during the time it takes for vegetation to re-establish is addressed in the construction phase impact assessment (Section 10.1.2.2).

The operational phase of the feeder line, as a component of the Project, could result in an influx of people into the area seeking employment/other opportunities. It can reasonably be expected that an increased human population in the CHAA will put pressure on the wetland habitats preferred by Grey Crowned Crane. These pressures could manifest in increased rates of habitat alteration and deforestation, reducing habitat quality and quantity for Grey Crowned Crane.

Although Grey Crowned Crane can tolerate a low degree of anthropogenic disturbance in foraging habitat (e.g. subsistence and commercial farming practises), in Ugandan wetlands it has been observed to be intolerant of human proximity within 100-200m (Olupot, 2014), flying away on approach; a factor which also affects breeding success as breeding birds flush from nests on approach, causing increased rates of predation, reduced time at the nest (either incubating or feeding), and ultimately nest abandonment. Increased human presence in the CHAA is likely to further reduce habitat quality for Grey Crowned Crane in the CHAA.

Effects from reductions in habitat quality and quantity during operation are predicted to be beyond the expected range of natural disturbance perturbations.

■ Habitat Connectivity

The impact of the feeder line operation as a barrier to the movement of Grey Crowned Crane during operation is likely to be neutral. The pipeline will be buried and the overlying vegetation will have been rehabilitated. Disturbance levels due to human presence in the area are expected to be minimal, compared to construction phase.

Impacts on habitat connectivity are predicted to be within the expected range of natural disturbance perturbations during operation.

■ Abundance and Distribution

The impact of the feeder line operation on the abundance and distribution of Grey Crowned Crane during operation is likely to be adverse. Although the pipeline will be buried and the overlying vegetation will be rehabilitated, restoring the extent of available foraging habitat, increased human presence in the CHAA throughout the operational lifetime of the feeder line is likely to result in settlement patterns that focus on wetland and riparian areas, which provide livestock grazing and crop production opportunities, and sources of freshwater. This is likely to affect the abundance and distribution of Grey Crowned Crane within the CHAA.

Impacts on species abundance and distribution are predicted to be beyond the expected range of natural disturbance perturbations during operation.

■ Survival and Reproduction

The impact of the feeder line operation on the abundance and distribution of Grey Crowned Crane during operation is likely to be adverse. As mentioned, increased human presence in the CHAA throughout the operational lifetime of the feeder line is likely to result in settlement patterns that focus on wetland and riparian areas. This further reduces the likelihood that Grey Crowned Crane would use the affected wetlands for

breeding during operation, and increases the likelihood of chick capture/nest abandonment if they did continue to use the area for breeding.

Impacts on species survival and reproduction are predicted to be beyond the expected range of natural disturbance perturbations during operation.

Impact Classification

The Grey Crowned Crane sensitivity is high because it is Endangered, and triggers Tier 2 critical habitat.

Impacts to Grey Crowned Crane habitat quantity and quality will be adverse. The geographical extent of impacts will be regional because population influx is expected to affect wetland habitat across the CHAA which will be reduced in quality as a result of habitat degradation and sensory disturbances, associated with in-migration. Impact duration will be into the far future (~25 years). Nevertheless, the magnitude of the effects of operation of the pipeline on Grey Crowned Crane habitat quantity and quality across the CHAA is considered low. Therefore, the magnitude and sensitivity combine to produce a moderate overall impact level, pre-mitigation. Following the application of appropriate mitigation measures, the impact significance is expected to remain moderate, as the pressures on Grey Crowned Crane associated with increased human presence across the CHAA are expected to be difficult to mitigate, affecting habitat quantity and quality (Table 39).

Impacts to Grey Crowned Crane habitat connectivity will be neutral. The geographical extent of impacts will be local because effects will be restricted to the 120 m of rehabilitated wetland habitat that will be crossed by the pipeline. The magnitude of the effects of operation of the pipeline on Grey Crowned Crane habitat connectivity is therefore considered negligible. The magnitude and sensitivity combine to produce a minor overall impact significance, and no further mitigation measures are considered necessary (Table 39).

The impact of the feeder line operation on the abundance and distribution of Grey Crowned Crane in the CHAA during operation is likely to be adverse. The geographical extent of impacts will be regional because population influx is expected to affect wetland habitat across the CHAA. Impact duration will be into the far future (~25 years). The magnitude of the effects of population influx during the operation of the pipeline on Grey Crowned Crane abundance and distribution is considered low. Therefore, the magnitude and sensitivity combine to produce a moderate overall impact level, pre-mitigation. Following the application of appropriate mitigation measures, the impact significance is expected to remain moderate, as the pressures on Grey Crowned Crane habitat suitability associated with increased human presence in the CHAA are expected to be difficult to mitigate, affecting the local distribution of the species (Table 39).

Impacts to the survival and reproduction of Grey Crowned Crane will be adverse. The geographical extent of impacts will be regional because population influx is expected to affect wetland habitat across the CHAA. Impact duration will be into the far future (~25 years). The magnitude of the effects of in-migration during operation of the pipeline on Grey Crowned Crane survival and reproduction is considered low. Therefore, the magnitude and sensitivity combine to produce a moderate overall impact level, pre-mitigation. Following the application of appropriate mitigation measures, the impact significance is expected to remain moderate, as the pressures on Grey Crowned Crane habitat suitability for breeding associated with human presence in the CHAA are expected to be difficult to mitigate, and the sensitivity of the receptor will remain the same (Table 39).

Table 39: Potential operation phase impacts to Grey Crowned Crane

Indicator of potential impact	Pre-mitigation			Post-mitigation (pre-offsets)		
	Magnitude	**Sensitivity of the Receptor**	**Significance**	**Magnitude**	**Sensitivity of the Receptor**	**Significance**
Habitat quality and quantity	Low – 2	High – 4	Moderate - 8	Low – 2	High – 4	Moderate - 8

Indicator of potential impact	Pre-mitigation			Post-mitigation (pre-offsets)		
	Magnitude	Sensitivity of the Receptor	Significance	Magnitude	Sensitivity of the Receptor	Significance
Habitat connectivity	Negligible - 1	High – 4	Minor - 4	Negligible - 1	High – 4	Minor - 4
Abundance and distribution	Low – 2	High – 4	Moderate - 8	Low – 2	High – 4	Moderate - 8
Survival and reproduction	Low – 2	High – 4	Moderate - 8	Low – 2	High – 4	Moderate - 8

Prediction Confidence

Given the information available, there is a reasonable understanding of the potential Project impacts on the Grey Crowned Crane and its habitat in the CHAA.

The spatial extent of wetland habitats in the CHAA was broadly mapped based on knowledge of the study area, baseline studies, literature and reports (see Section 6.1.1). The actual extent of possible habitat may have been over-estimated.

11.2.2.2   *What impact could the operation of the Feeder line have on Nahan's Francolin?*

Nahan's Francolin is a Vulnerable and range-restricted species. In the CHAA, it is restricted to the Bugoma Central Forest Reserve. It triggers Tier 2 critical habitat under Criterion 2 (Section 9.2, APPENDIX F).

Bugoma Central Forest reserve (Bugoma CFR) will not be directly affected by pipeline operation, which at its nearest point will be at least 1,8 km from the Bugoma CFR boundary. The indirect impacts of population influx to the CHAA, due to expectations of work or opportunities generated by the Project, are considered since this could impact on the forest reserve, and subsequently Nahan's Francolin.

Impact Indicators

As the pipeline will be at least 1.8 km from the Bugoma CFR boundary, no effects on habitat connectivity are predicted. Therefore, the indicators used to assess effects of the population influx associated with the operation of the feeder line on Nahan's Francolin were: habitat quantity and quality, abundance and distribution, and survival and reproduction.

Potential changes in habitat quantity and quality, abundance and distribution, and survival and reproduction were assessed qualitatively by considering changes in disturbances arising from increased human presence in the CHAA. These disturbances were considered in light of known or inferred effects to the survival and reproduction of buttonquail species for which data on these types of effects are available.

Impact Assessment

■   Habitat Quality and Quantity

The Nahan's Francolin's degree of vulnerability to disturbance is unknown. Birds are known to be sensitive to land use and habitat alteration (Lussier et al. 2006). The behavioural response of species to disturbance will depend on species-specific tolerance levels, disturbance type and frequency, group size for socially-foraging animals, and local conditions, such as the availability of alternative foraging sites (Madsen 1998). A reduction in habitat quality and quantity may have conservation implications and consequences for the population of this species.

The operational phase of the feeder line, as a component of the Project, could result in an influx of people into the CHAA seeking opportunities. It can reasonably be expected that an increased human population in the area surrounding the Bugoma Central Forest Reserve will put pressure on the forest. These pressures could manifest in increased rates of habitat alteration and deforestation. Nahan's Francolin is a shy, forest-dependent species (Sande et al. 2009a) and thus is also probably sensitive to disturbance arising from deforestation/human presence in the forest. These factors could combine to reduce the habitat quality and quantity for Nahan's Francolin.

Effects from loss of habitat are predicted to be beyond the expected range of natural disturbance perturbations.

■   Abundance and Distribution

Nahan's Francolin is reported to be relatively common in the Bugoma Central Forest Reserve (Plumptre et al. 2011). Although the pipeline will be at least 1.8 km from the Bugoma CFR boundary, the indirect impacts of population influx to the CHAA, due to expectations of work or opportunities generated by the Project, could ultimately affect the abundance and distribution of Nahan's Francolin in the CHAA.

The operation of the pipeline, as a component of the overall Project, could result in an influx of people into the area seeking jobs and/or opportunities. It can reasonably be expected that an increased human population in the area surrounding the Bugoma CFR and within the CFR itself will exacerbate existing pressures on the forest. These pressures are likely to manifest in increased rates of bush meat hunting and habitat alteration. These factors could reduce the abundance and distribution of Nahan's Francolin.

Effects from the operation of the pipeline are predicted to be beyond the expected range of natural disturbance perturbations.

■   Survival and Reproduction

The Nahan's Francolin's degree of vulnerability to direct disturbance, particularly during the breeding season, is not well understood. Generally, for birds, the behavioural response of species to disturbance will depend on species-specific tolerance levels, disturbance type and frequency, group size for socially-foraging animals, and local conditions such as the availability of alternative breeding sites (Madsen 1998). Many studies have reported a reduction in breeding success attributable to human disturbance (for a review, see Hill et al. 1992). Mechanisms include: increased rates of predation, nest abandonment and reduced time at the nest, either incubating or feeding. Clearly, a reduction in breeding output may have conservation implications and consequences for the local population of Nahan's Francolin.

The operation of the pipeline, as a component of the overall Project, could result in an influx of people into the area seeking opportunities. It can reasonably be expected that an increased human population in the area surrounding the Bugoma CFR and within the CFR itself will exacerbate existing pressures on the forest. These pressures could manifest in increased rates of bush meat hunting and habitat alteration, which could reduce the survival and reproductive success of Nahan's Francolin.

These effects to the survival and reproductive success of Nahan's Francolin are predicted to be beyond the expected range of natural disturbance perturbations.

Impact Classification

The Nahan's Francolin's sensitivity is high because it is range-restricted, and triggers Tier 2 critical habitat.

Impacts to the Nahan's Francolin's habitat quantity and quality will be adverse. The geographical extent of impacts will be regional because effects are restricted to Bugoma CFR. Impact duration will be long-term. The magnitude of the impact of population influx associated with the operation of the pipeline, on the habitat quantity and quality of the Nahan's Francolin is expected to be negligible (see Section 10.2.1.3). Therefore, the intensity and sensitivity combine to produce a minor overall impact level during the operational phase of the Project, and no further project-specific mitigation measures for the operation phase are considered necessary (Table 23).

Impacts to the Nahan's Francolin's abundance and distribution could be adverse. The geographical extent of impacts will be regional because effects are restricted to Bugoma CFR. Impact duration will be long-term. The magnitude of the impact of population influx associated with the operation of the pipeline on the abundance and distribution of the Nahan's Francolin is expected to be negligible (see Section 10.2.1.3). Therefore, the intensity and sensitivity combine to produce a minor overall impact level during the operational phase of the feeder line, and no further project-specific mitigation measures for the operation phase are considered necessary (Table 23).

Impacts to the survival and reproduction of Nahan's Francolin could be adverse. The geographical extent of impacts will be regional because effects are restricted to Bugoma CFR. Impact duration will be long-term. There is a possibility that individuals could be killed or severely disturbed as a result of population influx to the region during the operation phase. A threshold of 10% for this species' survival and reproduction in the CHAA is reasonable, and it is not expected that this number of individuals in the local population within Bugoma CFR will be affected. The magnitude of the effects of operation of the feeder line on the survival and reproduction of the Nahan's Francolin is therefore negligible. Therefore, the intensity and sensitivity combine to produce a minor overall impact level during the operational phase of the feeder line, and no further project-specific mitigation measures for the operation phase are considered necessary (Table 23).

Table 40: Potential impacts in the operational phase to the Nahan's Francolin

Indicator of potential impact	Pre-mitigation			Post-mitigation		
	Magnitude	Sensitivity of the Receptor	Significance	Magnitude	Sensitivity of the Receptor	Significance
Habitat quality and quantity	Negligible - 1	High – 4	Minor - 4	Negligible - 1	High – 4	Minor - 4
Abundance and distribution	Negligible - 1	High – 4	Minor - 4	Negligible - 1	High – 4	Minor - 4
Survival and reproduction	Negligible - 1	High – 4	Minor - 4	Negligible - 1	High – 4	Minor - 4

Prediction Confidence

Given the information available, there is a reasonable understanding of the potential direct, indirect and induced impacts that the operation of the feeder line could have on the Nahan's Francolin and its habitat in the CHAA.

The spatial extent of the dense forest habitat in the CHAA was broadly mapped based on knowledge of the site, baseline studies, literature and reports (see Section 6.3.1.1). The actual extent of possible habitat may have been over-estimated.

11.2.2.3 *What impact could the operation of the Feeder line have on Eastern Chimpanzee?*

Eastern Chimpanzee is an Endangered species. A population occurs in the Bugoma Central Forest Reserve. This species triggers Tier 1 critical habitat.

Bugoma Central Forest reserve (Bugoma CFR) will not be directly affected by pipeline operation, which at its nearest point will be at least 1,8 km from the Bugoma CFR boundary. The indirect impacts of population influx to the CHAA, due to expectations of work or opportunities generated by the Project, are considered since this could impact on the forest reserve, and subsequently Eastern Chimpanzee.

Impact Indicators

As the pipeline will be at least 1.8 km from the Bugoma CFR boundary, no effects on habitat connectivity during operation are predicted. Therefore, the indicators used to assess effects of the population influx associated with the operation of the feeder line on Eastern Chimpanzee were: habitat quantity and quality, abundance and distribution, and survival and reproduction.

Potential changes in habitat quantity and quality, and abundance and distribution, were assessed qualitatively by considering changes in disturbances arising from increased human presence in the CHAA. These disturbances were considered in light of known or inferred effects to the survival and reproduction of other populations of chimpanzees for which data on these types of effects are available.

To assess effects to survival and reproduction as a result of in-migration and potential associated increases in poaching and disease spread, in-migration rates were assessed based on the data presented in the social impact assessment. A literature review of the impact of contact with humans was also conducted.

Impact Assessment

■   Habitat Quality and Quantity

The potential for the feeder line (as a component of the overall Project) to be attractive for people seeking opportunities could result in a substantial increase the current population around the Bugoma Central Forest Reserve. An increasing human population could lead to an increase in the demand for agricultural and timber resources, resulting in increased rates of habitat alteration and deforestation, which, in turn could further fragment, change, and degrade Bugoma CFR and surrounding habitat.

The degree of vulnerability to disturbance experienced by chimpanzees is reasonably well known (for example, see Parren and Byler 2003, Rabanal et al. 2010, Thompson and Wrangham 2013). The chimpanzees living in and around the Bugoma Central Forest Reserve most likely experience sensory disturbances at present from human activities, given the high human populations living around the reserve. Indeed, groups are known to forage in the agricultural fields surrounding the forest, and hence, would more than likely be used to human noises and disturbances (McLennan 2008). As such, the potential sensory disturbances arising from population influx associated with the operation of the pipeline are likely to be minimal. Nevertheless, the magnitude of noise may not be the most important determinant of chimpanzee response. Instead, chimpanzees may respond to 'new' noises or may associate particular noises with other occurrences (for example, machine noise may be associated with human presence, which chimpanzees may, in turn, associate with the presence of danger). Where humans pose a threat, chimpanzees generally avoid them (Hockings and Humle 2009, Parren and Byler 2003). Therefore, the degree of avoidance may depend on the behaviour of people, resulting in varying levels of indirect effects on the quality of available habitat for Eastern Chimpanzee.

Effects from the reduced habitat quantity and quality during operation are predicted to be beyond the expected range of natural disturbance perturbations.

■   Abundance and Distribution

The Bugoma Central Forest Reserve supports one of the top four Eastern Chimpanzee populations in Uganda, with a population of between 450 and 850 individuals (Plumptre et al. 2010). Given its distance from the forest, the operation of the feeder line is not expected to detrimentally affect the abundance or distribution of chimpanzees in the forest directly.

The long-term presence of the feeder line as a component of the overall Project could continue to influence influx of people into the area seeking opportunities. It can reasonably be expected that an increased human population in the area surrounding Bugoma CFR will put pressure on the forest. These pressures could manifest in increased rates of bush meat hunting, and reduced habitat availability, which could affect the abundance and distribution of Eastern Chimpanzee within Bugoma CFR.

Effects are predicted to be beyond the expected range of natural disturbance perturbations.

■   Survival and Reproduction

In-migration of people seeking opportunities associated with the Project and feeder line may adversely affect survival and reproduction of chimpanzees through poaching and disease transfer. Hunting and poaching is a recognised threat to chimpanzees in Bugoma Central Forest Reserve (Plumptre et al. 2003), and this pressure could increase as in-migration of people from other areas occurs.   Mitigation and management of in-migration (see Golder Associates 2018) will be very important to minimise potential effects on chimpanzees and other fauna species.

Disease is one of the major threats to Eastern Chimpanzees (Oates et al. 2008); increased abundance of people and competition for land and food resources between humans and chimpanzees could lead to higher rates of disease spread from humans to chimpanzees. Chimpanzees are closely related to humans; therefore, many diseases are transferrable between chimpanzees and humans (Formenty et al. 2003; Isabirye-Basulta and Lwanga 2008). Either direct or indirect contact with humans can spread disease. For example, there is evidence to suggest that respiratory illnesses have been transferred directly to chimpanzees from humans as a result of researcher and tourist contacts, often leading to outbreaks and death (Formenty et al. 2003). Human defecation in forest undergrowth can indirectly lead to spread of intestinal diseases, such as *Clostridium perfringens*, which can be fatal to chimpanzees (Fujita 2011). As forest fragments decrease in size, risks of contact with, and transmission of, disease from humans increases (Isabirye-Basulta and Lwanga 2008). Factors that lead to increased crop raiding or sharing of water resources can also increase the risk of disease spread (Hockings and Hulme 2009). As identified in the social impact assessment, communicable respiratory diseases are a significant concern in the LSA.

What effect the loss of individuals from the population could have is unknown. It is doubtful that the population could be reduced by 10% and hence, reach that critical population threshold due to population influx associated with the pipeline alone, nevertheless the potential impacts are predicted to be beyond the expected range of natural disturbance perturbations.

Impact Classification

The Eastern Chimpanzee's sensitivity is high because it is Endangered.

Impacts to the Eastern Chimpanzee's habitat quantity and quality will be adverse. The geographical extent of impacts will be regional because effects are restricted to Bugoma CFR. Impact duration will be long-term. The amount of influx that could be specifically attributed to the operation of the feeder line is expected to be negligible, therefore magnitude of the impact of population influx associated with the operation of the pipeline, on the habitat quantity and quality of the of the Eastern Chimpanzee is expected to be negligible.

Therefore, the magnitude and sensitivity combine to produce a minor overall impact level during the operation phase of the feeder line, and no further project-specific mitigation measures for the operation phase are considered necessary (Table 41).

Impacts to the Eastern Chimpanzee's abundance and distribution could be adverse. The geographical extent of impacts will be regional because effects are restricted to Bugoma CFR. Impact duration will be long-term. Given its distance from the forest, the operation of the feeder line is not expected to affect the abundance and distribution of Eastern Chimpanzee in Bugoma CFR, however the Project-associated population influx has the potential to generate impacts. The amount of influx that could be specifically attributed to the operation of the feeder line is expected to be negligible, therefore the magnitude of the effects of operation on the abundance and distribution of the Eastern Chimpanzee is negligible. Therefore, the magnitude and sensitivity combine to produce a minor overall impact level during the operation phase of the feeder line, and no further project-specific mitigation measures for the operation phase are considered necessary (Table 41).

Impacts to the survival and reproduction of the population of Eastern Chimpanzee in Bugoma Central Forest Reserve could be adverse. The geographical extent of impacts will be national because effects could extend well beyond the CHAA. Impact duration will be long-term. There is a possibility that individuals could be killed or severely disturbed as a result of Project-related population influx during the operation phase. A threshold of 10% for this species' survival and reproduction in the CHAA is reasonable, and it is expected that this

number of individuals in the local population within Bugoma Central Forest Reserve could be affected through direct mortality from bush meat hunting or other disturbance. However, the amount of influx that could be specifically attributed to the operation of the feeder line is expected to be negligible, therefore, the magnitude of the effects of operation on the survival and reproduction of the Eastern Chimpanzee is expected to be negligible. Therefore, the magnitude and sensitivity combine to produce a minor overall impact level during the operation phase of the feeder line, and no further project-specific mitigation measures for the operation phase are considered necessary (Table 41).

Table 41: Potential impacts in the operation phase to the Eastern Chimpanzee

Indicator of potential impact	Pre-mitigation			Post-mitigation		
	Magnitude (the expected size of the impact)	Sensitivity of the Receptor	Significance	Magnitude (the expected size of the impact)	Sensitivity of the Receptor	Significance
Habitat quality and quantity	Negligible - 1	High – 4	Minor - 4	Negligible - 1	High – 4	Minor - 4
Abundance and distribution	Negligible - 1	High – 4	Minor - 4	Negligible - 1	High – 4	Minor - 4
Survival and reproduction	Negligible - 1	High – 4	Minor - 4	Negligible - 1	High – 4	Minor - 4

Prediction Confidence

Given the information available, there is a reasonable understanding of the potential direct, indirect and induced impacts that the operation of the feeder line could have on the Eastern Chimpanzees and their habitat in the CHAA.

The spatial extent of the dense forest habitat in the CHAA was broadly mapped based on knowledge of the site, baseline studies, literature and reports (see Section 6.1.1). The actual extent of possible habitat may have been over-estimated.

12.0 RECOMMENDATIONS FOR MITIGATION AND MONITORING

In applying mitigation to the impact assessment process, it was assumed that the proposed Project design followed the mitigation hierarchy; that is: avoidance; minimisation; rehabilitation; offsets and additional conservation actions (after BBOP 2012, and CNOOC's in-house biodiversity management and aquatic and terrestrial habitat management specifications), and that the Project components and activities assessed here have taken into consideration the application of the mitigation hierarchy. The general principals of the mitigation hierarchy incorporated into the Project design are outlined in Section 12.1.

Nevertheless, additional, impact-specific mitigation measures have been developed for each impacted valued component, in order to minimise residual impacts as much as possible, and ensure that these specific measures are carried through to the Project ESMP for ongoing monitoring and management. These recommended mitigation measures for specific construction and operation-related Project impacts and the schedule for their completion is provided in Section 12.2.

12.1 Mitigation Hierarchy

The following sections describe, at a high level, the mitigation measures that CNOOC will use. These mitigation measures follow the mitigation hierarchy (sensu, BBOP 2012), as embodied in CNOOC's *Biodiversity Management Specification* (CNOOC 2014a) and *Aquatic and Terrestrial Habitat Management Specification* (CNOOC 2014b).

12.1.1   Avoidance

Avoidance measures include:

■ Locate Project infrastructure in already disturbed and affected habitats, where feasible.

■ Locate primary roads (and other linear facilities) away from sensitive areas, where feasible.

■ Reuse existing or remnant road networks where possible.

■ Limit areas of surface disturbance.

12.1.2   Minimisation

Minimisation measures are measures taken to reduce the duration, magnitude and/or extent of impacts to valued components that cannot be completely avoided, as far as is practically feasible. Minimisation measures include:

■ Footprint and Infrastructure

   ▪ Limit width of roads and size of Project component areas.

   ▪ Plan an access and road network to minimise total length.

■ Physical Hazards

   ▪ Restrict vehicle speeds on roads.

   ▪ Use of buses to transport workers.

   ▪ As possible, restrict construction traffic to daylight hours to reduce the risk of vehicle collisions.

   ▪ Install under road crossing structures (for example, culverts) suitable for amphibians and small reptiles, along the access road to reduce road mortalities and improve habitat connectivity.

   ▪ Do not leave pipeline trenches open overnight.

   ▪ Employ appropriate identification techniques for guy wires and other tall structure like drill rigs.

■ People Management

   ▪ Preferentially hire from the local communities to minimise regional human population growth and the associated increase in human encroachment into valued component habitat and direct mortality from illegal hunting.

   ▪ No hunting or collection of fish, flora and fauna permitted for staff and/or contractors.

   ▪ Identify no-go areas for Project personnel; for example, the lake shore and the Bugoma Lagoon.

   ▪ Diseases and pests are controlled to a large extent by proper cleaning, disinfecting, and/or sterilising. To this end, for example, CNOOC will implement widely accepted protocols aimed at minimising the risk of transmitting amphibian chytrid fungus disease in/or around the Project site on footwear, vehicles, field equipment, or while handling amphibians in the wild.

   ▪ Prevent or minimise the potential for community exposure to water-borne, water-based, water-related, vector-borne disease, and other communicable diseases that could result from Project activities. Explore opportunities during the project life cycle to improve environmental conditions that could help reduce their incidence.

   ▪ Mandatory environmental training for all workers and contractors that highlights conservation issues and species-specific sensitivities.

- Noise

  - Noise mitigation developed for human receptors will benefit valued components receptors.

  - Limit hours of operation to avoid nocturnal valued component activity periods (that is, nocturnal species).

  - Minimise noise-related disturbances (for example, vehicular traffic) within 200 m of identified sensitive receptors. Some mitigations with special relevance to sensitive valued components include:
    - selection of equipment with lower sound power levels
    - installing enclosures or acoustic barriers without gaps, and with continuous minimum surface density of 10 kg.m^{-2} to minimise transmission of sound through the barrier
    - installing vibration isolation devices for mechanical equipment or ensuring that foundations for equipment are designed to minimise transmission of vibration
    - re-locating noise sources to less sensitive areas to take advantage of distance and shielding
    - installation of barriers at facility boundaries such as vegetation curtains or overburden storage areas/soil berms.

  - Minimise higher frequency noises.

  - Stage any progressive noise disturbances (for example, construction activities) to begin at the centre of disturbance (that is, start construction farthest away from known sensitive receptors like population centres) and move progressively towards the edge of habitats, allowing populations to adjust to increasingly closer noise.

- Light

  - Do not use bare light bulbs or any lighting pointing upward or outwards, particularly at the periphery of the project footprint or out into the lake.

  - Use the minimum number and brightness of lights required for safety.

  - Use narrow spectrum bulbs to minimise the range of species affected by lighting (for example, longer wave length red or yellow bulbs rather than "natural" or white light).

  - Light only high-risk stretches of roads such as crossings and merges.

  - Implement a Light Management Plan, where lighting that is not needed at a given time is turned off.

  - Retention of at least 10 m of unlit habitat (for example, on either side of key bat commuting/foraging areas) to prevent loss of habitat connectivity.

- Other

  - Develop and adhere to airborne pollutant critical load benchmarks (see Golder Associates 2014g) for terrestrial and/or aquatic system impacts for the Project.

  - Use dust control methods, such as covers, water suppression, or increased moisture content for open materials storage piles.

  - Control garbage through incineration and covering of landfill to avoid attracting fauna.

  - Conduct site clearing in a pattern to avoid creating habitat 'islands' within the footprint.

  - Conduct site clearing so that progression of clearing moves animals towards intact habitat.

12.1.3   Reclamation

■   Reclamation of all disturbed areas with indigenous species after decommissioning to approximate pre-existing vegetation.

■   Reclamation of those areas in the Project's construction footprint that are no longer needed for the operational phase will minimise the amount of disturbed habitat. Areas no longer required for the Project should be reclaimed as soon as possible. For example, reclamation of existing disturbances within the CHAA that will not be needed for the project.

■   Access roads used for construction that will not be needed for Project operation will be closed and reclaimed to natural vegetation when they are no longer needed.

12.1.4   Offsetting

In line with the IFC's PS6, offsetting has been considered as an option to achieve no net loss and, preferably, net gain, when residual impacts are identified for valued components that trigger critical habitat and/or natural habitat designations, and where reclamation following the Project's decommissioning are expected not to meet the no net loss philosophy for a valued component. As required, possible offsetting strategies for each affected valued component are discussed in Section 13.0. Actual offsetting strategies should be developed on a landscape-scale, in liaison with other partners and as part of a Biodiversity Action Plan.

12.2   Site-Specific Mitigation Measures and Schedule for Completion

12.2.1   Pre-construction Phase

Prior to the commencement of construction activities, a number of additional studies should be conducted to gain a more thorough understanding of certain biodiversity valued components. These studies will also better inform those impacts and impacts that have a high degree of uncertainty. These include the following:

h)   Confirm that the Critically Endangered Mud Snail (*Gabbiella candida*), and the range restricted and Near Threatened Snail (*Bellamya rubicunda*) do not occur in CHAA, prior to commencement of construction of the new water intake and pumping station.

i)   The nesting times of Grey Crowned Crane on the Buhuka Flats.

j)   The relative importance of the Buhuka Flats for migratory bird species.

k)   The precise boundaries and locations of the wetlands along the pipeline route.

l)   The location of caves and cavities along the escarpment that could be important for cavity-roosting bats.

12.2.2   Construction and Decommissioning Phase

The mitigation measures are presented below and summarised on Table 42. Possible offset mechanisms are summarised in Table 50.

12.2.2.1   *Construction and Decommissioning Phase Impacts on Ecosystems of Concern*

Near-shore habitats of Lake Albert

The following impact mitigation is recommended to minimise the risks of spillages and discharges affecting the near-shore habitats of Lake Albert:

■   Make provision for the designs of well pads to be checked by pollution control experts to ensure that the risks of spillage/overflow associated with drilling pollution management systems is minimised.

■   Establish a pollution management system, to be fully defined in the Contractor's contractual commitments, covering personnel, training, lines of responsibility, immediate action requirements, on-site

spill kits, and all other factors necessary to ensure there is a provision for effective preventative and corrective action during all stages of construction and drilling.

■ All machinery and vehicles must be certified as being free of weed propagules, prior to travelling to the construction site. Issue clearance certificates for each piece of machinery and equipment. The responsibility for ensuring that vehicles are free of weed propagules lies with the vehicle operators, and certification should be verified by CNOOC prior to entry to site.

■ Develop a culture of zero tolerance for pollution during the construction phase of the project.

■ Provide a high level of competent environmental oversight during drilling of wells and construction of the CPF.

■ Provide for thorough induction training of all construction personnel regarding pollution management, and ongoing refresher training throughout the construction/drilling contracts.

■ Provide specific training to staff responsible for the oversight of pollution control systems

■ Ensure structured, daily, monitoring of pollution control systems on the well pads and at the CPF to minimise the risk of inadvertent spills and to respond quickly and effectively to any spills that occur. Emphasis must be on preventative measures.

■ If biocides are used in hydrotest water, then the discharge should be retained until it is confirmed to pass biotoxicity testing standards; if it fails to achieve these it should be treated appropriately to achieve required standards.

■ Develop specific biological monitoring performance indicators as a part of the Construction and Drilling EMPs.

The following impact mitigation is recommended to minimise the risks of the construction of the new water intake station affecting sediment drift patterns on the near-shore habitats of Lake Albert:

■ Construction of the water intake station on wooden or concrete piles, rather than extending a rock foundation-type structure (similar to the existing jetty) from the lake shore to the intake point, to minimise effects on lakeshore currents and long-shore drift of sediments.

■ In the case where sediment build-up on the wave-ward side of the water-intake station structure becomes an impediment to its daily operation, excavated sediment should be redistributed to any eroded areas down-drift of the intake structure, as well as at the existing jetty structure.

Escarpment Vegetation Corridors

The following mitigation and monitoring is proposed:

■ Pre-construction surveys for species of concern associated with the escarpment vegetation corridors, in particular, bats and potential bat roosts, should be completed.

■ Construction activities that generate noise and vibrations, particularly blasting activity that may be necessary to excavate trenches for the pipeline, should only occur during designated times.

■ The use of high-frequency noise emitters (e.g. vehicle reverse signals) should be minimised.

■ Rehabilitation of vegetation communities following completion of construction work and burial of pipeline.

■ Develop plans, with Government, to reduce the risk of in-migration and subsequent increases in natural resource harvesting pressure into the area during the construction phase (further detail of the actions required are included in Social Impact Assessment)

■ Develop specific biological monitoring performance indicators as a part of the Construction and Drilling EMPs.

Wetlands

The following impact mitigation and monitoring is recommended:

■ Undertake pre-clearance surveys for wetland species of concern within and near the project footprint, such as nesting and foraging sites of the Grey Crowned Crane. Implement measures to ensure that the risk to these species is minimised.

■ Minimise wetland vegetation cleared for the Kamansinig flowline crossing to the smallest possible footprint.

■ Demarcate the construction right of way across the Kamansinig wetland to prevent inadvertent damage outside of this footprint.

■ Preferably undertake the construction of the flowline crossing across the Kamansinig wetland in the dry season.

■ Prohibit access to personnel outside of the defined project work sites and access roads. Train personnel to understand the sensitivity of the local environment in induction and ongoing tool box talks.

■ Specifically prohibit project personnel from access to the Bugoma Lagoon which is resource of exceptionally high ecological and cultural value. The Bugoma Lagoon is a part of the Kamansinig wetland system, all of which is regarded as sensitive

■ Ensure that erosion protection measures are in place during construction to minimise runoff from disturbed areas into the rivers and wetlands

■ Develop a detailed method statement for the flowline wetland crossing of the Kamansinig River to well Pad 3; defining the requirements to contain construction equipment within the construction footprint, to minimise compaction of wetland soils, to reinstate any clay layers and replace soils in the correct order and to return the wetland to the same profile that existed before construction.

■ Ensure that all vehicles and machinery are in sound mechanical order, do not have any oil leaks and are fitted with appropriate mufflers to minimise nuisance affecting wildlife.

■ Ensure that any pumps, generators or other equipment containing oil used to manage water at the wetland crossing are located on impervious plastic sheeting or drip trays.

■ Prohibit any refuelling of equipment within 100 m of a wetland.

■ Minimise the use of backfill intended to provide firm footing for vehicles in wetlands, and implement measures to ensure that diffuse flow of water in the wetlands is maintained.

■ Manage all hazardous products and wastes to minimise the risk of escaped outside of controlled areas (management according to measures recommended in Waste)

■ Adjust the final design of the canals channelling stormwater and treated sewage effluent from the CPF to remain outside of the seasonally wet areas associated with River 1 as far west as possible, crossing the river channel just upstream of the road culvert.

■ From the culvert onward, it may be necessary to canalise the flow to the lake. Use open cross section swales for this purpose (not concrete canalisation), reinforced if necessary and grassed. Finalise the canal design and the alignment of the stormwater drains with the assistance of a wetland ecologist.

Bugoma CFR

The following impact mitigation and monitoring is recommended:

■ De-list the R5 from the proposed oil road upgrades. CNOOC has confirmed that it does not need this road, either for construction or operational purposes. The Ugandan Government has been formally

notified. CNOOC will use the P1 as the major haul road during the construction phase and, if upgraded in time, the R7.

■ Limit vehicle speeds to 40 km/h along the P1 road in the section from Mpanga to Nsozi. Monitor vehicle speeds and fine drivers who do not comply with the speed limit.

■ Prohibit transport of construction materials in the area of the forest at night.

■ Widen the P1, where necessary, on the non-forest side of the road in order to minimise forest habitat loss.

■ Ensure that all EPC contract transporters are fully aware of the risks to wildlife in the Bugoma Forest.

■ Increase monitoring of population changes in the CHAA and, in particular, any incursions into the BCFR by settlement or people harvesting natural resources. A strategy for this initiative is discussed in further detail in the Cumulative Impact Assessment.

■ Implement the Influx Management Strategy and Framework Plan (Golder Associates 2018) that has been developed to manage the potential influx of people into the LSA. However, this plan can only focus on those measures over which CNOOC has control, and to support the range of government and donor projects in Uganda aimed at socio-economic development and environmental conservation. How this translates to the potential influx of people along an improved P1 road is unknown.

12.2.2.2 *Construction and Decommissioning Phase Impacts on Species of Concern*

Mud Snail (*Gabbiella candida*)

The following impact mitigation and monitoring is recommended:

■ Undertake final targeted, once off, specialist surveys for *G. candida* before construction starts at the sites where construction disturbance will occur in Lake Albert (jetty expansion and water intake). The surveys should ascertain the presence/absence of *G. candida* in the near-shore habitats of Lake Albert within the CHAA.

■ Since this species triggers Tier 1 Critical Habitat, if it is found to be present, work in near-shore habitats should be postponed until appropriate solutions for the conservation and management of *G. candida* are devised by suitably experienced molluscan specialists, and approved by NEMA.

■ If found to be present, the Client will need to demonstrate that the proposed construction activities will affect less than 10% of the known global population of the species – a comprehensive survey of habitats with potential to support the Mud Snail on the shores of Lake Albert will be required to support this demonstration. Thereafter, if less than 10% of the known population would be affected, a Species-Specific Action Plan as part of the overall Biodiversity Action Plan (BAP) must be developed to achieve net gain for the affected species.

■ The construction phase mitigation measures for near-shore aquatic habitats (Section 12.2.2.1) should be implemented and strictly adhered to in order to minimise potential loss, fragmentation or degradation of the Mud Snail's habitat.

Grey Crowned Crane

The following impact mitigation and monitoring is recommended:

■ Implement the mitigation set out for wetlands under Section 12.2.2.1 to reduce further loss, fragmentation and degradation of habitats.

■ Implement measures to avoid and minimise impacts on Grey Crowned Crane abundance and distribution, and reproduction and survival in the CHAA, and the Buhuka Flats in particular. Measures should include:

- ▪ Restrict access by any CNOOC staff, subcontractors and members of the public from any identified areas of breeding habitat used by Grey Crowned Crane within 200 m of suitable nesting sites.

- ▪ Prohibit CNOOC staff and construction subcontractors from entering areas beyond the construction rights of way.

- ▪ Develop and disseminate community education programmes on Grey Crowned Crane habitat conservation, prevention of illegal trade in wild birds and chicks, and prevention of incidences of poisoning.

- ▪ Develop a Grey Crowned Crane conservation plan for the Buhuka Flats.

- ■ Develop and implement a long-term research and monitoring programme to improve understanding of the behaviour and status of Grey Crowned Crane in the CHAA (this recommendation is developed further in Cumulative Impact Assessment).

Nahan's Francolin

The following impact mitigation and monitoring is recommended:

- ■ Implement the mitigation set out for Bugoma CFR under Section 12.2.2.1.

- ■ Large, mature buttressed trees that constitute suitable nesting habitat for Nahan's Francolin should be avoided during vegetation clearance works for the P1 road upgrade.

- ■ Implement measures to minimise impacts on Nahan's Francolin abundance and distribution, and reproduction and survival in the CHAA, particularly those arising from sensory disturbance caused by human presence and mechanical noise generated during construction activity associated with the P1 road upgrade activity. These should include restrictions in operating hours for heavy machinery, use of low-pitched reverse alerts, and restriction of access for road construction workers to areas beyond the road upgrade right of way.

- ■ Develop and implement a long-term research and monitoring programme to improve understanding of the behaviour and status of Nahan's Francolin in Bugoma Forest (this recommendation is developed further in Cumulative Impact Assessment).

- ■ Support the government in enforcement of existing government forestry policies in Uganda.

Eastern Chimpanzee

The following impact mitigation and monitoring is recommended:

- ■ Implement the mitigation set out for Bugoma CFR under Section 12.2.2.1.

- ■ Implement measures to minimise impacts on Eastern Chimpanzee abundance and distribution, and reproduction and survival in the CHAA, particularly those arising from sensory disturbance caused by human presence and mechanical noise generated during construction activity associated with the P1 road upgrade activity. These should include restrictions in operating hours for heavy machinery, use of low-pitched reverse alerts, and restriction of access for road construction workers to areas beyond the road upgrade right of way.

- ■ Develop and disseminate community education programmes on Eastern Chimpanzee habitat conservation, and prevention of illegal trade in wild animals for live trade and bushmeat, in liaison with existing Eastern Chimpanzee conservation programmes (e.g. Jane Goodall Institute Uganda's environmental education programme).

- ■ Develop and implement a long-term research and monitoring programme to improve understanding of the behaviour and status of the Eastern Chimpanzee in Bugoma Forest (this recommendation is developed further in Cumulative Impact Assessment).

- Support the government in enforcement of existing government forestry policies in Uganda.

Table 42: Mitigation and management measures for biodiversity, during the construction and decommissioning phases of the Project

Specific impact	Affected ecosystem/species of Concern	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Responsible Entity	Training Necessary
Reduced abundance/ distribution of species of concern Reduced survival/ reproduction of species of concern	Grey Crowned Crane Escarpment vegetation corridor Wetlands	Pre-clearance surveys for species of concern and habitats of special significance within and near the Project footprint; e.g. nesting sites of species of concern (Grey Crowned Crane), bat roosting sites	■ Number of species located ■ Locality and populations of invasive species ■ Location of significant habitats, including nesting sites ■ Locations of suitable relocation sites for individuals ■ Number of individuals relocated ■ Realignment of Project footprint to avoid sensitive habitats	Weekly, before any clearing activities	CNOOC and Contractors	■ Identification of species of concern ■ Management and control of invasive species ■ Impactive management of bat roosts ■ Handling of animals ■ Impactive translocation of threatened plants, and/or collection of reproductive material
	Mud Snail (*Gabbiella candida*)	Targeted surveys for Mud Snail (*Gabbiella candida*)	■ Number of survey plots and samples	Once off before construction activities	CNOOC	■ Specialist required to survey for, and identify, snails
Spread of invasive species	Near-shore habitats Escarpment vegetation corridor Wetlands Bugoma CFR	All machinery and vehicles entering the site should be certified clear of weed propagules	■ Inspection forms and clearance certificates for each vehicle and piece of machinery	As required before new machinery or vehicles arrive at site	CNOOC and Contractors	■ Impactive clean down of machinery and vehicles to remove weed seeds

Specific impact	Affected ecosystem/species of Concern	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Responsible Entity	Training Necessary
			working on the site			
Sensory disturbance	Near-shore habitats Escarpment vegetation corridor Wetlands Bugoma CFR Grey Crowned Crane Nahan's Francolin Eastern Chimpanzee	All vehicles and machinery are in sound mechanical order and fitted with appropriate mufflers	■ Service records for each piece of machinery and vehicle ■ Daily pre-start inspection logs for each vehicle and piece of machinery	Daily	CNOOC and Contractors	■ Daily pre-start vehicle inspection
Sensory disturbance	Near-shore habitats Escarpment vegetation corridor Wetlands Bugoma CFR Grey Crowned Crane Nahan's Francolin	Noise management	■ Noisy construction activities only occur during designated times ■ High frequency noise emitters minimised	Daily	CNOOC and Contractors	■ Noise management
Clearing of vegetation	Near-shore habitats Escarpment vegetation corridor Wetlands Bugoma CFR	Restrict access Minimise clearance footprint	■ No go areas identified and marked on the ground ■ Amount of vegetation cleared kept to absolute minimum	Daily	CNOOC and Contractors	■ Information on erosion and sediment control ■ Impactive fauna management during vegetation clearing

Specific impact	Affected ecosystem/species of Concern	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Responsible Entity	Training Necessary
			■ Clearing of vegetation to occur at the edges of contiguous vegetation patches first to allow disturbed fauna to move away ■ Area of bare ground exposed at any one time			
Levelling and grubbing of ground for placement of infrastructure	Near-shore habitats Escarpment vegetation corridor Wetlands Bugoma CFR	Minimise extent of vegetation clearance Implement erosion sediment and dust control measures	■ Area of bare ground exposed at any one time ■ Erosion and sediment control measures in place and functional ■ Dust fall-out beyond the construction footprint ■ Appropriate storage and handling of topsoil to be used in rehabilitation works	Daily, before works commence Immediately before impending rain event	CNOOC and Contractors	■ Impactive erosion and sediment control ■ Topsoil handling and management

Specific impact	Affected ecosystem/species of Concern	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Responsible Entity	Training Necessary
Levelling and grubbing of ground for placement of infrastructure	Near-shore habitats Escarpment vegetation corridor Wetlands Bugoma CFR	Rehabilitation of disturbed areas following completion of construction activities	■ Area of exposed soil ■ Success of rehabilitation measures ■ Establishment of a cover crop	Monthly	CNOOC and Contractors	■ Rehabilitation of disturbed ground
Accidental spillages	Near-shore habitats Wetlands	Management and clean-up of chemical spills	■ Number of spills, including volume spilt ■ No adverse impacts from spills	Monthly	CNOOC and Contractors	■ Impactive spill response and clean-up
Sensory disturbance Collision risk	Wetlands Bugoma CFR	Traffic management	■ Speed limits of traffic within Project footprint ■ No mortality of wildlife in the LSA ■ No driving at night	Monthly	CNOOC and Contractors	■ Safe driving
Mortality/ injury risk	Escarpment vegetation corridor Wetlands	Trenching and pipeline laying – prevention of fauna injuries and mortality	■ Trenches are not left open overnight ■ If trenches are to be left open overnight, adequate ramps for the egress of trapped animals must be installed	Every morning before work commences	CNOOC and Contractors	■ Safe handling and removal of animals trapped in trenches

Specific impact	Affected ecosystem/species of Concern	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Responsible Entity	Training Necessary
			■ Adequate refuges must be installed at regular intervals along the open trench (e.g., wet sacks) ■ Number of animals relocated from the trench			
Vegetation clearance Earthworks Pipeline crossings	Wetlands	Construction in wetlands and watercourses	■ Maintenance of natural flow regimes ■ Flow volumes the same downstream of excavation compared to upstream ■ No sediment-laden water leaves construction area, use of coffer dams ■ Assessment of potential acid sulphate soils before excavation commences ■ If acid sulphate soils detected,	Weekly, or as required before excavation in wetlands	CNOOC and Contractors	■ Management and treatment of acid sulphate soils

Specific impact	Affected ecosystem/species of Concern	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Responsible Entity	Training Necessary
			adequate lime must be available on site to treat spoil from the excavation activities			
Reductions in Habitat quality	Near-shore habitats Escarpment vegetation corridor Wetlands	Control Night lighting	■ All night lighting face in towards the Project footprint ■ No lights face out towards the lake ■ Lighting should be kept to a functional minimum in all areas ■ Lamps should not emit light at angles greater than 70° ■ Lights that emit a broad spectrum of light with a high UV component should be avoided ■ Polarised light sources should not be used	Monthly	CNOOC	■ Impactive night lighting

Specific impact	Affected ecosystem/species of Concern	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Responsible Entity	Training Necessary
Reduction in habitat quality Reduction in survival/ reproduction due to attraction of predatory/ scavenging species	Grey Crowned Crane	Putrescible and industrial waste	■ All food wastes must be stored appropriately to discourage vermin ■ Volume of waste removed, recycled, reused	Monthly	CNOOC	■ Waste management
Accidental spillages	Near-shore habitats Wetlands Grey Crowned Crane	Water quality and water management	■ In situ water quality downstream of Project footprint (pH, EC, TDS, TSS, DO) ■ Monthly water quality parameters in the lake, wetlands and watercourses (pH, EC, TDS, TSS, DO, metals, hydrocarbons) ■ Volume of water extracted and treated on site	Weekly and monthly	CNOOC	■ Water quality monitoring ■ Waste water treatment
Reduction in habitat quality	Grey Crowned Crane	Air quality	■ No noticeable odours at	Monthly	CNOOC	■ Odour management and detection

Specific impact	Affected ecosystem/species of Concern	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Responsible Entity	Training Necessary
			boundary of Project footprint			
Population influx	Near-shore habitats Escarpment vegetation corridor Wetlands Mud Snail Grey Crowned Crane Nahan's Francolin Eastern Chimpanzee	People management	■ No personnel and/or contractors allowed beyond footprint of Project ■ Designated no-go areas, e.g., Lake Albert, wetlands, Bugoma Central Forest Reserve	As required	CNOOC and Contractors	■ Inductions for all staff

12.2.3   Operation Phase

The mitigation measures for the operation phase of the Project are presented in tabular format in Table 43. Possible offset mechanisms are summarised in Table 50.

12.2.3.1   *Operation Phase Impacts on Ecosystems of Concern*

Near-shore habitats of Lake Albert

The following impact mitigation is recommended to minimise the risks of spillages affecting the near-shore habitats of Lake Albert:

■   Establish a pollution management system, to be fully defined in CNOOC's EMP as well as in any sub-contractor's contractual commitments, covering personnel, training, lines of responsibility, immediate action requirements, on-site spill kits, and all other factors necessary to ensure there is a provision for effective preventative and corrective action during all stages of operation.

■   All machinery and vehicles must be certified as being free of weed propagules, prior to travelling to the site. Issue clearance certificates for each piece of machinery and equipment. The responsibility for ensuring that vehicles are free of weed propagules lies with the vehicle operators, and certification should be verified by CNOOC prior to entry to site.

■   Develop a culture of zero tolerance for pollution during the operation phase of the project.

■   Provide a high level of competent environmental oversight during drilling of wells and operation of the CPF.

■   Provide for thorough induction training of all operation personnel regarding pollution management, and ongoing refresher training throughout the operational lifetime of the project.

■   Provide specific training to staff responsible for the oversight of pollution control systems

■   Ensure structured, daily, monitoring of pollution control systems on the well pads and at the CPF to minimise the risk of inadvertent spills and to respond quickly and effectively to any spills that occur. Emphasis must be on preventative measures.

■   Develop specific biological monitoring performance indicators as a part of the Drilling EMPs.

Escarpment Vegetation Corridors

The following mitigation and monitoring is proposed:

■   The use of high-frequency noise emitters (e.g. vehicle reverse signals) should be minimised.

■   Ongoing monitoring and additional rehabilitation of vegetation communities over the buried pipeline as necessary, throughout the lifetime of the Project.

■   Develop plans, with Government, to reduce the risk of in-migration and subsequent increases in natural resource harvesting pressure into the area during the operation phase (further detail of the actions required are included in Social Impact Assessment).

■   Develop specific biological monitoring performance indicators as a part of the Project Operation EMPs.

Wetlands

The following impact mitigation and monitoring is recommended:

■   Prohibit access to personnel outside of the defined project work sites and access roads. Train personnel to understand the sensitivity of the local environment in induction and ongoing tool box talks.

- Specifically prohibit project personnel from access to the Bugoma Lagoon which is resource of exceptionally high ecological and cultural value. The Bugoma Lagoon is a part of the Kamansinig wetland system, all of which is regarded as sensitive

- Ensure that erosion protection measures are in place during operation to minimise runoff from disturbed areas into the rivers and wetlands.

- Ensure that all vehicles and machinery are in sound mechanical order, do not have any oil leaks and are fitted with appropriate mufflers to minimise nuisance affecting wildlife.

- Ensure that any pumps, generators or other equipment containing oil used to manage water at the wetland crossing are located on impervious plastic sheeting or drip trays.

- Prohibit any refuelling of equipment within 100 m of a wetland.

- Manage all hazardous products and wastes to minimise the risk of escaped outside of controlled areas (management according to measures recommended under Waste)

- Monitoring should remain ongoing at frequent intervals to ensure that rehabilitated vegetation continues to thrive and progress, and to confirm that the recommended mitigation measures to minimise wetland erosion and flow concentration remain satisfactorily functioning.

Bugoma CFR

The following impact mitigation and monitoring is recommended:

- De-list the R5 from the proposed oil road upgrades. CNOOC has confirmed that it does not need this road, either for construction or operational purposes. The Ugandan Government has been formally notified. CNOOC will use the P1 as the major haul road during the construction phase and, if upgraded in time, the R7.

- Limit vehicle speeds to 40 km/h along the P1 road in the section from Mpanga to Nsozi. Monitor vehicle speeds and fine drivers who do not comply with the speed limit.

- Prohibit transport of Project-related materials in the area of the forest at night.

- Ensure that all EPC contract transporters are fully aware of the risks to wildlife in the Bugoma Forest.

- Increase monitoring of population changes in the CHAA and, in particular, any incursions into the Bugoma CFR by settlement or people harvesting natural resources. A strategy for this initiative is discussed in further detail in the Cumulative Impact Assessment.

- Implement the Influx Management Strategy and Framework Plan (Golder Associates 2014) that has been developed to manage the potential influx of people into the LSA. However, this plan can only focus on those measures over which CNOOC has control, and to support the range of government and donor projects in Uganda aimed at socio-economic development and environmental conservation.

12.2.3.2   Operation Phase Impacts on Species of Concern

Mud Snail (*Gabbiella candida*)

The following impact mitigation and monitoring is recommended:

- If found to be present within the CHAA, the Client will need to demonstrate that the proposed operation of the Project will affect less than 10% of the known global population of the species –a comprehensive survey of habitats with potential to support the Mud Snail on the shores of Lake Albert will be required to support this demonstration. Thereafter, if less than 10% of the known population would be affected, a Species-Specific Action Plan as part of the overall Biodiversity Action Plan (BAP) must be developed to achieve net gain for the affected species.

Grey Crowned Crane

The following impact mitigation and monitoring is recommended:

- Implement the mitigation set out for wetlands under Section 11.2.3.1 to reduce further loss, fragmentation and degradation of habitats.

- Implement measures to minimise impacts on Grey Crowned Crane abundance and distribution, and reproduction and survival in the CHAA, and the Buhuka Flats in particular. Measures should include:

  - Restrict access by any CNOOC staff, subcontractors and members of the public from any identified areas of breeding habitat used by Grey Crowned Crane within 200 m of suitable nesting sites.

  - Erect/plant screens between operation activities and wetland habitats in order to reduce the likelihood of disturbance of Grey Crowned Crane via human presence, and minimise noise disturbance.

  - Prohibit CNOOC staff and construction subcontractors from entering areas beyond the operational footprint.

  - Develop and disseminate community education programmes on Grey Crowned Crane habitat conservation, prevention of illegal trade in wild birds and chicks, and prevention of incidences of poisoning.

- Develop and implement a long-term research and monitoring programme to improve understanding of the behaviour and status of Grey Crowned Crane in the CHAA (this recommendation is developed further in Cumulative Impact Assessment).

Nahan's Francolin

The following impact mitigation and monitoring is recommended:

- Implement the mitigation set out for Bugoma CFR under Section 12.2.3.1.

- Implement measures to minimise impacts on Nahan's Francolin abundance and distribution, and reproduction and survival in the CHAA, particularly those arising from sensory disturbance caused by traffic generated during operation, and effects arising from increased public access to the forest facilitate by the upgraded road. These should include restrictions in operating hours for heavy machinery, use of low-pitched reverse alerts, and restriction of access for Project employees and contractors.

- Develop and implement a long-term research and monitoring programme to improve understanding of the behaviour and status of Nahan's Francolin in Bugoma Forest (this recommendation is developed further in Cumulative Impact Assessment).

- Encourage ecotourism projects run by community groups, and initiate community conservation awareness programmes.

- Support the government in enforcement of existing government forestry policies in Uganda.

Eastern Chimpanzee

The following impact mitigation and monitoring is recommended:

- Implement the mitigation set out for Bugoma CFR under Section 11.2.2.1.

- Implement measures to minimise impacts on Eastern Chimpanzee abundance and distribution, and reproduction and survival in the CHAA, particularly those arising from sensory disturbance caused by human presence and mechanical noise generated by traffic and enhanced public access to the forest.

- Develop and disseminate community education programmes on Eastern Chimpanzee habitat conservation, and prevention of illegal trade in wild animals for live trade and bushmeat, in liaison with

existing Eastern Chimpanzee conservation programmes (e.g. Jane Goodall Institute Uganda's environmental education programme).

■ Develop and implement a long-term research and monitoring programme to improve understanding of the behaviour and status of the Eastern Chimpanzee in Bugoma Forest (this recommendation is developed further in Cumulative Impact Assessment).

■ Support the government in enforcement of existing government forestry policies in Uganda.

Table 43: Mitigation and management measures for biodiversity, during the operation phase of the Project

Specific impact	Affected ecosystem/species of Concern	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Responsible Entity	Training Necessary
Reductions in Habitat quality and quantity Sensory disturbances Collision risk	Near-shore habitats Escarpment vegetation corridor Wetlands Bugoma CFR Grey Crowned Crane Nahan's Francolin Eastern Chimpanzee	Ongoing monitoring of sensitive habitats and populations of species of concern	■ Population abundance and distribution of species of concern ■ Locality and populations of invasive species ■ Condition and extent of significant habitats, including nesting sites ■ Collision mortalities	Six-monthly	CNOOC	■ Identification of species of concern ■ Management and control of invasive species ■ Impactive management of bat roosts ■ Impactive translocation of threatened plants, and/or collection of reproductive material
Reductions in Habitat quality and quantity	Near-shore habitats Escarpment vegetation corridor Wetlands Bugoma CFR	Ongoing monitoring of rehabilitated areas	■ Extent of area of exposed soil ■ Success of rehabilitation measures ■ Establishment of a cover crop	Six-monthly	CNOOC	■ Monitoring and assessment of vegetation
Introduction/ spread of invasive species	Near-shore habitats Wetlands	Inspection of vehicles entering the site for weed propagules	■ Inspection forms and clearance certificates for each vehicle and piece of machinery working on the site	As required before new machinery or vehicles arrive at site	CNOOC and Contractors	■ Impactive clean down of machinery and vehicles to remove weed seeds

Specific impact	Affected ecosystem/species of Concern	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Responsible Entity	Training Necessary
Sensory disturbance	Grey Crowned Crane Nahan's Francolin Eastern Chimpanzee	All vehicles are in sound mechanical order and fitted with appropriate mufflers	■ Service records for each piece of machinery and vehicle ■ Daily pre-start inspection logs for each vehicle and piece of machinery	Daily	CNOOC and Contractors	■ Daily pre-start vehicle inspection
Sensory disturbance	Grey Crowned Crane Nahan's Francolin Eastern Chimpanzee	Noise management	■ Noisy activities only occur during designated times ■ High frequency noise emitters minimised	Daily	CNOOC and Contractors	■ Noise management
Accidental spillages	Near-shore habitats Wetlands	Management and clean-up of chemical spills	■ Number of spills, including volume spilt ■ No adverse impacts from spills	Monthly	CNOOC and Contractors	■ Impactive spill response and clean-up
Collision risk	Grey Crowned Crane Nahan's Francolin Eastern Chimpanzee	Traffic management	■ Speed limits of traffic within Project footprint ■ No mortality of wildlife in the LSA ■ No driving at night	Monthly	CNOOC and Contractors	■ Safe driving
Reductions in Habitat quality	Grey Crowned Crane Nahan's Francolin	Night lighting	■ All night lighting faces in towards	Monthly	CNOOC	■ Impactive night lighting

Specific impact	Affected ecosystem/species of Concern	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Responsible Entity	Training Necessary
	Eastern Chimpanzee		the Project footprint ■ No lights face out towards the lake ■ Lighting should be kept to a functional minimum in all areas ■ Lamps should not emit light at angles greater than 70° ■ Lights that emit a broad spectrum of light with a high UV component should be avoided ■ Polarised light sources should not be used			
Reduction in habitat quality Reduction in survival/ reproduction due to attraction of predatory/	Grey Crowned Crane	Putrescible and industrial waste	■ All food wastes to be stored appropriately to discourage vermin ■ Volume of waste removed, recycled, reused	Monthly	CNOOC	■ Waste management

Specific impact	Affected ecosystem/species of Concern	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Responsible Entity	Training Necessary
scavenging species						
Accidental spillages	Near-shore habitats Wetlands	Water quality and water management	■ In situ water quality downstream of Project footprint (pH, EC, TDS, TSS, DO) ■ Monthly water quality parameters in the lake, wetlands and watercourses (pH, EC, TDS, TSS, DO, metals, hydrocarbons) ■ Volume of water extracted and treated on site	Weekly and monthly	CNOOC	■ Water quality monitoring ■ Waste water treatment
Reduction in survival/ reproduction Reduced habitat quality	Grey Crowned Crane	Air quality	■ No noticeable odours at boundary of Project footprint	Monthly	CNOOC	■ Odour management and detection
Population influx	Near-shore habitats Escarpment vegetation corridor Wetlands Bugoma CFR	People management	■ No personnel and/or contractors allowed beyond footprint of Project	As required	CNOOC and Contractors	■ Inductions for all staff

Specific impact	Affected ecosystem/species of Concern	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Responsible Entity	Training Necessary
	Mud Snail Grey Crowned Crane Nahan's Francolin Eastern Chimpanzee		■ Designated no-go areas, e.g., Lake Albert, wetlands, Bugoma Central Forest Reserve, wetlands			

13.0 OFFSETTING STRATEGY

Possible offset options as part of the mitigation strategy for the Project are outlined on Table 50. Post-offset residual risks are discussed in the sections that follow. It is noted that a biodiversity action plan for the design and implementation of appropriate offsets to ensure no-net-loss of natural habitat, and net gain of critical habitat, must be developed in association with partnering organisations, including the other partners (TUOP and TOTAL) and BLAC. This is outside the current scope of the ESIA, but will be required to demonstrate compliance with Lender standards.

13.1 Construction and Operation Phase Impacts on the Near-Shore Environment of Lake Albert

Successful application of offsets means that the overall impact level from the Project becomes negligible or positive. A positive overall result for natural habitat, such as the near-shore habitats of Lake Albert, is a target that CNOOC is working towards to meet IFC requirements, and partner expectations.

Offsetting is required to compensate for adverse residual impacts to natural habitat. A possible offsetting mechanism is supporting improved management of the near-shore aquatic habitats within the CHAA, which should curb degradation of these habitats. However, to be considered an offset, this improved management must work to reduce human disturbance that may be affecting habitat.

One way to do this is to educate the local population about the potential impacts their activities could have on the near-shore aquatic habitats. For example: the safe handling and disposal of fuels and oils used for out-board motors; and the use of less destructive fishing methods in the near-shore habitats, such as seining, which are known to affect these habitats detrimentally (Wandera and Balirwa 2010).

The mitigation hierarchy is an important process that has been used to minimise impacts to the near-shore habitats. The focus for the continued use of the mitigation hierarchy during construction will be continued development and implementation of mitigation measures through monitoring and adaptive management during construction. Direct footprint impacts have largely been avoided and the level of realisation of impacts from disturbance is uncertain.

As noted above, the focus for reducing impacts to near-shore habitats is mitigation to lessen various types of disturbance that may occur. Optimising mitigation will reduce the need for offsetting. However, offsetting options to compensate for impacts to these habitats have been identified above. The goal of these offsets would be to work towards no net loss of natural habitats within in the CHAA. Although reasonable mechanisms exist, there is still uncertainty associated with offsetting because proposed actions require third-party participation beyond the control of the Project. Offset feasibility is classed as possible at this time, which results in a high-risk level for the Project (Table 44).

Table 44: Post-offset residual risk: construction phase impacts on near-shore environment of L. Albert

Description of Offsets	Residual Impact	Risk Level for not being successful
Education of the local people about the potential impacts their activities could have on the near-sure aquatic habitats. For example: the safe handling and disposal of fuels and oils used for out-board motors; and the use of less destructive fishing methods in the near-shore habitats, such as seining.	positive	high risk

13.2 Construction and Operation Phase Impacts on Wetlands in the CHAA

The construction and operation of the airstrip, flowlines and in-field roads will be see the direct and indirect loss of natural habitat on the Buhuka Flats; the construction of the feeder line will also result in direct and indirect losses of natural wetland habitat. Under PS6, no net loss of natural habitat is required to meet the standards. Successful application of offsets means that the overall impact level from the Project becomes negligible or positive. A positive overall result for highly sensitive and unique biodiversity values is a target that CNOOC is working towards to meet IFC requirements, and partner expectations.

Offsetting is required to compensate for loss of natural habitat supported on the Buhuka Flats. A possible offsetting mechanism is the support of improved management of wetlands in the wider Albertine Graben; in particular, known breeding sites for Grey Crowned Cranes and Shoebills. However, to be considered an offset, this improved management must work to reduce human disturbance that may be affecting the habitat.

One way to do this is to provide assistance to UWA, and other research organisations, with monitoring and conservation of the Grey Crowned Crane and Shoebill.

The mitigation hierarchy is an important process that has been used to minimise impacts to the wetlands of the CHAA. The focus for the continued use of the mitigation hierarchy during construction will be continued development and implementation of mitigation measures through monitoring and adaptive management during construction.

As noted above, the focus for reducing impacts to the wetlands of the CHAA to lessen various types of disturbance that may occur. Optimising mitigation will reduce the need for offsetting. However, natural vegetation of permanent wetlands and seasonally flooded grasslands will still be lost. Therefore, offsetting options to compensate for that loss have been identified above. The goal of those offsets would be to work towards no net loss of the habitats in the CHAA. Although reasonable mechanisms exist, there is still uncertainty associated with offsetting because proposed actions require third-party participation beyond the control of the Project. Offset feasibility is classed as possible at this time, which results in a high-risk level for the Project (Table 45).

Table 45: Post-offset residual risk: construction phase impacts on wetlands in the CHAA

Description of Offsets	Residual Impact	Risk Level for not being successful
Assistance to UWA, and other research organisations, with monitoring and conservation of the Grey Crowned Crane and Shoebill in the local area and their habitats.	positive	high risk

13.3 Construction and Operation Phase Impacts on the Mud Snail G. candida

Successful application of offsets means that the overall impact level from the Project becomes negligible or positive. A positive overall result for highly sensitive and unique biodiversity values, such as the Mud Snail, is a target that CNOOC is working towards to meet IFC requirements, and partner expectations.

Offsetting is required to compensate for adverse residual impacts to Mud Snails. A possible offsetting mechanism is supporting improved management of the near-shore aquatic habitats within the CHAA, which should curb degradation of these habitats. However, to be considered an offset, this improved management must work to reduce human disturbance that may be affecting habitat.

One way to do this is to educate the local population about the potential impacts their activities could have on the near-sure aquatic habitats. For example: the safe handling and disposal of fuels and oils used for out-

board motors; and the use of less destructive fishing methods in the near-shore habitats, such as seining, which are known to affect these habitats detrimentally (Wandera and Balirwa 2010).

The mitigation hierarchy is an important process that has been used to minimise impacts to the Mud Snail. The focus for the continued use of the mitigation hierarchy during construction will be continued development and implementation of mitigation measures through monitoring and adaptive management during construction. Direct footprint impacts have largely been avoided and the level of realisation of impacts from disturbance is uncertain.

As noted above, the focus for reducing impacts to Mud Snails is mitigation to lessen various types of disturbance that may occur. Optimising mitigation will reduce the need for offsetting. However, offsetting options to compensate for impacts to Mud Snails have been identified above. The goal of these offsets would be to work towards no net loss and eventually net gain to Mud Snail habitat and populations in the CHAA. Although reasonable mechanisms exist, there is still uncertainty associated with offsetting because proposed actions require third-party participation beyond the control of the Project. Offset feasibility is classed as possible at this time, which results in a high-risk level for the Project (Table 46).

Table 46: Post-offset residual risk: construction phase impacts on Mudsnails in the CHAA

Description of Offsets	Residual Impact	Risk Level for not being successful
Education of the local people about the potential impacts their activities could have on the near-sure aquatic habitats. For example: the safe handling and disposal of fuels and oils used for out-board motors; and the use of less destructive fishing methods in the near-shore habitats, such as seining	positive	high risk

13.4   Construction and Operation Phase Impacts on Bugoma CFR

Successful application of offsets means that the overall impact level from the Project becomes negligible or positive. A positive overall result for highly sensitive and unique biodiversity values, such as the Bugoma Central Forest Reserve, is a target that CNOOC is working towards to meet IFC requirements, and partner expectations. Indeed, because the Bugoma Central Forest Reserve is identified as critical habitat under criteria 1 and 4, a net positive impact will be the goal.

Offsetting is required to compensate for adverse residual impacts to Bugoma Central Forest Reserve from induced and cumulative effects (see Cumulative Impact Assessment).

A possible offsetting mechanism is supporting improved management of the Bugoma Central Forest Reserve, and research on the threatened species that inhabit the forest. However, to be considered an offset, this improved management must work to reduce human disturbance that may be affecting habitat.

One way to do this is to provide assistance to the NFA for management of the Bugoma Central Forest Reserve, and the UWA, and other research organisations involved with the monitoring and conservation of threatened species.

The mitigation hierarchy is an important process that has been used to minimise impacts to the Eastern Chimpanzee. The focus for the continued use of the mitigation hierarchy during the road upgrade and construction will be continued development and implementation of mitigation measures through monitoring and adaptive management; including suggested measures for the Ugandan Government to apply in the management of the upgrade of the Hoima-to-Ikamiro Road.

As noted above, the focus for reducing impacts to the Bugoma Central Forest Reserve is mitigation to lessen various types of disturbance that may occur. Optimising mitigation will reduce the need for offsetting. However, offsetting options to compensate for impacts to the forest have been identified above. The goal of

these offsets would be to work towards no net loss of this forest in the CHAA and net positive impact for the reserve. Although reasonable mechanisms exist, there is still uncertainty associated with offsetting because proposed actions require third-party participation beyond the control of the Project. Offset feasibility is classed as unlikely at this time due to increased human pressures around the forest, which results in a high-risk level for the Project (Table 47).

Table 47: Post offset residual risk: Construction and operation phase impacts on Bugoma CFR

Description of Offsets	Residual Impact	Risk Level for not being successful
Supporting improved management of the Bugoma Central Forest Reserve.	positive	high risk

13.5   Construction and Operation Phase Impacts on Nahan's Francolin

Successful application of offsets means that the overall impact level from the Project becomes negligible or positive. A positive overall result for highly sensitive and unique biodiversity values, such as the Nahan's Francolin, is a target that CNOOC is working towards to meet IFC requirements, and partner expectations.

Offsetting is required to compensate for adverse residual impacts to Nahan's Francolin from induced and cumulative effects. Within Bugoma Central Forest Reserve, the population trend of this species appears to be decreasing, with the primary threats thought to be habitat loss through logging and clearance of forest for charcoal burning and agriculture (BirdLife International 2017).

A possible offsetting mechanism is supporting improved management of the Bugoma Central Forest Reserve, and research on the population of Nahan's Francolin in that forest. However, to be considered an offset, this improved management must work to reduce human disturbance that may be affecting habitat.

One way to do this is to provide assistance to UWA and other research organisations with monitoring and conservation of the Nahan's Francolin, and the NFA for management of the Bugoma Central Forest Reserve.

The mitigation hierarchy is an important process that has been used to minimise impacts to the Nahan's Francolin. The focus for the continued use of the mitigation hierarchy during construction will be continued development and implementation of mitigation measures through monitoring and adaptive management during construction; including suggested measures for the Ugandan Government to apply in the management of the upgrade of the P1 Road.

As noted above, the focus for reducing impacts to Nahan's Francolin is mitigation to lessen various types of disturbance that may occur. Optimising mitigation will reduce the need for offsetting. However, offsetting options to compensate for impacts to Nahan's Francolin have been identified above. The goal of these offsets would be to work towards no net loss and eventually net gain to Nahan's Francolin populations in the CHAA. Although reasonable mechanisms exist, there is still uncertainty associated with offsetting because proposed actions require third-party participation beyond the control of the Project. Offset feasibility is classed as possible at this time, which results in a moderate risk level for the Project (Table 48).

Table 48: Post offset residual risk: construction and operation phase impacts on Nahan's Francolin

Description of Offsets	Residual Impact	Risk Level for not being successful
Supporting improved management of the Bugoma Central Forest Reserve, and research on the population of Nahan's Francolin.	positive	moderate risk

13.6   Construction and Operation Phase Impacts on Chimpanzee

Successful application of offsets means that the overall impact level from the Project becomes negligible or positive. A positive overall result for highly sensitive and unique biodiversity values, such as the Eastern Chimpanzee, is a target that CNOOC is working towards to meet IFC requirements, and partner expectations.

Offsetting is required to compensate for adverse residual impacts to Eastern Chimpanzee from induced and cumulative effects. Within Bugoma Central Forest Reserve, the population trend of this species appears to be decreasing, with the primary threats thought to be habitat loss through logging and clearance of forest for charcoal burning and agriculture, bush meat hunting, and killing of crop raiding individuals (Plumptre et al. 2003, 2010).

A possible offsetting mechanism is supporting improved management of the Bugoma Central Forest Reserve, and research on the Eastern Chimpanzee population in that forest. However, to be considered an offset, this improved management must work to reduce human disturbance that may be affecting habitat.

One way to do this is to provide assistance to UWA and other research organisations involved with the monitoring and conservation of the Eastern Chimpanzee, and the NFA for management of the Bugoma Central Forest Reserve.

The mitigation hierarchy is an important process that has been used to minimise impacts to the Eastern Chimpanzee. The focus for the continued use of the mitigation hierarchy during the road upgrade and construction will be continued development and implementation of mitigation measures through monitoring and adaptive management; including suggested measures for the Ugandan Government to apply in the management of the upgrade of the P1 Road.

As noted above, the focus for reducing impacts to Eastern Chimpanzees is mitigation to lessen various types of disturbance that may occur. Optimising mitigation will reduce the need for offsetting. However, offsetting options to compensate for impacts to Eastern Chimpanzees have been identified above. The goal of these offsets would be to work towards no net loss and eventually net gain to Eastern Chimpanzee populations in the CHAA. Although reasonable mechanisms exist, there is still uncertainty associated with offsetting because proposed actions require third-party participation beyond the control of the Project. Offset feasibility is classed as possible at this time, which results in a moderate risk level for the Project (Table 49).

Table 49: Post offset residual risk: construction and operation phase impacts on Eastern Chimpanzee

Description of Offsets	Residual Impact	Risk Level for not being successful
Supporting improved management of the Bugoma Central Forest Reserve, and research on the population of Nahan's Francolin.	positive	moderate risk

Table 50: Possible offset options as part of the mitigation strategy for the Project

Offset required	Mechanism	Responsibility	Details
Natural habitat - near-shore aquatic Critical habitat – Mud Snail	■ Improved management of the near-shore aquatic habitats within the CHAA	CNOOC	■ Education programme for the local population about the potential impacts their activities could have on the near-shore aquatic habitats ■ The safe handling and disposal of fuels and oils used for out-board motors ■ The use of less destructive fishing methods in the near-shore habitats, such as seining
Natural habitat - vegetation of the escarpment	■ Improved management of the wider Murchison Falls National Park-Budongo-Bugoma-Kagombe-Itwara Forest Reserves-Semliki/Toro Wildlife Reserve corridor	CNOOC, TOTAL, Tullow	■ Provision of assistance to UWA, and other research organisations, in forming and collaborating in a committee to devise long-term management goals and measures for the wildlife corridor ■ Action plan to ensure that the management goals and measures devised by the committee are actioned, implemented and monitored on the ground
Natural habitat - wetlands	■ Improved management of wetlands in the wider Albertine Graben; in particular, known breeding sites for Grey Crowned Cranes and Shoebills	CNOOC	■ Provision of assistance to UWA, and other research organisations, with monitoring and conservation of the Grey Crowned Crane and Shoebill
Natural habitat – Bugoma Central Forest Reserve Critical habitat – Nahan's Francolin Critical habitat – Eastern Chimpanzee	■ Improved management of the Bugoma Central Forest Reserve, and research on the threatened species that inhabit the forest	CNOOC	■ Assistance to the NFA for management of the Bugoma Central Forest Reserve, and the UWA, and other research organisations involved with the monitoring and conservation of threatened species.

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APPENDIX A

Critical Habitat Approach and Method of Assessment

The purpose of defining critical habitat is to identify areas of a particularly sensitive nature for biodiversity conservation that deserve special attention and may require extraordinary mitigations. Importantly, as mentioned in Section 3.1.1, critical habitat exists independent of a project, and can be identified without reference to a project; that is, a project may be proposed in critical habitat, but the critical habitat is present under baseline conditions and is not defined by the size of the project footprint or other project effects. As such, the critical habitat assessment does not focus solely on the project footprint, which, in this case is the Kingfisher Development Area and the proposed feeder line route (Figure 1). Rather, it focuses on a wider area, as encompassed by the CHAA (Figure 2).

The concepts of irreplaceability and vulnerability are important when identifying critical habitat. These concepts are widely used in systematic conservation planning as the basis for determining relative ecological importance (Langhammer et al. 2007). Systematic conservation planning is a structured approach to prioritising and managing areas considered important for the protection of natural values (Sarkar and Illoldi-Rangel 2010). The irreplaceability (that is, rarity or uniqueness) of a site is the degree to which geographic options for conservation will be lost if that particular site is lost (Margules and Pressey 2000). For example, a site is irreplaceable if it contains one or more endemic species found only in that location. Vulnerability (or degree of threat) refers to the likelihood that a site's biodiversity value will be lost in the future (Margules and Pressey 2000). Hence, vulnerability can also be seen as a measure of irreplaceability over time, rather than space. Sites facing low threat can still be conserved in the future, but highly vulnerable sites will have to be protected now or they may be lost entirely (Langhammer et al. 2007).

Vulnerability can be measured on a site-basis (that is, the likelihood that the species will be locally extirpated from a site) or a species-basis (that is, the likelihood that the species will go globally extinct) (Langhammer et al. 2007). Sites with both high irreplaceability and high vulnerability should, therefore, receive priority for conservation to prevent biodiversity loss (Margules and Pressey 2000, Langhammer et al. 2007). Habitats supporting irreplaceable and extremely vulnerable biodiversity features are likely to constitute critical habitat, and such features should be identified under baseline conditions at the ecological scales appropriate for their designation.

Assessment Criteria

Critical habitat designation, typically, should be determined on a case-by-case basis according to the concepts of irreplaceability and vulnerability (IFC 2012b). Hence, when applying this guidance, it is often possible to identify critical habitat using the five primary criteria provided by the IFC (2012a), that is:

1) Habitat of significant importance to critically endangered and/or endangered species.

2) Habitat of significant importance to endemic and/or restricted-range species.

3) Habitat supporting globally significant concentrations of migratory species and/or congregatory species.

4) Highly threatened and/or unique ecosystems.

5) Areas associated with key evolutionary processes.

However, these are only a guideline, and it is important to remember that critical habitat can include values that do not necessarily discretely fit into the above categories, and are often important in their own right on the local scale. Therefore, in addition to the above five criteria, the following criteria were also considered for the Kingfisher Area and proposed pipeline route (after, IFC (2012b)). These criteria do not have quantitative thresholds for assessment, or much qualitative guidance suggested in the guidance notes (that is, IFC 2012b). Nevertheless, they were considered in the critical habitat screening process:

6) Areas required for seasonal refugia for critically endangered and/or endangered species.

7) Ecosystems of known special significance to critically endangered or endangered species for climate adaptation purposes.

8) Concentrations of vulnerable species in cases where there is uncertainty regarding the listing, and the actual status of the species may be critically endangered or endangered.

9) Areas of primary/old-growth/pristine forests and/or other areas with especially high levels of species diversity.

10) Landscape and ecological processes (for example, water catchments, areas critical to erosion control, disturbance regimes) required for maintaining critical habitat.

11) Habitat necessary for the survival of keystone species; that is, species that act as ecosystem engineers and drive ecosystem process an functions, for example, elephants in savannah woodlands and their foraging behaviours that maintain vegetation structure.

12) Areas of high scientific value, such as those containing concentrations of species new and/or little known to science.

13) An area of known high concentrations of natural resources exploited by local people.

14) Areas that meet the criteria of the IUCN's Protected Area Management Categories Ia, Ib and II, although areas that meet criteria for Management Categories III-VI may also qualify depending on the biodiversity values inherent to those sites.

15) KBAs, which encompass inter alia Ramsar Sites, IBAs, Important Plant Areas (IPA) and Alliance for Zero Extinction Sites.

16) Areas determined to be irreplaceable or of high priority/significance based on systematic conservation planning techniques carried out at the landscape and/or regional scale by governmental bodies, recognized academic institutions and/or other relevant qualified organizations (including internationally-recognized NGOs).

17) High Conservation Value (HCV) areas.

Given the above, the determination of critical habitat is not absolute. Consequently, gradients of critical habitat can be recognised based on the relative vulnerability (that is, degree of threat) and irreplaceability (that is, rarity or uniqueness) of the habitat. The IFC, therefore, subdivides critical habitat into Tier 1 and Tier 2 for Criteria 1 to 3 (Table 1, IFC, 2012a, b). Although the same restrictions and mitigation standards apply regardless of which tier of critical habitat is identified, the tiers are intended to distinguish degree of biodiversity value, and identify the likelihood that effective mitigation is possible. Paragraph 61 of GN6 (IFC 2012b) reveals that the IFC considers compliance with all aspects of paragraphs 17 to 19 of PS6 "possible" in Tier 2 critical habitat, but "unlikely" in Tier 1 critical habitat. For Criteria 1 to 3, quantitative and qualitative thresholds for distinguishing the tiers of critical habitat have been developed by the IFC, whereas no such thresholds are presented for criteria 4 to 17.

Table B1: Thresholds for Tier 1 and Tier 2 critical habitat

Criteria	Tier 1	Tier 2
1 **(EN or CR species)**	(a) Habitat required to sustain ≥ 10 percent of the global population of a CR or EN species/subspecies where there are known, regular occurrences of the species and where that habitat could be considered a discrete management unit for that species. (b) Habitat with known, regular occurrences of CR or EN species where that habitat is one of 10 or fewer discrete management sites globally for that species. (c) Wide ranging, large EN and CR mammals may be Tier 1 despite not triggering a threshold through the discrete management unit concept, due to additional considerations (e.g., great apes due to anthropological and evolutionary significance, as well as ethical considerations).	(a) Habitat that supports the regular occurrence of a single individual of a CR species and/or habitat containing regionally- important concentrations of a Red-listed EN species where that habitat could be considered a discrete management unit for that species/ subspecies. (b) Habitat of significant importance to CR or EN species that are wide-ranging and/or whose population distribution is not well understood and where the loss of such a habitat could potentially impact the long-term survivability of the species. (c) As appropriate, habitat containing nationally/regionally important concentrations of an EN, CR or equivalent national/regional listing.
2 **(Endemic or Restricted-range species)**	(a) Habitat known to sustain ≥ 95 percent of the global population of an endemic or restricted-range species where that habitat could be considered a discrete management unit for that species (e.g., a single-site endemic).	(a) Habitat known to sustain ≥1 percent but <95 percent of the global population of an endemic or restricted-range species where that habitat could be considered a discrete management unit for that species, where data are available and/or based on expert judgment.

Criteria	Tier 1	Tier 2
3 **Migratory and/or congregatory species**	(a) Habitat known to sustain, on a cyclical or otherwise regular basis, ≥ 95 percent of the global population of a migratory or congregatory species at any point of the species' lifecycle where that habitat could be considered a discrete management unit for that species.	(a) Habitat known to sustain, on a cyclical or otherwise regular basis, ≥1 percent but <95 percent of the global population of a migratory or congregatory species at any point of the species' lifecycle and where that habitat could be considered a discrete management unit for that species, where adequate data are available and/or based on expert judgment. (b) For birds, habitat that meets BirdLife International's Criterion A4 for congregations and/or Ramsar Criteria 5 or 6 for Identifying Wetlands of International Importance. (c) For species with large but clumped distributions, a provisional threshold is set at ≥5 percent of the global population for both terrestrial and marine species. (d) Source sites that contribute ≥1 percent of the global population of recruits.

From: IFC 2012

Note: EN = endangered; CR = critically endangered; ≥ = more than or equal to; < = less than; > = more than

Given all of the above, for the purposes of this impact assessment, the identification of critical habitat followed a three-step approach:

a)   Identification of DMUs within the CHAA.

b)   Screen valued components within the spatial unit of analysis against the 17 critical habitat criteria described above.

c)   Map critical habitat for those valued components that trigger it in the CHAA.

Discrete Management Units

The IFC define a DMU as an area with a "clearly demarcated boundary within which the biological communities and/or management issues have more in common with each other than they do with those in adjacent areas" (IFC 2012b, GN6, paragraph 65). The DMU represents the scale at which critical habitat was assessed using the quantitative thresholds identified in IFC PS6 GN6 for Criteria 1 to 3 (IFC 2012b) within the CHAA. The delineation of a DMU varied depending on the species, subspecies or biodiversity feature of concern, yet, as mentioned, was confined to the CHAA. For example, a small, rare ecosystem (for example, vegetation type) may be an appropriate DMU for a locally endemic plant species; however, this would not be appropriate for a large-ranging fauna species. Depending on the size of the ecosystem and geographic range of the species, the DMU may more appropriately include several patches along a topographical feature that expands across a region, rather than constraining the analysis to the CHAA.

DMUs were evaluated on a case-by-case basis and assigned for a particular species or feature. We defined DMUs using both ecological and management boundaries. For many biodiversity features, the DMU was the same spatial extent as the CHAA because of marked differences in biodiversity management practices across

the area. The DMUs for Criteria 4 and 5 were delineated using the CHAA or other ecological boundary to encompass the biodiversity values of interest.

Screening Valued Components

The determination of critical habitat for valued components required that each valued component potentially present in the CHAA was screened against each of the 17 criteria presented above, as summarised below. It should be noted that the screening occurred for all valued components, that is, ecosystems and habitats and species of concern, although quantitative thresholds are only applicable to Criteria 1 to 3. For the remainder, qualitative thresholds were derived.

To distinguish between Tier 1 and Tier 2 (Criteria 1 to 3), using the defined quantitative thresholds (see IFC 2012b), the proportion of the global population occurring within a DMU for a given species was estimated. The quantitative threshold was strictly applied where DMUs were small, but expert judgment was used to assess irreplaceability and vulnerability when identifying critical habitat for large DMUs. A hierarchy of approaches was used to achieve this, from most to least preferred:

1) population estimates

2) global area of occupancy

3) global extent of occurrence

4) expert opinion.

Estimates of population size within a DMU, if known, were compared to global estimates when available. When population data were unavailable (as was the case in most instances), the proportion of the known range extent for the species of concern was calculated to approximate the population size, using either area of occupancy (AOO) (if available) or extent of occurrence (EOO) as a surrogate. The AOO consists of the area within the EOO that is truly occupied by a species, excluding cases of vagrancy (IUCN 2001). This metric takes into account the fact that a species does not generally occupy the full extent of its range, which may contain unsuitable or unoccupied habitats. The global EOO is a boundary that encompasses all known, inferred or projected occurrences of a species (IUCN 2001). The EOO is generally measured as a minimum convex polygon that contains all occurrence sites for a given species. The EOO can be continuous or, in some cases, is disjunct and consists of many polygons. The proportion of the global EOO within the CHAA was the most commonly applied surrogate for population size for critical habitat assessment. The number of DMUs for a particular species present globally was also used as a surrogate for population size, when that information was available. Where data were unavailable, global EOO was estimated using expert opinion.

■ Criterion 1

For Criterion 1, the protected status of all identified species of concern potentially occurring within the CHAA (see Section 3.3.3.2 of the main report and the associated probability analysis for species of concern in the CHAA) was searched on the IUCN's Red List of Threatened Species (IUCN 2014a). Actual records of species within the CHAA were obtained from the Global Biodiversity Information Facility (GBIF 2014) to determine their local AOO. Where records did not exist within the GBIF, inferred distribution records were obtained from: Kalema and Beentje (2012) (plants); Mandahl-Barth G (1954) (freshwater molluscs); Greenwood (1966) (fish); Carder and Tindimubona (2002), Davenport (2003) (butterflies); Miller and Miller (2003) (Odonata); Channing and Howell (2006) (amphibians); Spawls et al. (2004) (reptiles); Stevenson and Fanshawe (2002) (birds); and Butynski et al. (2013), Happold (2013), Happold and Happold (2013), Kingdon and Hoffman (2013a, b), Kingdon et al. (2013) (mammals). Due to the lack of information for most invertebrate taxa, the majority of these groups were not considered in this assessment.

Regional importance of the critical habitat was set based on published expert opinion, especially bearing in mind the distinct nature of the Albertine Graben and Lake Albert area compared to the wider area; that is, the wider area is a highly modified landscape.

■ Criterion 2

For Criterion 2, the global EOO for all species of concern potentially present within the CHAA (see Section 3.3.3.2 of the main report, and the associated probability analysis for species of concern in the CHAA) was searched in the literature, or in available databases. EOO data were obtained from the Integrated Biodiversity Assessment Tool (IUCN 2014b) where they existed. Actual records of species within the CHAA were obtained from the Global Biodiversity Information Facility (GBIF 2014) to determine their local EOO. Where records did not exist within the GBIF, inferred distribution records were obtained from: Kalema and Beentje (2012) (plants); Mandahl-Barth G (1954) (freshwater molluscs); Greenwood (1966) (fish); Carder and Tindimubona (2002), Davenport (2003) (butterflies); Miller and Miller (2003) (Odonata); Channing and Howell (2006) (amphibians); Spawls et al. (2004) (reptiles); Stevenson and Fanshawe (2002) (birds); and Butynski et al. (2013), Happold (2013), Happold and Happold (2013), Kingdon and Hoffman (2013a, b), Kingdon et al. (2013) (mammals). Due to the lack of information for most invertebrate taxa, the majority of these groups were not considered in this assessment. It is noted that for many species EOO and AOO data were not available in any of these sources. As such, a precautionary approach was assumed.

Restricted-range criteria for species of concern were defined based on guidance provided by the IFC (2012b). All species with ranges (EOO) of 50 000 km^2 or less were considered restricted range, and were assessed for critical habitat against Criterion 2. In cases where both the AOO and EOO were known, only the AOO was used to define the range size and screen species. For invertebrates and aquatic species, restricted-range species were defined based on guidance provided by the IFC (GN6 paragraph 80, IFC 2012). All species with global ranges of 20 000 km^2 or less were considered as restricted-range (Holland et al. 2012).

■ Criterion 3

All observed (see APPENDIX A) and potential migratory or congregatory species (see Section 3.3.3.2 of the main report, nd the associated probability analysis for species of concern in the CHAA) that may occur in the CHAA were screened. This list of species was used to determine if the area contained irreplaceable and/or extremely vulnerable habitats used either periodically or consistently by migratory or congregatory species. All migratory species were identified using information from BirdLife International (2013b), the CMS (2014), the IUCN (2014a), or other published literature.

■ Criterion 4

Criterion 4 is triggered by ecosystems that are threatened, house unique assemblages of biome-restricted species, or are recognized for high conservation value, including protected areas. Where data permitted, quantitative categories and criteria from Rodriguez et al. (2011) were applied to evaluate ecosystem status. Ecosystems considered critically endangered or endangered were identified as critical habitat, and ecosystems rated as vulnerable were evaluated on a case-by-case basis in consultation with appropriate experts. Ecosystems with unique assemblage of species, or of high conservation value were evaluated based on field data, literature and consultation with experts.

It should be noted that there is a distinction between habitat (that is, a consistent assemblage of adapted flora and fauna) and ecosystem (that is, a group of habitats with similar function). Ecosystem level analyses were focused on ecosystems delineated using vegetation communities identified within the CHAA as mapped as part of the baseline studies (APPENDIX B) and land use and land cover class assessment (APPENDIX C).

■ Criterion 5

Critical habitat for key evolutionary processes does not have quantitative thresholds (for example, see IFC, 2012a). For the purposes of this assessment, expert opinion was used to identify critical habitat with respect to Evolutionarily Distinct and Globally Endangered (EDGE) species, and other unique qualifiers, if they were identified to occur within the CHAA.

Criterion 5 applies to landscape-level features that can influence key evolutionary processes. Key landscape features such as habitat islands, and areas important for climate change adaptation were identified using literature review and consultation with experts. Criterion 5 also applies at the species

level for "distinct species" which include those coined as "Evolutionarily Distinct and Globally Endangered" (EDGE) (GN 95 IFC 2012b, Jetz et al. 2014, ZSL 2014). Species screened included all those identified by a geographically-based search of the EDGE species database that covered the spatial extent of the CHAA.

To assess whether critical habitat exists in the CHAA for identified EDGE species, a two-fold approach was applied. First, habitat associations of a given species were summarised and the relative uniqueness or rarity of those habitats was qualitatively discussed. Second, the relative importance of the CHAA for a particular species was evaluated. This is a useful guide because here we are only considering EDGE species, rather than other aspects of key evolutionary processes. Essentially this is a check that additional species not picked up under other criteria, may trigger the critical habitat definition.

■ Criteria 6 to 17

For the remaining criteria, screening involved: a review of available reports, *viz.*: Emerton and Muramira (1999); AWE (2008a, b, 2013a, b, 2014a, b); Lamprey (2009); NEMA (2010); Plumptre et al. (2003, 2005, 2007, 2010, 2011); AECOM (2012, 2013); consultation with local experts (for example, Makerere University, Wildlife Conservation Society (WCS), Fisheries Department of Fisheries Resources (DFR), Uganda Wildlife Authority (UWA), Wetlands Management Department (WMD), National Forest Authority (NFA); as well as expert knowledge. These criteria are important for the screening of habitat and ecosystem integrity valued components, as well as ecosystem services valued components. In particular:

▪ Areas required for seasonal refugia for critically endangered and/or endangered species were screened qualitatively using the information contained in the available reports and in scientific literature, and using the knowledge gained from consultation.

▪ Ecosystems of known special significance to critically endangered or endangered species for climate adaptation purposes were screened qualitatively using the information contained in the available reports and in scientific literature, and using the knowledge gained from consultation.

▪ Concentrations of vulnerable species in cases where there is uncertainty regarding the listing, and the actual status of the species may be critically endangered or endangered, were screened qualitatively using the information contained in the available reports and in scientific literature, and using the knowledge gained from consultation.

▪ Areas of forests and/or other areas with especially high levels of species diversity were screened for the entire CHAA based on the data contained in Plumptre et al. (2010, 2011) and AECOM (2012, 2013).

▪ Landscape and ecological processes (for example, water catchments, areas critical to erosion control, disturbance regimes) for maintaining critical habitat were screened qualitatively using the information contained in the available reports and in scientific literature.

▪ Habitat necessary for the survival of keystone species were screened qualitatively using the information contained in the available reports and in scientific literature, and using the knowledge gained from consultation.

▪ Areas of high scientific value, such as those containing concentrations of species new and/or little known to science were screened qualitatively using the information contained in the available reports and in scientific literature, and using the knowledge gained from consultation.

▪ Areas of known high concentrations of natural resources exploited by local people were screened qualitatively and quantitatively using the information gained from the stakeholder engagement (see Golder Associates 2014a), available reports and in scientific literature.

- Protected areas meeting the IUCN's management categories, and overlapping the CHAA, were screened based on data obtained from the World Database on Protected Areas (WDPA 2014) and the IBAT (IUCN 2014b).

- KBAs overlapping the CHAA were screened based on data obtained from the IBAT (IUCN 2014b).

- The CHAA was screened for other areas of high priority/significance based on information gained from consultation and contained within Plumptre et al. (2010, 2011) and AECOM (2012, 2013).

- The CHAA was screened for areas of HCV based on information gained from consultation and contained within Plumptre et al. (2010, 2011) and AECOM (2012, 2013).

Distribution of Critical Habitat

Critical habitat should be defined spatially in an ecologically sensible manner specific to the biodiversity feature for which it was designated, and cannot be focused either only on sampling points or on an entire study site, without appropriate support. Therefore, the critical habitat was delineated using the following approaches, from most to least preferred:

1) Occupancy or habitat association models derived from empirical data.

2) Occupancy or habitat association models derived from literature review and consultation with experts.

3) Range maps or population locations derived from empirical data and/or expert opinion.

4) Entire CHAA identified as critical habitat where uncertainty concerning range or habitat associations precluded more precise mapping.

The final product was a series of critical habitat maps developed individually for each biodiversity value triggering critical habitat. During the impact assessment process, these maps were used as the basis for applying the mitigation hierarchy (Section 9.1).

APPENDIX B

Terrestrial Ecology Baseline Study

ECOLOGICAL BASELINE REPORT FOR THE DRY SEASON SURVEYS IN THE KINGFISHER FIELD DEVELOPMENT AND PIPELINE ROUTE AREAS

A report prepared for China National Offshore Oil Corporation (CNOOC) Uganda Ltd.

By Eco & Partners with Golder Associates

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Back Ground to the studies

Biodiversity Impact Assessment

Biodiversity can be defined as the variety of life at different levels of biological organisation and all the ecological and biological processes through which they are connected. The assessments for terrestrial ecology and aquatic ecology primarily address effects to biodiversity at the level of the individual species. Species are the basic components of ecological communities and are the most recognisable units of biodiversity. Efforts to conserve biodiversity often focus at the species level. However, effects to the higher ecosystem level of biological organisation are also the subject of the biodiversity impact assessment, and have been scoped in order to meet IFC requirements and the partners' expectations. .

The biodiversity impact assessment also addresses effects to ecosystem services, which are the benefits to people generated by a functioning natural environment. Ecosystem services are integrated with biodiversity in because of the substantial importance of biodiversity, at all levels of biological organization, for generating ecosystem services. However, ecosystem services encompass aspects of the physical environment such as clean water and soils capable of supporting agriculture, and are intrinsically linked to the social environment because ecosystem services do not exist without human beneficiaries.

Overall Objectives of the study

The project objectives of the biodiversity studies include:

- The identification of sensitive or unique habitats, which could suffer irreplaceable loss.

- The characterisation of the ecological integrity of the aquatic (including wetland) and terrestrial ecosystems in the project area and ascertain seasonal variation

- Refinement of the list of SoCs and if these trigger critical habitat.

- Identify populations and trends of exotic and invasive species.

- Identify and describe potential sources of risk to the biodiversity and ecosystem services of the project site, associated with the development;

- Evaluation of the extent of site-related impacts in terms of selected ecological indicators.

- Identify the potential direct, indirect and cumulative environmental impacts associated with the proposed project;

- Recommend suitable mitigation measures where applicable.

- Develop a monitoring programme and action plan for the biodiversity and ecosystem services affected by the project development.

■ **Terrestrial ecology specialist study**

The overall scope includes:

■ Desktop review of all available data and development of remotely-sensed habitat maps. Ideally, these maps will be developed based on SPOT imagery.

■ Confirm potential SoC through discussion with local experts, critical habitats and areas of focus.

■ Identify suitable sampling sites for field team in the dry and wet season.

■ Establish the current drivers of change of the terrestrial ecosystems within the project area based upon desktop assessment and discussion with local experts.

Habitats and Flora

■ Identify, map, quantify and describe in detail the different vegetation communities and habitat types within the project area using field methods agreed to by all partners. These studies will also confirm the vegetation and land cover mapping produced above. This includes the area of the wider EA3 block.

■ Determine the species composition and abundance in each vegetation community or habitat within the site, using both qualitative and quantitative survey techniques.

■ Identify species, or vegetation communities of concern.

■ **For Wetlands in particular: -**

■ Identify and map wetland areas in the project area and surrounding areas. Available remote sensing images, topographic maps, vegetation maps and existing information on wetlands will be collected and will serve as a basis for identifying possible wetland areas.

■ Report and quantify the floristic community on the identified wetlands. Vegetative community sampling will be conducted to describe cover abundance of plant species and also to identify and locate local endemics or rare/threatened species. Trees, shrubs and the herbaceous layer will all receive appropriate sampling programmes. Data will be collected for abundance, the structure summarised and key species identified

Mammals

■ Identify, map, quantify and describe the habitats likely to host mammals in the area of the site, in conjunction with the Habitats and Flora Study.

■ Determine the occurrence and abundance of mammals in the site, using both qualitative and quantitative survey techniques, especially SoC. Specific focus will be upon small mammals (that is, bats, rodents, shrews, and the like).

Avifauna

- Identify, map, quantify and describe the habitats likely to host avifauna in conjunction with the Habitats and Flora Study. Particular attention will be paid to potential migratory corridors and nesting sites.

- Determine the occurrence and abundance of birds in the area of the site, using both qualitative and quantitative survey techniques, with particular focus on SoC (including migratory species).

Herpetofauna (Amphibians and Reptiles)

- Identify, map, quantify and describe the habitats likely to host amphibians and reptiles in the Project area, in conjunction with the Habitats and Flora Study.

- Determine the occurrence and abundance of amphibians and reptiles in the Project area, using both qualitative and quantitative survey techniques, with particular focus on SoC.

Invertebrates

- Identify, map, quantify and describe the habitats likely to host invertebrates of interest in the project area (indicator groups and SoCs), in conjunction with the Habitats and Flora Study. Particular attention shall be paid to groups such as butterflies, and dragonflies and damselflies (indicators, and SoCs). Additional groups that may be sampled include bees (indicators), ants (indicators), scorpions, katydids (indicators) and spiders.

- Determine the occurrence and abundance of indicator groups of invertebrates in the exploration area, using both qualitative and quantitative survey techniques, with particular focus on SoC.

Ecosystem Services

- Ecosystem services are the benefits to people generated by a functioning natural environment. The ecosystem services matrix of the site and wider project area will be assessed by:

- Identification of the range of ecosystem services supplied by the project area in consultation with the social team.

- Prioritisation of those ecosystem services based on dependence of local beneficiaries, and substitutability and replaceability of the services.

- Assessment of the ecosystems within the project area's capacity to supply the range of ecosystem services, particularly the priority services.

- Assess the current drivers of change to the supply of ecosystem services.

- Assess the project's effects to the supply of and demand for ecosystem services.

- Establish fish habitat mapping and a fish community inventory.

■ Assess the potential effect of the project on the local river functioning, wetland functioning and near-shore functioning of Lake Albert, and the aquatic biota.

Species of Concern defined

These are species that are either IUCN listed, country or regional listed, migrants, species of restricted range occurrence (such as those that might be restricted to the Albertine Rift) or any other criteria that on the basis of which, might trigger consideration of the habitat where they occur as critical.

International Requirements

Critical habitat is a concept used by international finance companies like the International Finance Corporation (IFC), as part of their approach to risk management and sustainable development. The IFC's critical habitat concept considers and expands on a variety of pre-existing ideas and definitions for priority sites for biodiversity conservation, such as Key Biodiversity Areas, Alliance for Zero Extinction sites, World Heritage Sites, and Ramsar Convention on wetlands of international importance. The IFC's approach is supported by a broad array of conservation organizations and is increasingly accepted and applied by a variety of banks (as lenders) and other private companies (as developers). Hence, PS6 and the concept of critical habitat are emerging as best-practice guidelines for biodiversity conservation in the private sector.

The survey scope outlined was aimed to go some way to identify critical habitats within and around the site.

SECTION 1: ECOLOGICAL BASELINE OF VEGETATION AND FLORA FOR KINGFISHER FIELD DEVELOPMENT PROJECT

1.   **General introduction and background**
1.1 Introduction

This report presents the findings of a baseline environment report meant to feed into and inform the Environmental Social Impact Assessment (ESIA) for a proposed construction of a Central Processing Facility (CPF) in Kingfisher oil prospecting blocks in western Uganda. The report is a result of desk based studies and field work conducted in the project area. The first survey was made to the project area in Feb ending to early March 2014. This was a dry season. The second survey was made in May through June 2014. The results reported here are hence reflecting vegetation and flora of both dry and beginning of a wet season.

1.2   General survey area

The survey area lies in mid-western Uganda on the south-eastern shore end of Lake Albert. The area lies in Buhuka Parish, Kyangwali Sub-county, Hoima District, Western Uganda, within the Albertine Rift region, though outside any protected area. Climate of the area is equatorial with two wet seasons and a dry season. The area supports a range of habitats including open savanna grassland, wooded grassland, bushland, bushed grassland, thicket, woodland and wetlands (described in accordance with the most detailed and cited botanical classification by Langdale-Brown *et al*. 1964 on such a scale. These habitats are important for biodiversity conservation as they are habitats for a wide range of organisms and for providing essential ecosystem services.

The baseline surveys were conducted to cover the area in which the Central Processing Facility (CPF) where the oil, gas and water in the well fluids will be separated, and the pipeline by which crude oil from the CPF will be pumped to Kabaale by pipeline.

1.3   Purpose of study

This study was aimed at setting out the dry season and part of the wet season ecological baseline for the project area in order to provide a basis for assessment of the likely impacts of the proposed activities in the area. To this end this report will provide information about description of the general environmental baseline focusing on:
- o   designated sites and protected areas
- o   vegetation types and flora
- o   conservation status of species – internationally and nationally important species and habitats
- o   alien invasive species

2.   STUDY METHODS

2.1 INTRODUCTION

In this section, information is provided on the data sources used for the literature reviews of the baseline environment, as well as the methods used for the actual field surveys and any subsequent analysis required for the vegetation and flora.

The first baseline surveys were conducted during the dry season beginning 25th February till 8th March 2014. During this visit, an effort was made to become familiar with the project areas with the help of CNOOC staff, particularly the Community Liaison Officers (CLO). The plains and base of the escarpment were visited while based at the CNOOC camp in the valley. The pipeline route was scope-visited basing in Hoima. During these preliminary visits, the areas with natural vegetation were identified and waypoints recorded. Detailed surveys were later conducted along transects in the plains and base of the escarpment. In both surveys, a total of 10 transects with 116 plots were sampled for vegetation and flora in the Flats, 28 plots on 6 transects on the escarpment and 131 plots on 19 transects along the pipeline beyond the escarpment on the Plateau (Table 1.1, and Fig. 1.1). The second baseline surveys were conducted in the earlier-to-mid part of the wet season, from 28th May through 16th June. In both cases, the main vegetation types in the valley, escarpment and along the pipeline route were surveyed. Along the pipleline route, relic areas that were deemed natural or near-natural were selected for survey, as most of it was under cultivation and settlement. Fig. 1.1 shows placement of the transects and plots in the project area.

Table 1.1 Distribution of survey transects and plots in the project area

Block	Number of transects	Number of plots
Flats	10	116
Escarpment	6	28
Plateau	19	131
TOTAL	**35**	**275**

Fig. 1.1 Location of survey plots in the Buhuka valley Flats (top), the Escarpment (second) and parts of the pipeline on the Plateau (third and fourth)

2.2 FLORA AND HABITAT SURVEYS

2.2.1 Existing Data Sources

A desk-based search was made of the literature available about the vegetation and flora of the project area from the rift valley, escarpment and beyond. Published literature relating to the baseline environment of the survey area was reviewed and compiled to provide a data source on the survey area. The data thus obtained was later ground thruthed during field surveys. The conservation status of the vegetation and flora were reviewed. The published IUCN (2014) Redlist and Kalema & Beentje (2012) were used for conservation status of species. This was intended to identify beforehand the unique, threatened, rare and other cases of conservation concern species and habitats known to occur in the area of the proposed pipeline and Central Processing Facility activities. The data sources used included Langdale-Brown *et al.* (1964), Plumptre *et al.* (2003, 2007), IUCN (2014).

The distribution of vegetation types identified during the desk based study complemented by Google Earth satellite imagery covering the same area were the basis for identification of tentative sample sites to cover the whole range and its habitat heterogeneity. These were later ground truthed by making a visit to sample areas with the Community Liaison Officer. In the process, the variation in habitat structure and composition by the dominant species of plants were noted, and the suitability of the tentative survey points evaluated.

2.2.2 Sampling techniques

The whole project area was conveniently divided into three main blocks, the Flats in the valley, the Escarpment and the areas beyond the escarpment, here referred to as the Plateau. A total of 275 plots along 35 transects were selected and sampled. These were chosen to provide representative coverage of the vegetation types identified within the project area during the desk based study and initial reconnaissance of the study area.

The greatest biological diversity in an area is associated with the maximum perceivable environmental gradients and therefore sampling along the steepest environmental gradient detects the maximum number of species in a given area (Wessels *et al.* 1998). Topographical sequences and changes in soil types are very important (Currie 1991). Accordingly, in each survey area, the main plant communities, which can be partly explained by topographical and soil variations, were identified. Sampling was then done along these gradsects (after Gillison and Brewer, 1985), taking into consideration the variation in such aspects as slope, observable indicators of soil moisture and soil type, as well as the plant community assemblages.

The gradsects were selected to represent the key Areas of Interest (AIO), viz: the Central Processing Facility (CPF), Construction Camp, Spoil Area, Well Pads, Contractors' Camp, Parking Lot, Existing Camp, Permanent Camp, Airstrip, Borrow Pit, Pipeline Route, as well as the

Refinery Area. At each sample site, the best observable gradsect was determined along which the plants were surveyed, traversing the main plant communities. All species of plants present were identified and recorded by slowly walking along the gradsect. The relative abundance of the plant species was assessed using the DAFOR scale where D=Dominant; A=Abundant; F=Frequent; O=Occasional; R=Rare, which is a quick though subjective method of assessing relative abundance (Kent & Coker 1992).

Azonal habitats believed to be unique within a given area were sampled. These included such areas as shallow depressions, old termite mounds, drainage channels, and others. This sampling regime was chosen with a view of capturing as wide a range of the vegetation types and species (Gillison & Brewer 1985, Økland 1990, Austin & Heylingers 1989 in Wessels *et al.* 1998, de Blois *et al*. 2002) in the area as possible.

The general vegetation type in each of the selected sites was characterized. This characterization was based on the floristic and landscape features observed in the different habitat types. Dominant species of plants in the woody and herbaceous layers were identified and used for this purpose. The general terrain and proximity to important features such as the lake or streams were noted. From this sampling, species of conservation concern and invasive species occurring in the area were identified and the geographical coordinates of their areas of occurrence recorded.

The plants that could not easily be identified in the field were collected as vouchers for subsequent identification and deposition in the Makerere University Herbarium (MHU). Geographical coordinates and altitude were recorded at every point of change in the vegetation communities.

2.2.3   Analysis of findings

The relative abundance of the species at each survey site was estimated using the DAFOR scale (see Kent & Coker 1992). In order to estimate the relative abundance of a species over the total area surveyed, a species was assigned a score of 5 for D, 4 for A, 3 for F, 2 for O and 1 for R in each of the surveyed sites where it occurred (see Appendix). In order to estimate the mean relative abundance of the species, these scores were summed up across all the sample points where the species occurred and the total divided by the total number of sample plots surveyed.

2.2.4 Limitations
The second visit was made at a time when the vegetation had not satisfactorily recovered from the previous dry spell. The surveys were separated by only about two months. The herbaceous vegetation was still far from reaching flowering stage. Consequently, a number plant species in the field layer, especially grasses, which are a key constituent element of the vegetation in the area, could not be confidently determined in the field, or even in the herbarium.

In a few cases, access limited the areas that could be sampled. The escarpment area was extremely steep in many places and it was not practical to access some of the very natural habitats. However effort was made to survey some areas along the escarpment as may be seen in Fig. 1.1.

3. BASELINE FINDINGS

The findings presented in this report are reflecting the part of the study conducted during the first two of the three planned surveys. This was during the end of the dry season and the earlier part of the wet season. The findings and conclusions presented here are hence still only preliminary. A more holistic picture will be presented after the remaining survey has also been conducted to provide the whole span of seasonal variations in the year.

3.1 DESK REVIEWS

Langdale-Brown *et al*. (1964) identified the following vegetation categories in the area:
   a) Dry *Hyparrhenia* Grass Savanna/Undifferentiated deciduous Thicket (Q3/V1) in valley
   b) *Themeda-Chloris* Grass Savanna (Q4) in the valley
   c) Dry *Combretum-Hyparrhenia* Savanna (N2) on escarpment
   d) Moist *Combretum-Terminalia-Albizia-Hyparrhenia rufa* Savanna/Medium Altitude Forest/Savanna Mosaic (K/F2) beyond the escarpment along the pipeline
   e) Moist *Combretum-Terminalia-Albizia-Hyparrhenia rufa* Savanna (K) beyond the escarpment along the pipeline
   f) *Cynometra-Celtis* Medium Altitude Moist Semi-deciduous Forest (D2) beyond the escarpment along the pipeline

In 2009, Plumptre *et al*. identified a total of 167 plant species in the adjacent Kabwoya Wildlife Reserve, both of which are in the same ecosystem landscape. They also report some human activities with impact on the vegetation and flora of the area that include grazing by cattle and charcoal burning. The National Biomass study of 2002 reports Grassland and Subsistence cultivation as common land uses in the area (Forest Department 2002).

The Bugoma Central Forest Reserve was identified by NEMA (2009) as one of the areas in the Albertine Rift area that are species rich. Plumptre et al. (2007) found the Murchison Falls National Park – Budongo–Bugoma–Kagombe–Itwara Forest Reserves – Semliki/Toro Wildlife Reserve corridor as important for biodiversity as a whole.

Kalema & Beentje (2012) provide information about broad distribution of tree species in Uganda and beyond. This, together with the IUCN redlists, were used to identify species that are threatened and those of restricted range. Kalema (2005) made a list of species of plants known from Semliki Wildlife Reserve. Although a number of species have not been recorded from the project area, these are mainly not of conservation concern.

3.2 HABITATS/VEGETATION TYPES

The following broad vegetation types were identified:
   i)   Wooded Grassland with *Acacia sieberiana*
   ii)   Woodland
   iii)   Thicket-Grassland mosaic with *Azima, Euphorbia, Acacia*

iv)   Open Grassland with *Cynodon, Sporobolus*
v)   Bushed Grassland
vi)   Bushland and Shrubland of *Acacia, Acalypha*
vii)   Wetland of *Phragmites, Typha, Cyperus* and seasonally flooded grassland (floodplains) of *Sporobolus pyramidalis, Cynodon dactylon*

The various vegetation types are discussed further below.

3.2.1 Wooded Grassland

These are habitats with a dominance of grasses in the herbaceous layer, and a canopy cover of woody plants often 10-50% (Langdale-Brown *et al*. 1964). *Hyparrhenia rufa* and *Sporobolus pyramidalis* were the dominant grasses. In the area surveyed, these communities were mainly on the escarpment and beyond (Fig. 1.2), but very limited in the rift valley. In the areas beyond the escarpment, many had been modified owing to cultivation. The most abundant woody plant species in Wooded Grassland were: *Rhus natalensis*, *Combretum collinum*, *Acacia hockii* and *Annona senegalensis*, while *Hyparrhenia rufa* and *Sporobolus pyramidalis* were the most abundant non-woody species.

Fig. 1.2 Wooded Grassland communities in the surveyed area with frequent burning

Woodland

These are vegetation communities where the tree crowns form a canopy which remains open (never interlocking) to allow growth of herbaceous vegetation, and lacks the multi-layered structure (Langdale-Brown *et al*. 1964). In the area surveyed, these were mainly riverine, occurring along the mainly seasonal water courses (Fig. 1.3), hence of limited distribution. Most were *Acacia* dominated woodlands and some were mixed with *Crateva* sp. and *Acalypha* sp. The most abundant plant species in Woodlands were *Tamarindus indica*, *Rhus natalensis* and *Acacia sieberiana,* with the understorey of *Grewia trichocarpa* and *Azima tetracantha. Hypoestes forskaolii*, *Panicum deustum* and *Sporobolus pyramidalis* were common herb layer species.

Fig. 1.3 Woodland with *Ficus* spp. and *Phoenix reclinata* along a water course

Thicket-Grassland Mosaic
Thickets are communities with mainly armed, much branching species of woody plants, either forming dense clumps or continuous shrubby and tree tangles sometimes approaching 100% cover (Langdale-Brown *et al*. 1964). The drier deciduous ones in the project area, especially in the rift valley flats, are usually 2-4 m high. In the project area, they are commonly interspersed with grassland, forming a mosaic (Fig. 1.4). The most abundant plant species in Thicket-Grassland mosaics were *Acacia brevispica*, *Acalypha fruticosa*, *Azima tetracantha*, *Euphorbia candelabrum*, *Cadaba farinosa*, *Dichrostachys cinerea.* Succulent *Sansevieria* spp. are a common occurrence under the shade conditions of the tangle while *Sporobolus pyramidalis*, *Cynodon dactylon*, *Aloe* sp. and *Cissus oliveri* were common species in the herb layer. In the valley, there are vast areas of bare ground due to heavy grazing by livestock (Fig. 1.4). This kind of vegetation type is of limited distribution in the project area beyond the escarpment, occurring mainly in the flat valley (Fig. 1.4).

Fig. 1.4 Thicket communities interspersed with grassland in the valley flats with very short overgrazed grass and bare patches of ground

Open Grassland

These are vegetation communities with a high coverage of the grass layer by far dominating the woody layer. Woody plant cover in these communities is very low (often <5%, Langdale-Brown *et al*. 1964), with only sparse occurrence of trees and shrubs (Fig. 1.5). The most abundant non-woody plant species in the project area were *Sporobolus pyramidalis*, *Pennisetum purpureum*, *Imperata cylindrica*, *Cynodon dactylon* and *Panicum maximum*. Grazing is by far the most evident factor affecting the structure of the community, keeping it at very low stature (Fig. 1.5). The woody species included *Acacia polyacantha* subsp. *campylacantha*, *Vernonia amygdalina*. Often, these grasslands supported some thicket communities. This vegetation type occurred mainly in the valley areas, being very limited beyond the escarpment.

Fig. 1.5 Open grassland communities heavily grazed in the valley flats

Bushed Grassland

These are vegetation communities of grassland with woody species (short shrubs) that do not form thicket but form scattered stands, thus allowing grass species to grow between them. The most abundant plant species in Bushed Grassland were *Combretum collinum*, *Sporobolus pyramidalis*, *Imperata cylindrica*, *Albizia grandibracteata* and *Vernonia amygdalina* (Fig. 1.6).

Fig. 1.6 Burnt bushed grassland beyond the escarpment (left) and lightlt Bushhed Grassland (right)

Bushland and Shrubland

Bushland communities are woody species dominated, with small trees and shrubs about 6 m high. These were mainly on the escarpment and beyond, but limited in the valley flats. The most abundant woody plant species were *Vernonia amygdalina*, *Acacia polyacantha* subsp. *campylacantha*, *Erythrina abyssinica*, *Acanthus polystachius* and *Albizia grandibracteata*. The herb layer was dominated by *Pennisetum purpureum*, *Imperata cylindrica*, *Cissampelos mucronata* and *Ipomoea cairica*. Shrublands are short with mainly shrubs and to about 4 m high. In the project area, Bushlands were mainly in ravines on the escarpment and some places beyond the escarpment. At the base of the escarpment were dense, near-pure *Acalypha fruticosa* shrubland forming dense tangles, difficult to penetrate in many places and with bare ground (Fig. 1.7).

Fig. 1.7 *Acalypha fruticosa* shrubland at the base of the escarpment, and riverine Bushland in gorge on escarpment (right bottom)

Wetlands

These are vegetation communities of either permanent of seasonal water logging (Ramsar Convention Secretariat 2013, Government of Uganda 1995) with vegetation adapted to this water presence regime. In the project area, the most extensive wetland communities were in the valley flats, particularly along the shores of Lake Albert (Fig. 1.8. Occasionally, some ravines on the escarpment carried water even in the dry spell, feeding into wetlands of grassy nature dominated by *Cyperus articulatus* and sparse *Typha* sp. (Fig. 1.8 a, b, c, d). One such semi-permanent wetland ecosystem runs from the base of the escarpment near 36 N 0250944 0138270 past the air strip before joining the permanent wetlands on the lake shore (Fig. 1.8h). The permanent ones were mainly composed of *Cyperus papyrus*, *Phragmites mauritianum* and *Typha capensis* (Fig. 1.8 e, f, g). Other abundant species were *Leersia hexandra*, *Cyperus articulatus*, *Cayratia ibuensis*, *Cyperus dives*, and *Echinochloa pyramidalis*. *Cynodon dactylon* was more common in the seasonally flooded grassland areas. Tha Buhuka flats are covered by extensive grasslands that get flooded during the wet seasons of the year. These are wetlands by the Ramsar Convention Secretariat (2013) and Uganda's wetland policy (Government of Uganda 1995) definitions.

a)

b)

c)

d)

e)

f)

g)   h)

Fig. 1.8 Wetland communities in the valley

2.2   FLORA
3.2.1 Species abundance

Overall, the most common plant species were: *Sporobolus pyramidalis, Cynodon dactylon, Panicum maximum, Flueggea virosa, Cyphostemma adenocaule*, *Acalypha fruticosa* in that order. The most common plant species in each of the main vegetation types are indicated in Table 1.2. *Sporobolus pyramidalis* and *Cynodon dactylon* are unpalatable to livestock, thus standing the grazing pressure to which many other graminoid and forb species are subjected. *Acalypha futicosa* (Fig. 1.7) and *Flueggea virosa* are also adaptable to browsing and other disturbances.

In the valley flats with floodplain, the most abundant species were *Cynodon dactylon, Sporobolus pyramidalis, Acalypha fruticosa, Phragmites kirkii, Capparis erythrocarpos, Senna* sp*., Asparagus africanus, Cissus oliveri, Typha capensis, Cyperus articulatus* and *Dichrostachys*

cinerea. Here, there are a number of species that can stand seasonal flooding regimes, such as *Cynodon dactylon*, *Cyperus articulatus*, and *Sporobolus pyramidalis*.

On the escarpment, where the oil conditions are most marginal and fragile in the project area, the most abundant species were *Acalypha fruticosa, Rhus natalensis, Hypoestes forskaolii, Terminalia brownii, Acacia brevispica, Cissus oliveri, Sporobolus pyramidalis* and *Enteropogon macrostachyus.*

Beyond the escarpment, on the Plateau, soil conditions, including drainage, are better, with only localized areas of water logging. There is however a strong element of human influences attracted to the better arable farming soils. Here, *Pennisetum purpureum, Acacia polyacantha, Imperata cylindrica, Vernonia amygdalina, Panicum maximum, Combretum collinum, Acanthus polystachius* were the most abundant species.

3.2.2 Species richness

Overall, a total of 89 families and 542 species were registered in the surveyed project area. The highest number of species was registered in Bushland, followed by Woodland and Wetland (Table 1.2). But these are vegetation types that were also accorded the highest sampling effort (Table 1.2). Naturally, they would be expected to yield more species. The species poorest vegetation type was Grassland with Thicket, and Bushed Grassland, both of which had the lowest number of sampling plots (only 15 each), owing to their representation in the entire landscape. However, analysis of the mean number of species richness per plot provides a different picture. The highest species richness per plot was in sites with Bushed Grassland, followed by Wooded Grassland and Woodland in that order, while the lowest was Wetland and Open Grassland. The general observation from these findings is that the more wooded vegetation communities registered highest species richness per sampling unit. Accordingly, the least wooded communities of Wetland and Open Grassland had the lowest species richness per sampling unit.

Table 1.2 Species richness, frequency and dominance by vegetation type

Vegetation Type	No. of plots surveyed	Species richness	Mean number of species per plot	Most frequent species	Most dominant species
Wetlands	60	301	5.02	i) Cynodon dactylon ii) Sporobolus pyramidalis	i) Cynodon dactylon ii) Leersia hexandra iii) Sporobolus pyramidalis iv) Cyperus articulatus

				iii) Leersia hexandra iv) Cyperus articulatus v) Cyperus dives vi) Typha capensis vii) Cyphostemma adenocaule viii) Hibiscus diversifolius	v) Typha capensis vi) Echinochloa pyramidalis vii Cyperus dives viii) Phragmites kirkii
Bushed Grassland	15	202	13.47	i) Asparagus flagellaris ii) Panicum maximum iii) Solanum incanum iv) Sporobolus pyramidalis v) Acalypha fruticosa vi) Cissus rotundifolia vii) Combretum collinum viii) Cynodon dactylon	i) Sporobolus pyramidalis ii) Acalypha fruticosa iii) Panicum maximum iv) Euphorbia candelabrum v) Combretum collinum vi) Azima tetracantha vii) Solanum incanum viii) Acacia brevispica
Bushland	55	369	6.71	i) Panicum maximum ii) Vernonia amygdalina iii) Acalypha fruticosa iv) Sporobolus pyramidalis v) Achyranthes aspera vi) Flueggea virosa vii) Albizia grandibracteata viii) Pennisetum purpureum	i) Acalypha fruticosa ii) Acacia brevispica iii) Pennisetum purpureum iv) Panicum maximum v) Vernonia amygdalina vi) Sporobolus pyramidalis vii) Acalypha bipartita viii) Albizia grandibracteata

Grassland with Thicket	15	91	6.07	i) Sporobolus pyramidalis ii) Acalypha fruticosa iii) Azima tetracantha iv) Aloe sp. v) Cadaba farinosa vi) Cynodon dactylon vii) Acacia brevispica viii) Euphorbia candelabrum	i) Sporobolus pyramidalis ii) Acalypha fruticosa iii) Azima tetracantha iv) Acacia brevispica v) Aloe sp. vi) Euphorbia candelabrum vii) Cynodon dactylon viii) Cadaba farinosa		
Open Grassland	38	250	5.79	i) Sporobolus pyramidalis ii) Cynodon dactylon iii) Pennisetum purpureum iv) Panicum maximum v) Acacia polyacantha vi) Imperata cylindrica vii) Vernonia amygdalina viii) Acalypha fruticosa	i) Sporobolus pyramidalis ii) Cynodon dactylon iii) Pennisetum purpureum iv) Panicum maximum v) Acacia polyacantha vi) Imperata cylindrica vii) Vernonia amygdalina viii) Phragmites kirkii		
Woodland	46	318	6.91	i) Acalypha bipartita ii) Cyphostemma adenocaule iii) Flueggea virosa iv) Hoslundia opposita v) Rhus natalensis vi) Panicum maximum vii) Asparagus	i) Acalypha bipartita ii) Albizia grandibracteata iii) Flueggea virosa iv) Rhus natalensis v) Terminalia brownii vi) Acacia polyacantha vii) Grewia mollis viii) Panicum maximum		

				flagellaris viii) Vernonia amygdalina	
Wooded Grassland	27	240	8.89	i) Combretum collinum ii) Acacia hockii iii) Panicum maximum iv) Rhus natalensis v) Annona senegalensis vi) Flueggea virosa vii) Hoslundia opposita viii) Sporobolus pyramidalis	i) Rhus natalensis ii) Combretum collinum iii) Acacia polyacantha iv) Panicum maximum v) Acacia hockii vi) Sporobolus pyramidalis vii) Hyparrhenia rufa viii) Imperata cylindrica

3.2.3 Life forms

Most species were herbs, trees, or shrubs (Fig. 1.9). Climbers were least frequent. The woody species altogether contributed 38.6% by species richness as compared to 61.4% of the non-woody species. In the valley flats with floodplains, the commonest were herbs and shrubs (Fig. 1.10). In the escarpment, the commonest were shrubs (Fig. 1.11) while in areas beyond the escarpment the herbs and trees were the commonest (Fig. 1.12). Woody climbers were the least common in all parts of the project area.
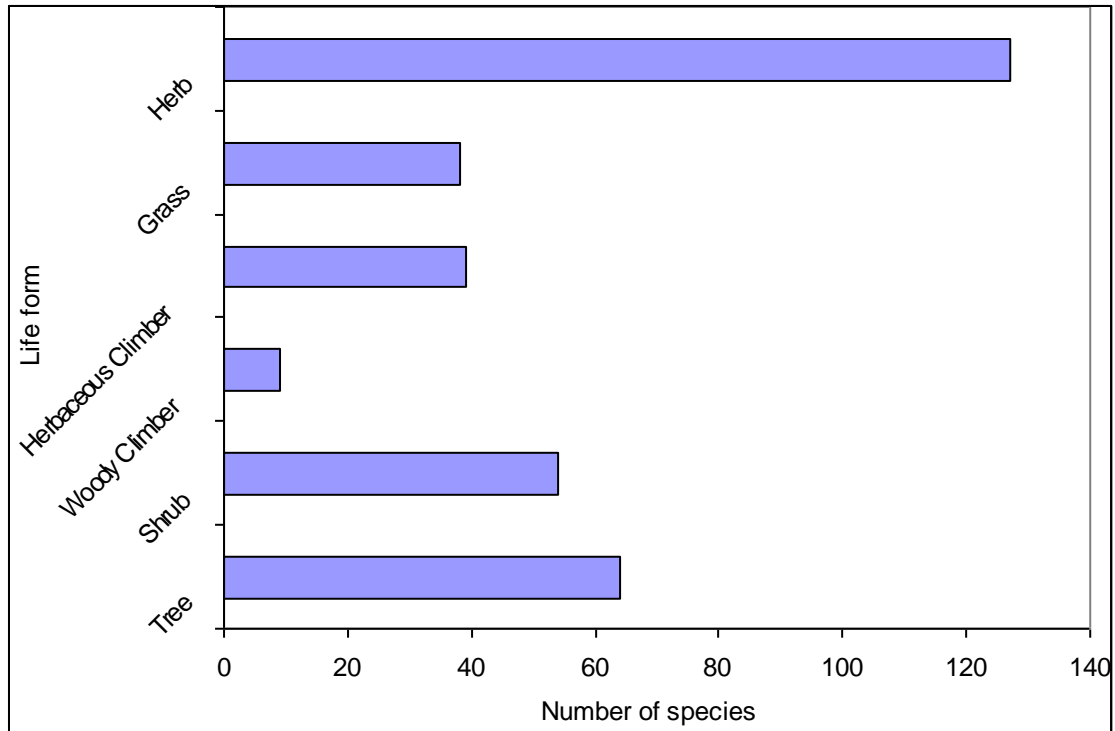
Fig. 1.9 Overall distribution of life forms in all the survey areas
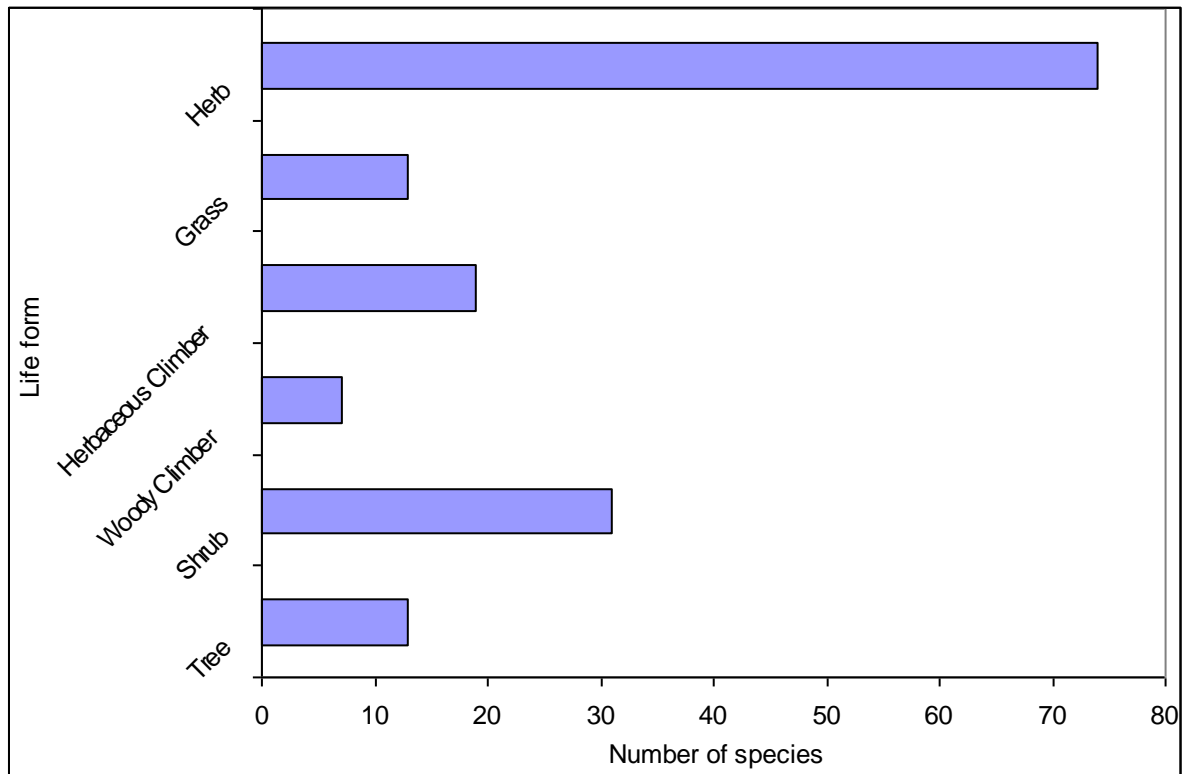
Fig. 1.10 Distribution of life forms in the valley flats
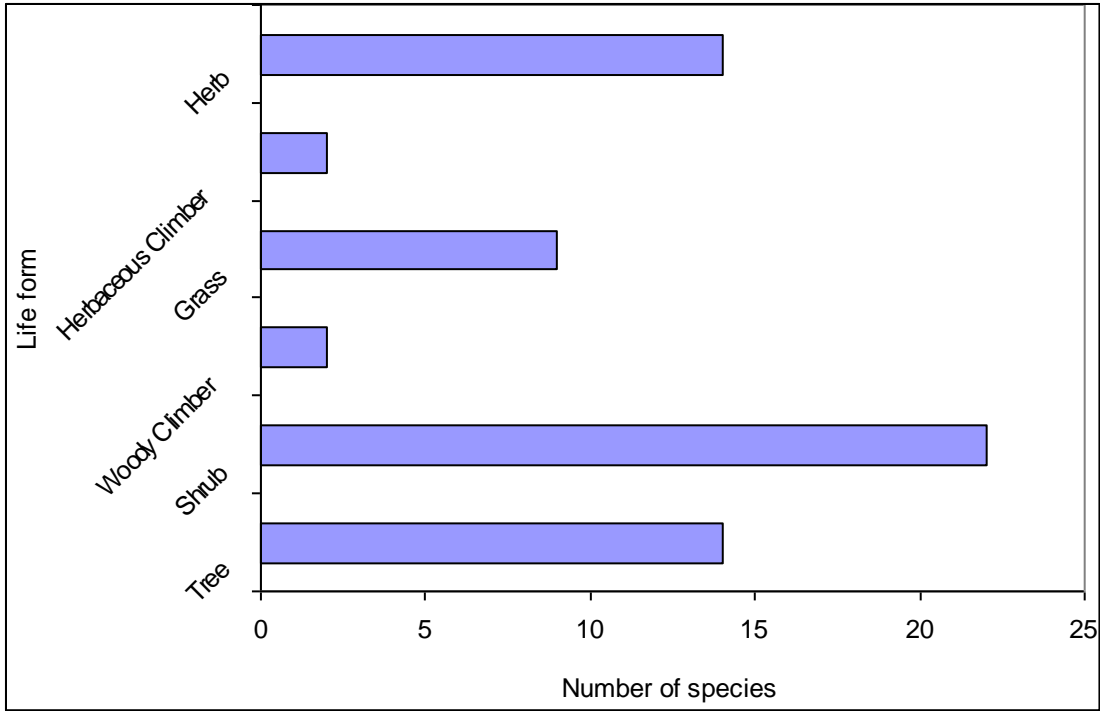
Fig. 1.11 Distribution of life forms on the escarpment

Fig. 1.12 Distribution of life forms beyond escarpment

3.2.4 Relative abundance and frequency

The DAFOR scale used was transformed to estimate the relative abundance of the species as explained in the methods in *Section 2.2.3*. This method gives a general picture about the relative abundance of the species. Accordingly, *Sporobolus pyramidalis* registered the highest relative abundance across all survey areas and all communities together followed by *Cynodon dactylon* and *Pennisetum purpureum*. A total of 94 species were quite uncommon in the survey sites, recorded from only one site and in each of the sites rated Rare (R) on the DAFOR scale. These include *Cordia africana*, *Cordia millennii*, *Cynometra alexandrii*, *Pterygota mildbraedii*, *Markhamia lutea*, all of which are good timber tree species, hence are under pressure from logging. None of these species is Red listed under IUCN. They are known from a number of localities in Bunyoro, Masaka, Mengo, Toro and Madi, and are widespread in Africa (Kalema & Beentje 2012). However, *Cordia millenii* is listed under Uganda's National Forestry Authority Reserved Species. It is therefore flagged for protection in Uganda owing to excessive felling for its high grade timber.

3.2.5 Species of conservation concern

Milicia excelsa is globally threatened, assessed as Lower Risk/near threatened ver 2.3 (IUCN 2013). It was recorded at 36N 282935 158810 in fallows; 36N 284458 158695 and 36N 284101 158935 in Bushland; and 36N 274062 151960 in Wooded Grassland. It is on Uganda's list of 'Reserved Tree Species' because it continues to be felled for its high quality timber, reducing its area of occupancy and its habitat quality. In Uganda, it is known to occur in the regons of Bunyoro, Mengo, Masaka, Mubende, Toro, West Nile, Madi, Acholi, Lango, Teso, Mbale and Busoga, and is widespread in Africa (Kalema & Beentje 2012). It is logged commercially throughout its range, and used for firewood, charcoal, timber, used especially for quality indoor and outdoor furniture. It is on Uganda's list of 'Reserved Tree Species'.

Cordia millenii at 36N 264541 140176 in cultivated land, is also globally threatened and assessed as Lower Risk/least concern ver 2.3 (IUCN 2013). Kalema & Beentje (2012) report that this and *Milicia excelsa* (Mvule Tree) are some of the tree species specifically targeted for exploitation especially for the supply of timber in Uganda although both are widespread in Africa.

Euphorbia candelabrum is CITES listed under Appendix II. It was recorded from Thicket habitats in the Rift Valley at 36N 248648 135896, 36N248720 136012, 36N 248788 136204, 36N 248808 136402, 36N 248874 136601 and 36N 248999 136989.

Aloe sp. All *Aloe* species are listed under Appendix II of CITES (http://www.cites.org/eng/app/appendices.php accessed April 2014). It was growing in nearly all Thicket-Grassland mosaic vegetation communities.

Tamarindus indica is not threatened in the IUCN sense, but of conservation concern in Uganda and is on the Uganda Reserved Tree Species List of NFA owing to its heavy exploitation. It was fairly common on the Escarpment in Woodland and Wooded Grassland e.g. at 36N 250537 138345 and 36N 250501 137322. It is commercially use for food in many parts of northern Uganda and Teso (Katende *et al*. 1995).

3.2.6 Invasive species

The following five plant species were recorded in the first part of the survey. They are invasive aliens in Uganda, with a potential to spread further in the project area with disturbance (Cronk & Fuller 1995) even though they are still generally uncommon in the survey area. They are mainly concentrated in the valley on the Buhuka Flats (Table 1.3). *Mimosa pigra* and *Lantana camara* are the commonest invasive alien species in the project area this far. They have been so far recorded from the highest number of plots and habitat type (Table 1.3). These two species are also some of the most notorious invasive alien species in the world (Lowe *et al*. 2000). *Eichhornia crassipes* (Water Hyacinth) is also one of the leading notorious 100 invasive alien species but this is still restricted in the project area to the shore environments around the Lake Albert.

   i)   *Mimosa pigra* - recorded from Bushland, Wetland and Woodland habitats in varying
   ii) *Pistia stratiotes* – in Wetland near Lake Albert at 36N 247864 137632 where it was locally Abundant
   iii) *Eichhornia crassipes* - recorded from Wetland
   iv) *Ricinus communis* – recorded from wetland and Woodland
   v)   *Lantana camara* – recorded from Bushland, Wooded Grassland, Bushed Grassland and Moist Bushland

Mimosa pigra L. (Fabaceae) - (Bashful plant) - is an erect, much branched prickly shrub reaching a height of 3 to 6 m (Fig. 1.13). It reproduces via buoyant seed pods that can be spread long distances in flood waters. It can spread through natural grassland floodplain ecosystems and pastures, converting them into unproductive scrubland, reducing biodiversity. It grows in open, moist sites such as floodplains and river banks. In the project area, it is at worrisome levels as it has the potential to increase its abundance rapidly.

The management issues associated with the species include:
- The weed suppresses abundance of birds, reptiles, and plants
- It can reduce the area of grazing land and the carrying capacity of the land. Furthermore, if livestock are reliant on natural water sources for drinking, their access to water may be blocked.

It may reduce water flow and increase silt levels, as it commonly colonizes watercourse edges. This may threaten the sustainability of reservoirs and canals and any livelihoods reliant on them.

Recommended control:

The best recommended control measure is physical uprooting of the shrubs, especially before flowering and/or fruiting stage.

Pistia stratiotes L. (Araceae) - Water Lettuce - is evident in the project area. It is observable on the fringes of the *Phragmites-Typha* swamps along the Lake Albert (Fig. 1.14). It is a common floating perennial weed of waterways also known as Nile cabbage, Water cabbage or Water lettuce. It inhibits slow moving water such as ponds, lakes, swamps, or irrigation canals. Its origin is disputable, between North America and Africa, but has spread to many parts of the world, especially tropical regions. It can propagate both vegetatively and sexually (Ramey 2001) and can hence grow and cover large areas pretty fast.

Some of the impacts it may cause include:
  i.   Dense mats of the species can block gas exchange at the air-water interface, reducing the dissolved oxygen content in the water and killing aquatic life
  ii.   They also block light, killing native submerged plants, thus altering immersed plant communities (Ramey 2001)
  iii. Massive coverage of water can block navigation
  iv.   Mosquitoes lay their eggs under the leaves, thus it can promote malaria incidence

Recommended control:
  i.   Mechanical harvesting e.g. raking - removing the water lettuce from the water - and transporting it to disposal areas on shore
  ii.   Sensitization of workers and communities to minimize its inadvertent or deliberate spread

Lantana camara L. (Verbenaceae) is a native shrub of tropical America, now introduced in many parts of the world, where it is invasive (Cronk & Fuller 1995, Binggeli 1998, Weber 2003, Walton 2006). The main dispersers are birds that eat the berries (Aravind *et al*. 2010). Some varieties of the species are cultivated as ornamentals (Floridata 2007). The leaves contain toxins that affect grazing animals such as goats and cattle (Barceloux 2008). Extracts of the fresh leaves have been found to have antibacterial properties and are traditionally used in Brazil in the treatment of respiratory system infections (Barreto *et al*. 2010). Places within which the shrub has so far been recorded are indicated in Table 1.3.

The main concerns about this species include:
  • It can become a dominant understorey shrub by suppressing native shrubs; the dense thickets can even transform woodland into shrubland
  • Its allelopathic (poisoning of the soil in its vicinity) qualities can affect the growth of nearby plants. It can therefore stall natural regeneration and poses a serious threat to native threatened plant species
  • It can invade a wide range of environments. Its prolific all-year flowering and seed production allows rapid dispersal, and the seeds are spread fairly long distances by birds
  • It can replace native pastures, threatening the habitat of local grazing fauna

- Its toxic leaves can cause many cases of cattle and sheep poisoning particularly young animals. Unripe berries are poisonous to humans and can cause death
- The dense thorny thickets can deter human access
- The capacity of the soil absorb water in dense stands of the shrub is reduced, increasing run-off and therefore soil erosion
- Thickets can be a breeding ground for malaria mosquitoes and tsetse flies

Recommended control:

Physical removal or burning can be effective, provided that desirable trees are introduced to shade out re-growing *L. camara* plants. This may be difficult when the plant covers extensive areas (Kalema 2012).

Ricinus communis L. (Euphorbiaceae) (Castor Oil Plant) is a small tree or shrub indigenous to the southeastern Mediterranean Basin, Eastern Africa, and India (Rana *et al*. 2012). It is widespread throughout tropical regions (and widely grown elsewhere as an ornamental plant. The seed contains ricin, a toxin, which is also present in lower concentrations throughout the plant.

In the project area, this species is still in low abundance (Fig. 1.16). This is easier to control by physical removal before flowering and fruiting stage.

Table 1.3 Invasive alien plant species' location and abundance in the project area

Family	Species	Life form	Habitat	Location	Coordinates	Abundance (DAFOR)
Fabaceae	*Mimosa pigra*	Shrub	Bushland	Floodplain	36N 248660 135696	Occasional
			Wetland	Floodplain	36N 247816 135306 and 36N 248166 135504	Occasional
				Floodplain	36N 248350 135582 and 36N 248697 135789	Dominant
				Floodplain	36N 248531 135673	Frequent
			Woodland	Floodplain	36N 249463 135944	Occasional
Araceae	*Pistia stratiotes*	Herb	Wetland	Floodplain	36N 247864 137632	Abundant

Family	Species	Life form	Habitat	Location	Coordinates	Abundance (DAFOR)
Pontederiaceae	*Eichhornia crassipes*	Herb	Wetland	Floodplain	36N 247456 136122	Rare
					36N 247897 137420 and 36N 246645 135057	Occasional
					36N 247864 137632	Frequent
Euphorbiaceae	*Ricinus communis*	Shrub	Wetland	Floodplain	36N 247864 137632	Frequent
			Woodland	Escarpment	36N 250425 137187	Occasional
Verbenaceae	*Lantana camara*	Shrub	Bushland	Beyond Escarpment	36N 274099 151564	Occasional
					36N 255066 137991	Rare
			Wooded Grassland		36N 274096 151763, 36N 273894 153547 and 36N 274062 151960	Frequent
					36N 274020 152155 and 36N 273918 152540	Occasional
			Bushed Grassland		36N 273993 152352	Frequent

Fig. 1.13 Invasive *Mimosa pigra* forming dense tangles

Fig. 1.14 *Pisitia stratiotes* in Phragmites-Typha wetland on the shores of Lake Albert

Fig. 1.15. *Eichhornia crassipes* in Phragmites-Typha wetland on the shores of Lake Albert

Fig. 1.16. Invasive *Ricinus communis* on escarpment bottom (left) and near a wetland (right)

3.2.7 Ecologically sensitive sites

The most ecologically critical habitats identified to-date are:

i)   Wetlands, both permanent and seasonal, whose hydrology may be adversely affected, consequently affecting the flora that is habitat-specific, e.g. species of *Typha*, *Cyperus articulatus, Phragmites mauritianum* and in turn the fauna dependent of them. Construction of the central processing facility and the pipeline are likely to affect the groundwater flow on which the wetlands are dependent, thus affecting their ecological integrity or even causing their loss.

ii)   Bushland and Wooded Grassland at the escarpment, the former mainly along ravines. The topography here is quite steep, making these habitats susceptible to soil erosion, or even landslides arising from any activity that may cause vegetation removal, destabilizing the fragile soils.

iii) Cultivation-modified habitats along the proposed pipeline route. These have relics of wetland in valley bottoms, Wooded Grassland, Bushland and Woodland in places. The area beyond the escarpment towards Hoima is much settled and cultivated, already suffering heavy degradation. The relics of natural or less disturbed patches of vegetation in places are instrumental as they are the last bits of refugium for biodiversity in these totally unprotected areas. A number of them are fragmented from one another, but there is some connectivity across some through rivers and seasonal streams. The forests are the most fragmented, having been cut down for cultivation (Fig. 1.17)

Fig. 1.17 Destroyed forest near Bugoma Central Forest Reserve

SECTION 2: INVERTEBRATES OF KINGFISHER FIELD DEVELOPMENT AND PIPELINE ROUTE
Background

Environmental changes and conversion of natural habitats greatly affect organism diversity (McNeely *et al.*, 1995). Habitat loss is a major threat to the loss of global biodiversity (Summerville & Crist, 2004) and it is regarded as the single greatest global threat facing fauna and flora (Ehrlich, 1988; Fahrig, 2001). Per se, human dominated landscapes now cover a majority of land area in many parts of the world (Ricketts *et al.,* 2001) making habitats dominated by human activities increasingly important for the conservation of biodiversity (Hilt *et al.,* 2006).

Insects dominate the terrestrial and aquatic ecosystems in terms of species richness, individual abundances and biomass (Wilson, 1985; Stork, 1988; Gaston, 1991). Their temporal and spatial distributions span the ranges occupied by many vertebrate and plant species, including finer-grained patch sizes and geographical distributions, more complex seasonal and successional sequences and patch dynamics with more rapid turnover (Gaston & Lawton, 1988).

Importance of insects as bioindicators

Insects are highly susceptible to the adverse effects of disturbances and landuse changes have been found to alter abundance and species richness of many insect groups. Many tropical species are locally endemic or are rare and with patchy distribution which predisposes them to increased extinction risk when habitats are modified (Terborgh, 1992). Consequently, conservation of many such species will depend on the capacity of fragmented habitats to support their populations.

Butterflies are known sensitive indicators of environmental change associated with natural and human-induced disturbances. Their populations are influenced by changes in local climatic conditions and the availability of host plants for larval and adult stages (Ehrlich *et al*., 1972; Thomas *et al*., 1998). Frequently disturbed environments are considered unstable and unpredictable and as a result have low species diversity, whereas less disturbed, more stable environments are expected to promote high species diversity (Odum, 1985).

The dragonflies that are predominantly diurnal, utilizing both aquatic and terrestrial habitats contribute greatly to the evaluation of environmental quality (Miller and Miller, 2003). They are known to be very sensitive to structural habitat quality and are used as indicator groups to evaluate landscape degradation. The amphibious larvae are critical in regard to water quality and aquatic morphology of streams. The adults are sensitive to habitat structure and are excellent indicators of river disturbances.

Study area and methods

Study area

Butterfly and dragonfly surveys were carried out in different sites that included;

i. Several sites in the Buhuka flats that included

➢ Areas along a stream and seasonally flooded wetland located near the airstrip (Site 1).
➢ The flats were mainly open heavily grazed grasslands with thickets dominated by *Euphorbia* sp (Site 2)
➢ Areas around pad 3 that was mainly burned with pockets of thickets mainly of *Caparis* sp (Site 3)
➢ Areas along the beach skirting the area around the lagoon area dominated by *Phragmites* sp (Site 4).
➢ Permanent swamp area located at the bottom of River Masika (Site 11).

ii. The escarpment consisting of light woodland with dense thickets, riverine forest located along gulleys.
iii. Beyond the escarpment along the pipeline route to the refinery area that consists mainly of cultivation, seasonal wetlands (fairly degraded), riverine vegetation especially along River Hohwa and pockets of natural woodlands.

Details of the different sites are summarized in table 1

Table 2.1. Sample sites for butterflies and dragonflies

Site number	Habitat description
1	Seasonally flooded wetland along a stream (Name??)
2	Open grassland with thickets
3	Pad 3 area
4	Lagoon area
5	Escarpement
6	Kabaale (refinery area)
7	Kaseeta
8	Hohwa
9	Kibale Butoole
10	Kamukya
11	R. Masika and large permanent swamp between R. Masika and L. Albert
12	Kisoga area

Butterfly sampling

The adult butterfly fauna of the target areas were sampled systematically using sweep net and baited traps.

Sweep netting
An established transect line was walked at constant pace, recording all the butterfly species seen on wings. Individuals that were difficult to identify on wings were taken and stored for further processing. Opportunistic observations were included to help build the species list.

Baited traps
Several traps (18 in number) baited with fermenting banana where set along transect lines and in strategic places like shaded areas. The traps were checked once in the morning. Specimens were identified and released and only specimens with difficult identification were collected for further processing.

Each of the butterfly species was assigned to one of the ecological categories as described by Davenport (1996). The major categories considered included forest dependent species (F), forest edge/woodland species (f), open habitat species (O), widespread species (W), migratory species (M), and wetland species (S).

Dragonflies
Adult dragonflies were sampled using sweep nets. The most effective technique was to wait until the adult dragonfly is just past the net and swing the net from behind. Some species were more easily caught when they flying about, perched or while basking. Voucher specimens were

collected and preserved for further laboratory identification. Whenever possible, photographs of individuals were taken as colors often fade on storage.

In most instances, only mature males were sampled to minimize impacts on breeding populations. Familiar local species were recorded by observation only, or catching them and releasing after confirmation. Particular attention was given to the local habitat where the species were found.

Species identification

The different species of butterflies encountered in the different sites were identified on wings from expert knowledge. Individuals whose correct identification could not be established in the field were taken as voucher specimens and identified using available field guides (e.g. Larsen, 1991; Kielland, 1990, Carder & Tindimubona, 2002, Larsen, 2006; Molleman, 2012). Cross checking was done using the reference collections at the Zoology Museum, Makerere. Some of the difficult members of Lycaenidae and Hesperidae families were identified by Torben Larsen and members of the Afrotropical Lepidoptera forum.

For dragonflies, familiar species were also identified in flight. Species with difficult identification were taken as voucher specimens. Laboratory identification was done at the Zoology Museum, Makerere using a power microscope and the relevant identification guides (e.g. Miller and Miller, 2003; Clausnitzer, 2002, and Picker *et al*, 2004). Detailed comparisons of photographs were also made using the site http://www.africa-dragonfly.net/. Majority of the photographed species were personally identified by Viola Clausnitzer and Klass-Douwe B Dijkstra.

Survey Results

A total of 155 species of butterflies and have collectively been recorded within the surveyed project areas; 62 species of butterflies during first field season and 154 species of butterflies during the second field season, with upto 92 species not previously recorded during first field season. Likewise 46 species of dragonflies have collectively been recorded from the different surveyed sites; 18 species during the first field season and additional 12 new species not previously recorded. The distribution of butterfly and dragonfly species varied between the different sites surveyed as well as between the two field seasons as shown in figures 1 and 2 respectively.
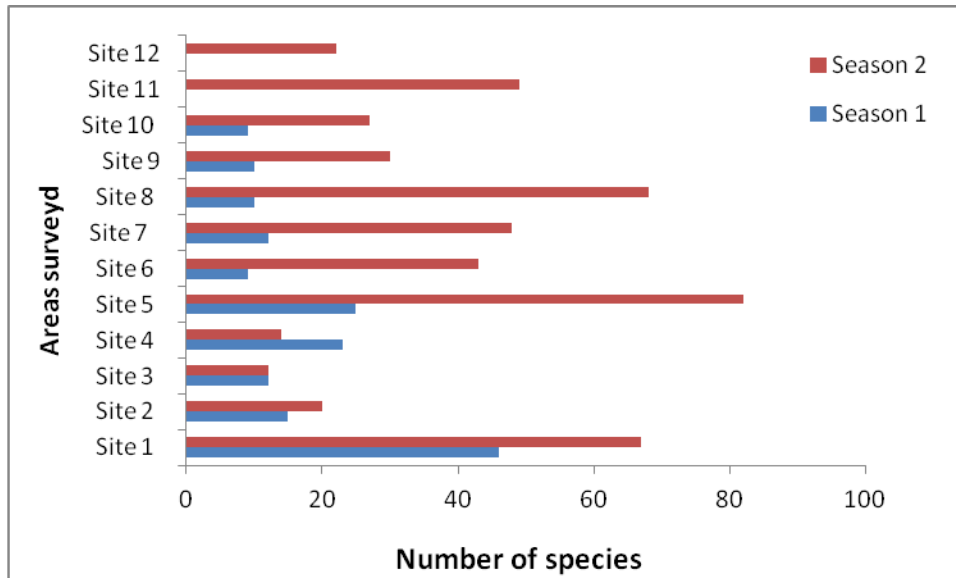
Figure 2.1. Butterfly species distribution amongst sites sampled

For butterflies, 38 forest dependent butterfly species including one forest highland species, 27 forests edge/woodland species, 25 migrant species, 20 open habitat species, 42 widespread species and only two wetland species were recorded in the Project areas.

Four species have been evaluated for the IUCN Red List, while the other species have not yet been evaluated. The four species are all categorized as being of least concern. Detailed account of each species is given in species account section.

From their ecological preferences, 27.3% of the total butterfly species recorded were those that are typically widespread: 13% of species were those typical of open habitats; 16.2% of species were migrants; 17.5 % were forest edge/woodland species; 24.7% were those characteristic of forest habitats and only 1.3% were those species that are wetland dependent.
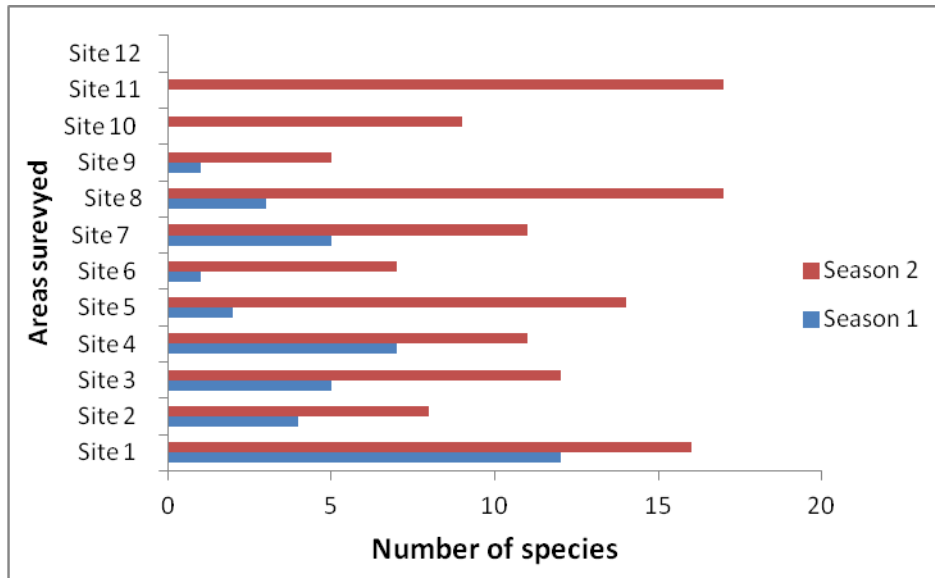
Figure 2.2. Dragonfly species distribution amongst sites sampled

All the dragonflies recorded have been assessed for the IUCN Red List and are all categorized as being of least concern (LC). But given the potential threats that have been noted for some of the species, the proposed oil project will sure impact on these species. Appendix 2 shows dragonfly species recorded in the different transects surveyed in the areas.

Key observation

a. The second field season registered more species and individuals of both dragonflies and butterflies compared to the first field season.
b. Seasonally flooded wetlands along the stream located near the airstrip and river Masika (escarpment area) was the most species rich in terms of dragonflies. The area located near Kisoga village was devoid of any dragonfly species.
c. The escarpment that comprised a combination of different habitat types was the most species rich in terms of butterflies. Areas around river Hohwa and the stream located near the airstrip were fairly species rich in terms of the butterfly fauna. Kibale-Butoole area was the least species rich in terms of the butterfly fauna
d. The areas along the lake especially near the lagoon and pad 3 were also relatively rich but more effort is needed to comprehensively evaluate their inset fauna
e. During the second field survey, the areas were very dry and hot, although the vegetation was fairly green, with several noted to be in flower. This is a possible

explanation for the observed turnover in individual abundances especially for the butterflies. The second survey over a different season brought out a very notable change in insect fauna.

Account of the four assessed species of butterflies

1. *Bicyclus jefferyi* has a large extent of occurrence in which it is common in forest clearings and edges of relatively wet forests. However, population trend is unknown.
2. *Eurema brigitta* is one of the fifteen most common butterflies in most of Africa and Asia and has a stable population trend
3. *Junonia oenone* has been described as potentially the last surviving butterfly in Africa. This species is found all over Africa and both its extent of occurrence and area of occupancy are very large. The population trend in largely unknown but there is no present threats to its global population.
4. *Zizina antanossa* is one of the most widely distributed butterflies in Africa, effectively being pan-African and extending to Yemen. It inhabits various types of open country, extending into disturbed area of the forest zone. Its population trend is unknown but it is not affected by any major threats at present, and is therefore very much a species of Least Concern.

For the dragonflies, one species recorded, *Mesocnemis singularis* (Karsch, 1891), although being of least concern, there is urgent need for monitoring of this species (IUCN).

SECTION 3: HERPETILES SURVEYS OF THE KINGFISHER DISCOVERY AREA
SEASON II

Lake Victoria Toad –*Amietophrynus vittatus*
(from wetland near airstrip in Buhuka flats)

Degen's Snake – *Croptaphopeltis degeni*
(from the Kiina wetland)

Smooth chameleon *Chamaeleo laevigatus*

(from the wooded savannah in the proposed refinery area)

3.1   INTRODUCTION

The surveys took place between 9th and 23rd June 2014. This was supposed to be towards the end of the wet season but in actual fact, the rains came in during the last two days of this survey. It was a follow up of an earlier survey carried out between months of February and March 2014 that targeted the dry season. Incidentally that season was wetter than the season during which the second survey was done.

3.2   OBJECTIVES

The main aim of the study was to make a baseline survey of the amphibian and reptilian fauna of the area in view of forthcoming activities taking into consideration of the wet season.

The specific objectives of the study were to:
  i.   Identify and document existing amphibian and reptilian species in the project area,
  ii.   Document important habitats of amphibian and reptilian species in the project area,
  iii. Describe the conservation status, if known (e.g. IUCN Red List, CITES) of these species occurring in the area with special attention given to rare and threatened, endemic or near endemic species,
  iv.   Evaluate the current environmental constraints in terms of human impacts in particular from the perspective of herpetofauna conservation,
  v.   Propose a monitoring plan

3.3   STUDY AREA AND METHODS

3.3.1 STUDY AREA

The study area encompassed the Buhuka Flats, Lake Albert shoreline, the escarpment and pipeline route and the refinery area, covering the parishes of Buhuka, Kyangwari and Kaseeta. Some habitats with which amphibian and reptilian fauna are associated had been mapped during the dry season study. The current study added in a few more.

A total of 19 sites around which surveys were done have been selected (Tab. 3.1) (Fig. 3.1). Eight of these were surveyed for amphibians and reptiles, five exclusively for amphibian fauna and six exclusively for reptilian fauna. This was eight more sites surveyed than the last season. The added points also included some Bugoma Forest Reserve sites that could act as controls. This is because several sites surveyed outside the forest were considered to have been continuous with Bugoma forest but are now under heavy cultivation. The herpetofaunal composition in Bugoma forest should therefore be close to the original composition while that along most of the pipeline and refinery areas could constitute a mixture a few forest generalists

and a majority of species that are dispersing from grassland habitats to occupy the new niches created as the forest cover shrinks further. The amphibian fauna were generally associated with water and wetlands while the reptilian habitats were spread all over the area the preferable ones being rocky outcrops, bushed, thickets and woody vegetation.

Table 3.1: Selected habitats that were surveyed for amphibians and reptiles

Site No	Site/Village	Northing	Easting	Altitude (m)	Taxa Surveyed	Description
1	Buhuka /Airstrip Swamp	N1.23949°	E030.74991°	639	Amphibians & Reptiles	Thicket-grassland, dominated by Acacia sp. ,Crateva and several grasses, Has a semi-permanent strip that passes through from the Barracks
2	CPF	N01.24693°	E030.74780°	627	Amphibians & Reptiles	Widely dispersed thickets of *Acalypha*, short dry grasses and over grazed near Pad 2 construcion site
3	Kiina wetland	N01.22070°	E030.72312°	622	Amphibians & Reptiles	A thick wetland with several *Cyperus* sp and other grasses, water logged along Lake Albert, edges over grazed

Site No	Site/Village	Northing	Easting	Altitude (m)	Taxa Surveyed	Description
4	River Masika	N01.22802°	E030.75270°	667	Reptiles	Area underlain by rock, with permanent water, massively cultivated & over grazed with sparsely dispersed thickets of *Acalypha*
5	Lagoon	N01 24738	E030 73708	621	Amphibians & Reptiles	Surrounded by elephant grass & several *Cyperus* sp. In close proximity to Lake Albert
6	Site C	N01.23735°	E030.74912°	640	Amphibians & Reptiles	Open grassland, heavily overgrazed with a village water source/ tap
7	Kyaploni	N1.44210°	E31.08393°	1082	Amphibians	Mimosa pigra, Elephant grass, Acacia polycantha, with wide food crops of maize, banana & cassava

Site No	Site/Village	Northing	Easting	Altitude (m)	Taxa Surveyed	Description
8	Nyamasoga	N01.43369°	E031.07183°	1060	Amphibians	Wetland with *Leersia*, Elephant grass surrounded by maize fields
9	Nyamarwa	N01. 43599°	E031.05333°	1054	Amphibians & Reptiles	Water dam, with *Leersia* and several *Cyperus* sp.
10	Refinery Boundary	N01.47101°	E031.06690°	1048	Reptiles	Abandoned farm lands, now regenerating dominated by *Albizia* & *Combretum* sp.
11	Kabakete	N01.46571°	E031.04511°	1012	Amphibians & Reptiles	Wetland dominated by *Cyperus* Sp, *Leersia*, other grasses
12	Kirugwara	N01.43303	E031.04193	1065	Reptiles	*Stereospamum* sp., *Sena* sp, *Albizia* & subsistence farming mainly maize
13	Ndongo	N01.41133°	E031.00150°	941	Amphibians	River Rutoha at the bridge, fast flowing water

Site No	Site/Village	Northing	Easting	Altitude (m)	Taxa Surveyed	Description
14	Zorobe wetland	N01.41541°	E031.03802°	1037	Amphibians	sand mining, surrounded with Elephant grass & *Cyperus* sp
15	Kasenta	N01.33619°	E030.91267°	1162	Amphibians & Reptiles	River crossing bridge – banks dominated by elephant grass
16	Kyamushesha	N01.29081°	E30. 88763°	1157	Reptiles	Farmlands dominated by maize, banana & Casava
17	Mahamba	N1.27981°	E30.86041°°	1157	Reptiles	Banana Garden
18	Kasoga/Buhumurro-Nsanga	N1.29127°	E30.84432°	1117	Rept Amphibians & Reptiles iles	Heavily disturbed wetland surrounded by *Eucalyptus* plantation
19	Bugoma forest	N01.31299°	E30.99641°	1089	Amphibians	Central Forest Reserve with flowing streams

3.3.2 METHODS

Visual Encounter Survey method and Opportunistic Survey were the main methods employed during the current study.

Visual Encounter Surveys (VES) are a well known and robust method for survey hepterofauna. VES is similar to the Timed Constrained Count (TCC) method described by Heyer *et al.*, (1994). Visual encounter surveys are used to document presence of amphibians and reptiles and are effective in most habitats and for most species that tend to breed in lentic habitats. They generate encounter rates of species in their habitats in a unit hour. The method comprised of moving through a homogeneous area/habitat for a unit hour, turning logs or stones, inspecting retreats and watching out for and recording surface-active species. The data gathered using this procedure provides information on species richness of the habitat. For amphibian fauna, the best results are achieved when the surveys take place in the evenings between 1900 and 2100 hours as this is when most amphibians are active.

Opportunistic records are those made outside the sampling points but occur in the surrounding area to be impacted by the project. It helps complete the checklist of the animals as much as possible. Amphibians and reptiles are mobile and can therefore be encountered outside their critical habitats both spatially and temporally. BioDiversity Pro (NHM, 1997) was used to calculate and plot various diversities.
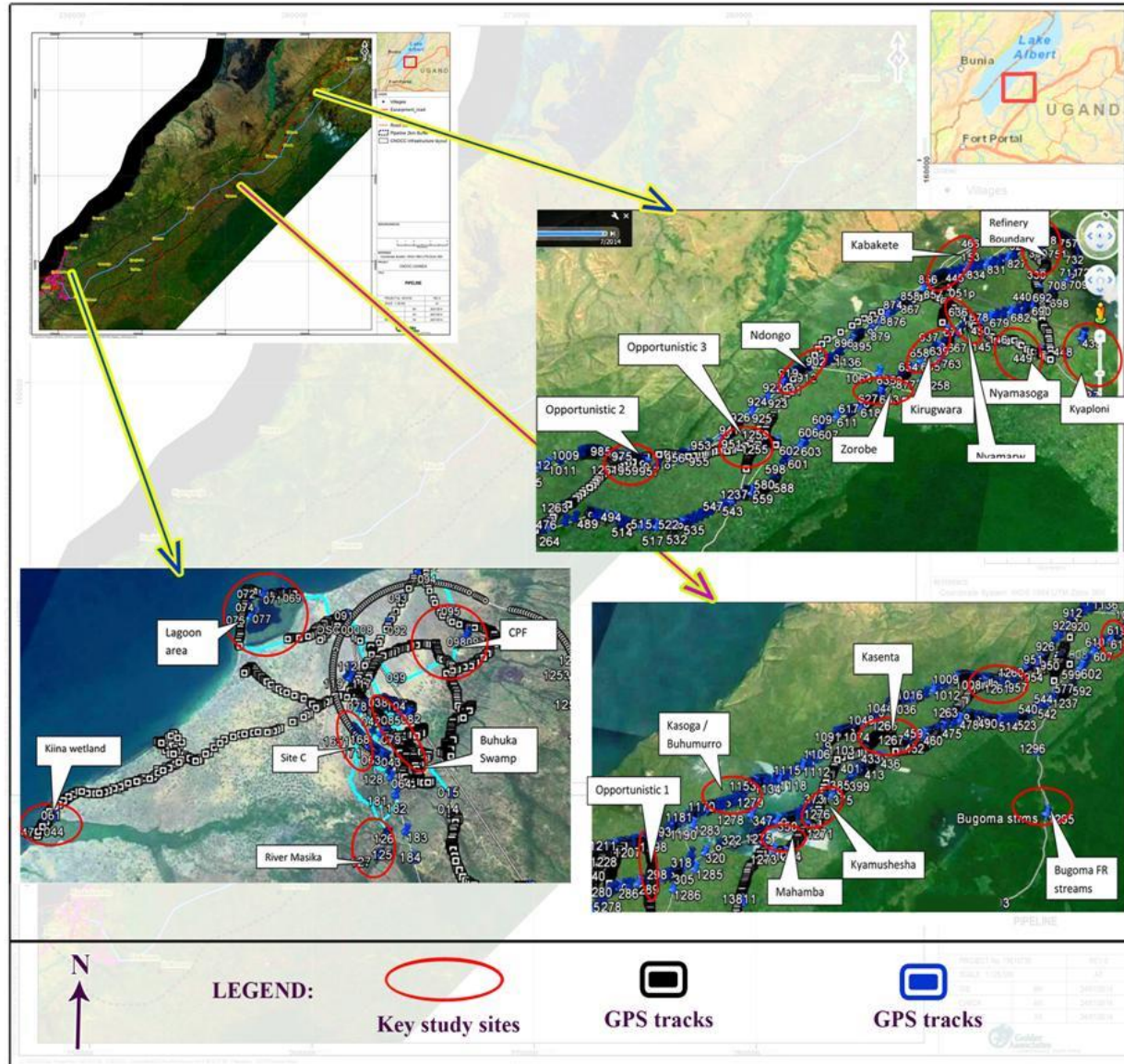
Figure 3.1: Google maps showing the sampling footprint with the key sites in Buhuka flats, along the pipeline and Refinery area

3.4   Results

3.4.1 Amphibian distribution and diversity

A total of 21 amphibian species belonging to seven families and 10 genera were recorded during the second season survey (Tab. 3.2). The combined diversity from the first and second surveys adds up to 23 species. This is 15 species more than recorded during the first survey (Appendix 1). This implies that the second survey was more thorough and addressed most of the sampling errors encountered in survey one.   A higher diversity of macro habitats utilized by amphibian fauna was surveyed, including some sites in Bugoma FR which were used as control experiment sites. More sampling effort was also applied based on recommendations from the first survey.

The most species diverse site for amphibians was Kabakete with 12 species, followed by Kiina and Zorobe sites each with 8 species, then Buhuuka wetland and Kayploni each with 7 species and then site C with six species. The commonest species was Ptychadena sp1 in 8 of the 19 sites, followed by *Hyperolius cinnamomeoventris* (7/19 sites), *Hyperolius kivuensis* and *Hoplobatrachus occipitalis* (each in 6/19 sites) and *Afrixalus fulvovitattus*, *Amietophrynus regularis* and *Ptychadena anchietae* (each in 5/19 sites)

Table 3.2 Showing amphibian fauna recorded

Family	Species	Authority	Common Name	IUCN Red List Status
Bufonidae	*Amietophrynus gutturalis*	Power, 1927	Guttural Toad	Least Concern (Lc)
Bufonidae	*Amietophrynus regularis*	Reuss, 1833	Common African toad	Lc
Bufonidae	*Amietophrynus vittatus*	Boulenger, 1906	Lake Victoria Toad	Data Deficient (DD)
Bufonidae	*Amietophrynus sp.*			
Hyperoliidae	*Afrixalus fulvovittatus*	Frost, 1985	Banded Banana Frog	Lc
Hyperoliidae	*Hyperolius kivuensis*	Ahl, 1931	Kivu Reed Frog	Lc
Hyperoliidae	*Hyperolius acuticeps*	Ahl, 1931		Lc

Hyperoliidae	*Hyperolius cinnamomeoventris*	Bocage, 1866	Cinnamom-bellied red frog	Lc
Hyperoliidae	*Hyperolius viridiflavus*	Dumeril & Bibron, 1841	Common Reed Frog	Lc
Hyperoliidae	*Kassina senegalensis*	Girard, 1853	Senegal Land Frog	Lc
Hyperoliidae	*Leptopelis sp.*			
Pyxicephalidae	*Amietia desaegeri*	Laurent, 1972		Lc
Ptychadenidae	*Ptychadena anchietae*	Bocage, 1868	Anchieta's Ridged Frog	Lc
Ptychadenidae	*Ptychadena mascareniensis cf nilotica*	Duméril & Bibron, 1841		Lc
Ptychadenidae	*Ptychadena porosissima*	Steindachner, 1867	Grassland ridged Frog	Lc
Ptychadenidae	*Ptychadena sp1*			
Dicroglossidae	*Hoplobatrachus occipitalis*	Günther, 1858	Crown Bull Frog	Lc
Phrynobatrachidae	*Phrynobatrachus mababiensis*	FitzSimons, 1932	Mababe river frog	Lc
Phrynobatrachidae	*Phrynobatrachus natalensis*	Smith, 1849	Natal-dwarf Puddle frog	Lc
Phrynobatrachidae	*Phrynobatrachus sp.*		_____	
Pipidae	*Xenopus victorianus*	Wagler, 1827	African Clawed frog	Lc

When cumulative number of species were plotted against the pooled samples (sites), a species accumulation curve starts leveling off by the 10th survey site implying that the maximum amphibian diversity in the study area during the dry/wet season was about to be reached (Fig. 3.2). It could only be slightly higher than the 21 that were recorded by the end of the sampling regime for both survey seasons. Species estimators are used to calculate the possible maximum number of species a habitat can have. Four estimators Chao 1, Chao 2, Jacknife 1 and Jacknife 2 were used. The maximum number of species posted by Chao 1 was 21 species, Chao 2 - 30 species, Jacknife 1 – 24 species and Jacknife 2 – 27 species. This means that the area surveyed could have between 21 and 30 amphibian species with more sampling effort and more micro and macro-habitats covered.
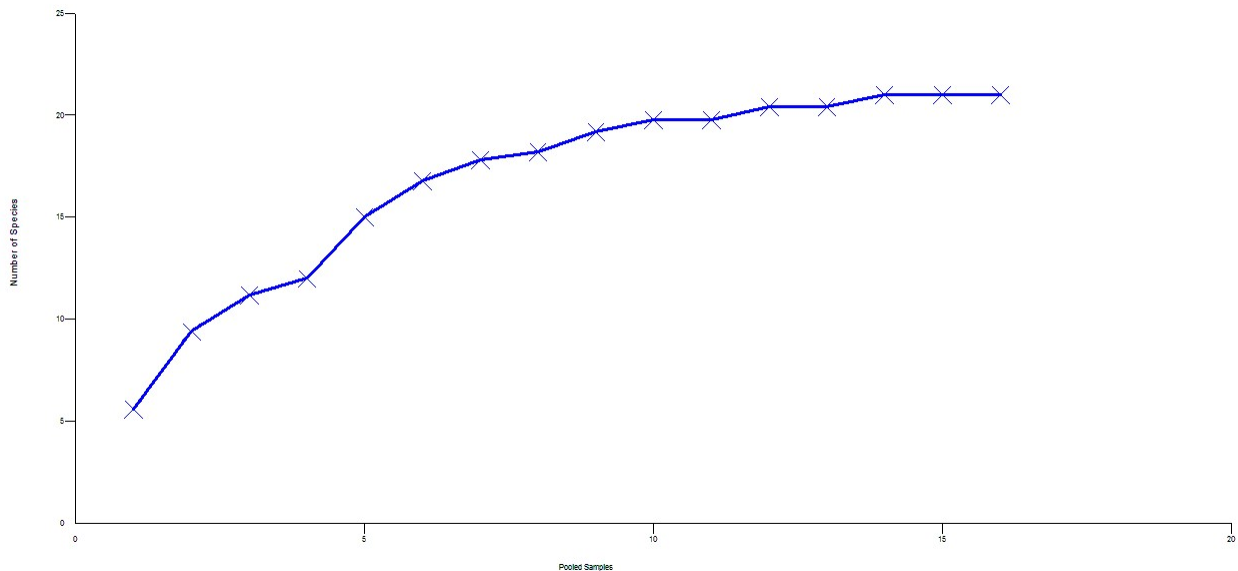
Figure 3.2: Species accumulation curve for amphibian fauna

3.4.2 Cluster Analysis for amphibian fauna

This method classifies objects judged to be similar according to distance or similarity measures. . Data can be quantitative or presence/absence. Bray-Curtis similarity using Group-Average clustering was used and gives a useful hierarchy of clusters. The more similar the sites, the lower the similarity distance (i.e. close to a similarity index of 100%). Dissimilar sites tend to link up at higher similarity distance (i.e. towards zero) and totally dissimilar sites never link-up at all.

The dendrogram below (Fig. 3.3) using amphibian data generally shows habitats in Buhuka flats and just over the escarpment forming one branch while most sites along the pipeline and the refinery form another branch. Buhuka swamp – the site between the airstrip and the barracks are the most similar sites and these two are in turn closely similar to Kiina wetland – i.e. close to 100% similarity. Site "Kirugwara is very similar to "Kasenta" and so are sites "Nyamarwa" and "Nyahaisa" though at a slightly lower similarity level.

When two sites are similar, in face of development, one site can be traded off for development while conserving the other. For example, developing site C while conserving Buhuka swamp can be a good trade off – since Buhuka swamp contains the same amphibian species composition like site C. This is one example how cluster analysis can be used to make management decisions/trade-offs in face of development. It should be an important tool in making developmental decisions when locating alternative development sites and pipeline routes.
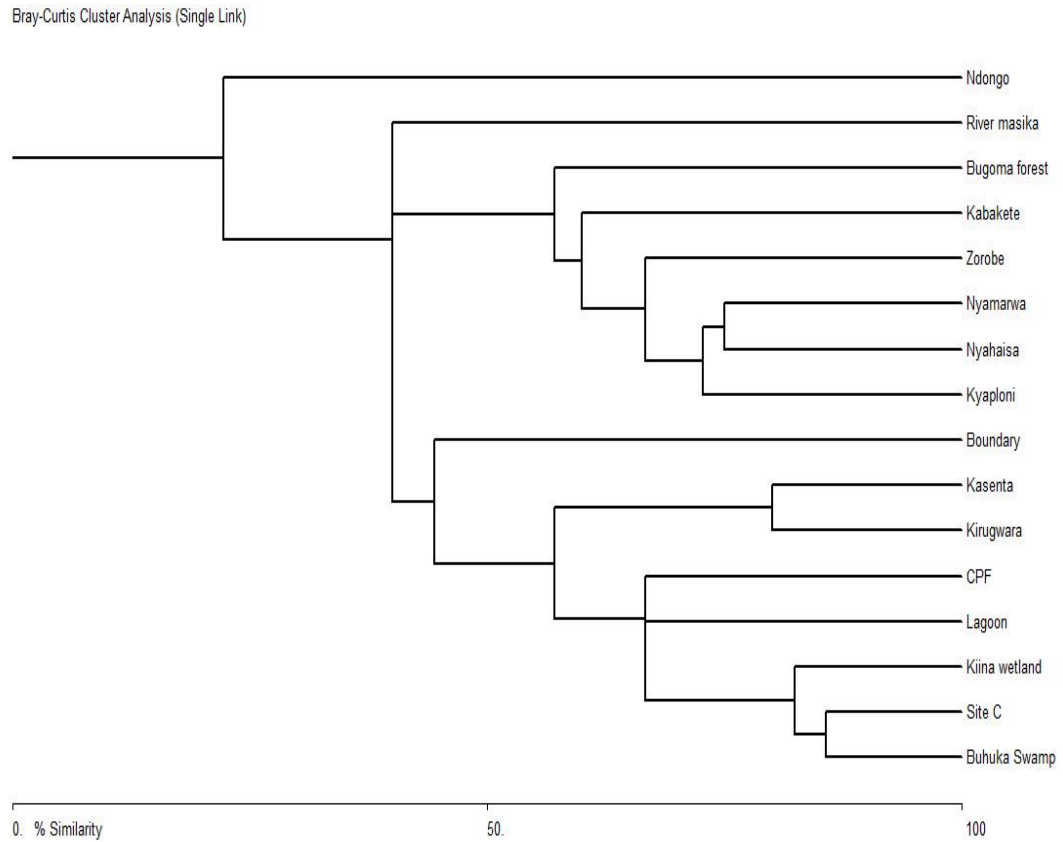
Figure 3.3: Dendrogram for Kingfisher, pipeline and refinery areas using amphibian data

3.4.3 Reptilian distribution and diversity

Thirteen reptilian species belonging to eight families and 11 genera were recorded during the study (Tab.3.3). The combined diversity from the first and second surveys adds up to 21 species. Six of the reptilian species recorded/reported during the first survey were not recorded during the second survey, 10 species recorded during the second survey were new and only three species were recorded for both seasons while two species were opportunistic records (Appendix 2).

Generally the reptilian diversity for each site was poor. The most diverse site was the area where the Central Processing Facility (CPF) will be located with 5 species, followed by Nsanga (4

species), River Masika and Site C each with 3 species. The rest of the sites has one two or no reptiles recorded in them. The commonest reptilian species were *Trachylepis maculilabris* recorded in 6/19 sites, followed by *Agama agama* (4/9 sites) and *Acanthocercus atricolis* and *Trachylepis striata* (each in 3/19 sites).

Table 3.3 Showing Reptiles that were recorded

Family	Species	Authority	Common name	IUCN Status
Pelomedusidae	*Pelusios subniger*	Lacépède, 1788	East African Black Mud Turtle	Lc
Geckoniidae	*Hemidactylus brookii*	Gray, 1845	Brook's House Gecko	NE
Agamidae	*Agama agama*	Linnaeus, 1758	Common Agama	Lc
Agamidae	*Acanthocercus atricollis*	Smith, 1849	Orange-headed Tree Agama	NE
Chamaelionidae	*Chamaeleo laevigatus*	Gray, 1863	Smooth chameleon	NE
Chamaelionidae	*Chamaeleo gracilis*	Hallowell, 1844	Graceful Chameleon	NE
Scincidae	*Trachylepis maculilabris*	Gray, 1845	Speckle-lipped Skink	LC
Scincidae	*Trachylepis striata*	Peters, 1844	African Striped Mabuya	NE
Gerrhosauridae	*Gerrhosaurus major*	Dumeril, 1851	Rough-scaled Plated Lizard	NE
Colubridae	*Philopthamnus bequaerti*	Schmldt, 1923	Uganda Green Snake	NE
Colubridae	*Crotaphopeltis degeni*	Boulenger, 1906)	Degen's Herald Snake	NE
Colubridae	*Psammophis subtaeniatus*	Peters, 1881	Stripped bellied sand snake	NE
Varanidae	*Varanus niloticus*	Linnaeus, 1766	Nile Monitor	NE

The species accumulation curve for reptiles is still rising steeply by the end of the survey of the4 second season (Fig. 3.4). This implies that more species could still be out there unrecorded and the species diversity of the study area is far higher than the current 13 recorded. It could also be higher than the 21 recorded when data for both survey seasons is combined. More sampling effort covering more macro-habitats is therefore still required.

When species estimators were calculated for reptilian fauna, the maximum number of species posted by Chao 1 was 13 species, Chao 2 - 30 species, Jacknife 1 – 20 species and Jacknife 2 – 27 species. This means that the area surveyed could have between 21 and 30 reptile species with more sampling effort and more micro and macro-habitats covered.
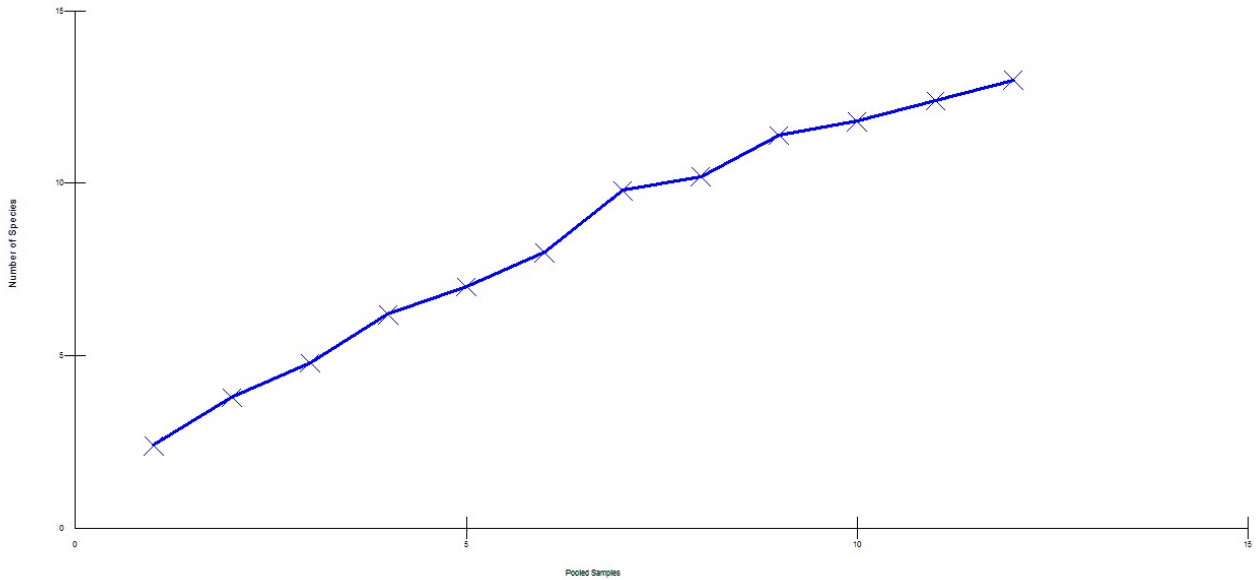
Figure 3.4: Species accumulation curve for reptilian fauna

3.4.4 Cluster Analysis for reptilian fauna

Using reptilian data, a dendrogram with one tree with no distinct branches (Fig. 3.5) shows all sites generally being clustered together. Kiina wetland is the most dissimilar site from all the others. The most similar sites with 100% similarity index are Mahamba and Nyamushesha along the pipeline. This is because the species composition in one site is 100% similar to the other. Other patterns worth mentioning are the three sub-branches with sites showing just above 60% similarity. These include the sites of Nsanga, Kasenta and Kirugwara inside the refinery area that cluster on one sub-brach, site C and River Masika in Buhuuka valley on another and the Buhuka swamp and the Lagoon area on yet another. For each set of the sub-clusters mentioned, conserving one site while using the adjacent one for development would maintain a similar reptilian composition in the former even though the latter is developed.

Bray-Curtis Cluster Analysis (Single Link)

Kiina wetland
Mahamba
Kyamushesha
Nsanga
Kasenta
Kirugwara
Boundary
Site C
River masika
CPF
Lagoon
Buhuka Swamp

0. % Similarity   50.   100
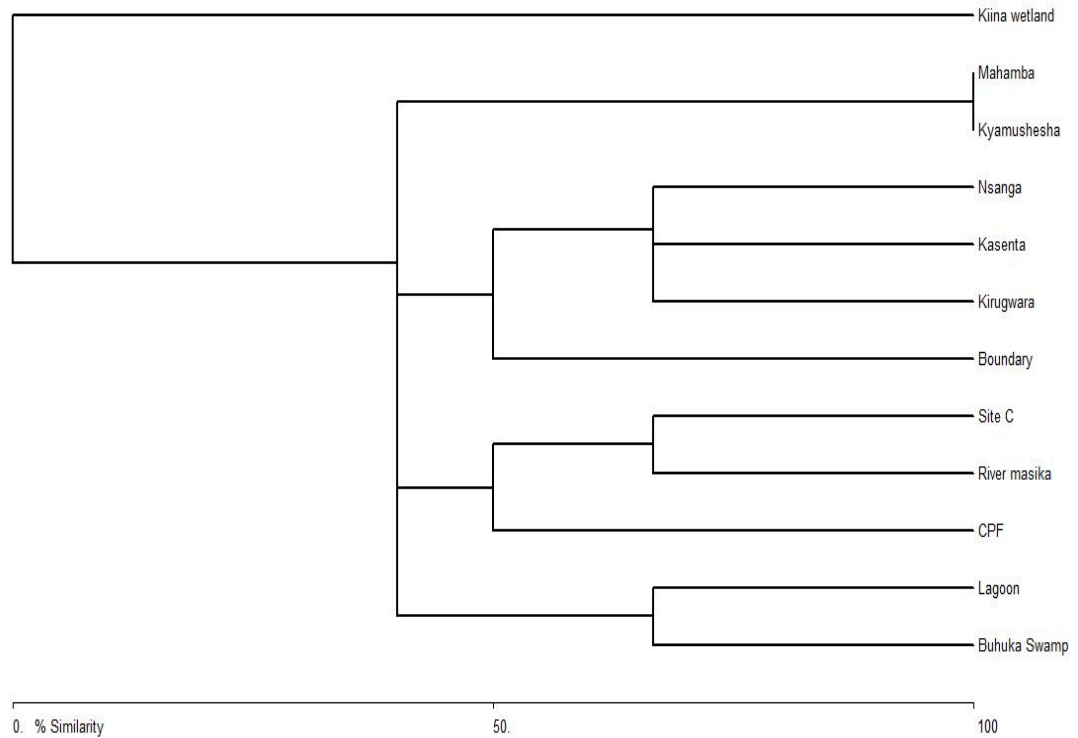
Figure 3.5: Dendrogram for Kingfisher, pipeline and refinery areas using reptilian data

3.4.5 Conservation status

Only two amphibian species *Amietophrynus vittatus* and *Amietia desaegeri* have a "Data Deficient (DD)" conservation status. All other species have been evaluates as "Low risk, Least Concern (Lr/Lc)". From the data gathered on *Amietophrynus vittatus,* the conservation status of this species should be reviewed and given as Low risk/Least concern since it is widely distribution along the shores of Lake Victoria, River Nile and their associated floodplains and wetlands. It also occurs in large numbers wherever it is found.

Most reptiles either have a "Not Evaluated (NE)" status or are considered as of "Low risk, Least Concern (Lr/Lc)". The exemption here is *Trionyx triunguis* - the Nile Soft-shelled Turtle. Although currently with an "NE" for Uganda, the Medtiterrenean subpopulation is Critically Endangered (Cr). The species is reported only in Lake Albert and in the Victoria Nile. Similar threats are reported for this species in the Albertine Graben. Its conservation status should

therefore be revisited to take into account of the current threats and forthcoming threats that will be exacerbated with oil and gas development activities. There were no species of concern during the surveys. However, it is worth noting that *Trionyx triunguis* – the Nile Soft-shelled Turtle population in the Albertine Graben is highly threatened by human activities ranging from collection by fishermen, hunting it when it comes on the shoreline to lay eggs and eating it as a delicacy and as well as for medicinal purposes locally as well as its eggs. Its shell (carapace) is sold for as much as Uganda shillings 10,000-30,000. should have the same conservation status similar to the Mediterranean subpopulation as Critically Endangered (Cr).

Table 3.4 Showing targeted surveys – species of concern

Species	Common name	IUCN Status
Trionyx triunguis -	Nile Soft-shelled Tortoise	Not Evaluated (NE)
Crocodylus niloticus	Nile Crocodile	CITES, observed in the area of the site
Pelusios rhodesianus	Mashona Hinged Terrapin	CITES
Amietophrynus vittatus	Lake Victoria Toad	DD, has been recorded in previous studies
Ptychadena christyi	Christy's Grass Frog	DD

3.5   ENVIRONMENTAL CONSTRAINTS

The Buhuka flats below the escarpment have generally been affected by over grazing, stone-mining, cultivation and scattered human settlements. These negatively impact the herpetofauna. However the existing patches of natural vegetation and wetlands areas provide potential herpetofauna habitats. The Oil and Gas development activities are taking more space and are envisaged even to take more thus resulting in the shrinking of the herpetofaunal habitats further. Management should seriously look into zoning off some of the natural habitats for in this high direct impact zone so that the species that remain in the area can use these habitats as refuge.

The escarpment overlooking the Buhuka flats, because of its ruggedness, is still relatively less impacted by development activities related to oil and gas. To some extent, the road

construction and pipeline construction will partly impact the area. However, the terrain will still be able to give the herpetofaunal species, particularly reptiles, some degree of protection.

The areas along the pipeline beyond the escarpment are under heavy cultivation for subsistence farming. A few spots – especially wetlands still contain some sizeable herpetofauna. However, the conservation of these sites is not certain. Conserving Bugoma CFR which is adjacent to most of the pipeline area could still be the only option so conserve the amphibian and reptilian species composition of the area. Otherwise, sustainable utilization of the wetlands along the pipeline area should be recommended for the current habitats with sizeable amphibian and reptilian fauna to retain some of their species composition.

3.5.1 Most important herpetofauna habitats

Kiina wetland and the adjacent Lake Albert shoreline near Kiina village and the permanent stream near the airstrip-barracks are among the most important amphibian fauna habitats. This is where *Trionyx triunguis*, *Amietophrynus vittatus* and other amphibian fauna were recorded. Other habitats include; shoreline area around the lagoon area. The ravines along the escarpment with rivers, both permanent and seasonal, cascading into Buhuka flats are other important habitats. Further along the pipeline area and

Beyond the escarpment along the pipeline and into the refinery area, some wooded savanna habitats were fairly good for reptilian fauna while most of the habitats good for amphibian fauna were seasonal and permanent wetlands – mostly associated with streams. These should be protected even during development phase since these wetlands are not only good for amphibian fauna, but also a source of water for animals and people in the area.

3.6 MONITORING PLAN

Through these surveys, baseline data has been collected. Key selected habitats and target species should be monitored following the seasonal fluctuations – twice during the wet seasons and twice during the dry seasons, basing on this baseline data collected.

3.7   CONCLUSION

- There is a moderate biodiversity in the sites based on the habitat structure and the species recorded. Any developments in the area should consider maintaining the heterogeneity of the habitat as this will ensure maintenance of a high biodiversity in these sites.

- Continuous herpetofauna monitoring during project implementation in the sites/areas with high/unique biodiversity will help track potential impacts of the project thus implementation of the necessary mitigation measures before it's too late

- The Nile Soft-shelled Turtle *Trionyx triunguis* is reported only in Lake Albert and in the Victoria Nile. Although currently with an "NE" for Uganda, the Mediterranean subpopulation is Critically Endangered (Cr). Similar threats are reported for this species in the Albertine Graben.

3.8   Recommendations

1. The conservation status of Trionyx triunguis – whose Mediterranean population is known to be critically threatened, and yet the same pressure factors face the species within the study area, should be quickly assessed and conservation measures implemented. The conservation status of this species should be revisited to take into account of the current threats and forthcoming threats that will be exacerbated with oil and gas development activities.

1.1 A quick method of assessment could employ the use a questionnaire particularly targeting the fishermen and fisher folk who are reported to highly and directly interact with this species as they fish.

1.2 The project development could negatively impact this species over a long time due to exposure of more people when they come to work and access the shorelines. The species meat and eggs are also craved for by the local people.

1.2.1   This could however be mitigated by the putting in place conservation intervention measures:-

- through educating the local people about the importance of this species

- the species could also be domesticated or farmed for its meat and eggs and

- some specimens taken to Uganda Wildlife Education Centre (UWEC) for ex site conservation.

2. Sensitive ecosystems like wetlands and wooded grasslands should be as much as possible avoided as these have unseen ecosystem services that are not easily replaceable. The ecosystem services provided include habitat and food provision for the herpetofauna.

3. In order to ensure quick recovery of the ecosystem after project activities, there should be minimum disturbance to the sites as much as possible.

4. If for any reason, Wetlands, trees and major thickets are cut down, measures should be put to replant these after the end of the construction of the developments. This will ensure quick recovery of the ecosystem and related biodiversity

5. The dendrograms show alternative habitats for either amphibian or reptilian fauna. The information provided by the dendrograms during the development phase. In face of development, when two sites are similar, one site can be traded off for developments while the other is conserved.

SECTION 4: ORNITHOLOGICAL SURVEYS OF THE KINGFISHER FIELD DEVELOPMENT AREA AND PIPELINE ROUTE

Introduction

The second of the three planned visit to the Kingfisher sites, together with the adjacent escarpment and proposed pipeline route, was made between 21st and 28th June. It had been anticipated that there would have been good rains by that time, whereas in fact the area was surprisingly dry; the swamps, which are potentially of considerable interests, held almost no water and very few birds.

This report supplements the first one, for February/March, and mainly highlights the points of most interest which had not been previously mentioned. The final report, in October, will contain more detail and a broader overview of the biodiversity importance of the areas surveyed, as exemplified by the birds they support. It is worth mentioning here that birds, being highly mobile, tend to reflect the nature of larger areas rather than points, except if there are key nesting or roosting sites.

Whereas in the previous visit, there were good numbers on Palearctic migrants – mainly waders – in May there were far fewer.

Methods

As in the first visit, landbirds were recorded along 2 km transects (with one exception, see below), each transect being predominantly within a single habitat, and collectively covering each of the main habitats in the survey area. Standard forms, as used by NatureUganda for the national bird monitoring programme, were used, and these required separate recording for each of the ten 200m sections that made up 2 km.

All birds were identified at sight (or sound) in the field, with occasional reference to Stevenson & Fanshawe (2002) where necessary.

Sites selected

The sites where counts of landbirds were made were exactly the same as in the first visit, the use of a GPS ensuring this. One additional site was added, namely along the foot of the escarpment, since the transect up the escarpment showed this area to be species-rich, and it could be affected by the planned developments.

Transect counts

Each site was visited twice, so that, with the earlier counts, there are now three data sets for each site; one or two more are planned for the final visit, provisionally in August. The results have been divided geographically into three, and are presented in Tables B1, B2 and B3. Numbers of birds were generally similar in this second visit to those counted in the first, but many additional species were recorded (and, conversely, many of those seen previously were not found this time). Areas of particular interest are described separately below.

Buhuka flats, including well sites and camp areas

Three transects are in the general area of the Flats, namely Arua (transect 1), Euphorbia (4) and camp grassland (2: Table B1), and so far 110 bird species have been recorded in them (or 150 if the 'foot of escarpment is included; see below). Eight Regionally-listed species of conservation concern are included, and a wide variety of other specialists, including waterbirds, grassland species, and aerial feeders. The more open areas are important for species such as Temminck's Courser, Grey Crowned Crane and a variety of plovers and lapwings, whilst the swamps, although seasonal, support a wide variety of bird species. It is, however, surprising that only seven raptor species have so far been recorded. The Albertine Rift valley is almost certainly a migratory route for these and other birds, and hence more might have been expected; the species recorded so far are all residents. Ideally, time should be spent in the area in late September or October to assess the importance of the area for migrants.

Records of particular interest included the following, mainly from the flats -

Grey-crowned Crane: parties of 8,4 and 2 in different sections (i.e, 14 birds) and they looked to be pairing up. There is sufficient wetland/swamp especially in pad 5 area that I suspect breeding may take place.

Collared Pratincole: pair with a recently fledged young was observed near pad 5.

Madagascar Bee-eater: at least 20 birds recorded, probably just arrived.

Great-spotted Cuckoo: an over-summering bird, or perhaps local breeder observed.

Honey Buzzard: an over-summering adult seen well. According to the bird atlas for Uganda (Carswell, *et al* 2005), this is a late date.

Brown Twin-spot: pair nest building.

Saddle-billed Stork: pair recorded, could possibly breed?

Red-collared Widowbird: both forms present, *concolor* and *tropicus.* It is unusual to find both at the same place.

Grey-headed Oliveback: a single adult seen of this uncommon species

Zebra Waxbill: pair nest building.

African Reed Warbler: at least five singing birds, these appear to have replaced the European Reed Warblers that have departed since March. The African birds' song is more scratchy and the habitat more grassland than the scrub favoured by European.

Cassin's Flycatcher: a pair breeding, bird sitting on nest, suspect eggs.

Processing plant area

The transect named 'foot of escarpment' (3 in Table B1) extends from the escarpment to the area designated for the processing plant and of the four transect sites on the flats, had the greatest species richness, mainly because it included an area of swamp, which presumably will be unaffected by the planned plant.

Escarpment

Its relative remoteness and difficulty of access have resulted in the escarpment retaining more woody vegetation than the flats below or the plateau above. No fewer than 95 species have been recorded on this single transect route (5, Table B2), far more than any other, and a further thirteen were added by making a 3 km walk along the foot of the transect (6, Table B2). Thus the escarpment is by far the most important site for landbirds, as well as for other biodiversity.

Pipeline

The proposed route for the pipeline passes through predominantly agricultural country. Such habitats are quite rich in bird species – the numbers per count were, on average, only slightly less than those for the flats (end of Table B3, cf Table B1). Transect site 10, towards the southern end of the pipeline route, was the most open and had noticeably fewer birds than the other three, which had more trees and other natural vegetation. It is interesting to see that at these four sites together, 144 bird species were recorded, compared to 130 at the four sites on the flats; and there were nine species of regional conservation concern, only one less than on the flats.

After completion of the third and final field visit, we shall analyse the differences between the various habitats in more detail, but we can already suggest that each has value, with different sites being important for different species.

Waterbirds

Repeat counts were made at the sites visited previously, and the results can be seen in Table B4.   Numbers of birds were much lower than in February and March, when the majority of them were Palearctic migrants. But there were still good numbers of waterbirds seen in the one-hour counts (Table B4), as some resident species, such as Long-tailed Cormorant and Little Egret, were more numerous in May. However, the big difference came in the transects (Table B$)< where the over 400 birds seen in March were now less than 50 in number.

The overall picture is of relatively large numbers of waterbirds, particularly along the shores of the lake, but also in the seasonal wetlands

Recommendations

The shores of the lake and some inland wetlands supported a wide variety of waterbird species, and during the period when migrants are present, the numbers were considerable. Clearly any risks of oil spillages need to be minimised both from a biodiversity point-of-view as well as any wider environmental and commercial concerns. We had expected to be able to learn more of the importance of the swamps during the May visit, but the fact that this part of Uganda had missed most of the rain elsewhere prevented this. Nevertheless, we expect that, by the third and final visit, much more rain will have fallen. Provisionally, it remains the case that in the flats, the swamps and lakeshore are important for waterbirds, whilst the escarpment is particularly important for landbirds, mainly because it retains some trees and other woody plants.

Plans for third visit

The provisional dates for the third and final visit for bird work are from about 10th to the 20th August. This will allow sufficient data to be collected for species-accumulation curves to be presented, and a preliminary estimate to be made of the species richness of each habitat. In addition the relative importance of each habitat, particularly with respect to birds of conservation concern, will be assessed. This will enable us to make recommendations as to how loss of bird diversity can be minimised.

Table B1. Transect counts showing numbers of land-birds at sites on the flats (and a few waterbirds from sites with swamps)

ATLASNO[a]	SPECIES NAME[b]	Habitat[a] and related information	1 ARUA			2 CAMP GRASSLAND			3 FOOT OF ESCARPMENT			4 EUPHORBIA		
	Temp		Warm	Hot	Warm	Mild	F.Hot	Mild	Hot	F.Hot	Mild	Hot	Mild	Mild
	Start time		1505	1520	746	720	1115	1003	1600	945	813	1030	815	1557
	Observers		RS/DP	RS/DP	RS/MK	RS/DP	RS/DP	RS/MK	RS/DP	RS/DP	RS/MK	RS/DP	RS/DP	RS/MK
	Date		26-Feb	2-Mar	23-May	27-Feb	2-Mar	22-May	27-Feb	2-Mar	22-May	27-Feb	2-Mar	22-May
			1	2	3	1	2	3	1	2	3	1	2	3
14	SQUACCO HERON	W				6	3		4	4				
17	CATTLE EGRET	G	10			4	21		5		P		8	
21	LITTLE EGRET	W							3					
22	INTERMEDIATE EGRET	W							2	3				
25	GREY HERON	R-NT,W					1			2				
26	BLACK-HEADED HERON	w		1	1	1			1	5	1		1	4
28	HAMERKOP	w	2		1	1	3		5	3	4			3
30	OPEN-BILLED STORK	A,w,G	3					1						

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ATLAS NO[a]			1 ARUA		2 CAMP GRASSLAND			3 FOOT OF ESCARPMENT			4 EUPHORBIA		
31	BLACK STORK	P,w	1	1									
36	MARABOU STORK	w	2	9	4	6	12	1	4		5	4	1
39	HADADA	w		2					2	1			
42	SACRED IBIS	W			1	5	1	9	2				
75	BLACK KITE	pA		4				2					
76	AFRICAN FISH EAGLE	W					1						1
77	PALM-NUT VULTURE									1		1	
86	BROWN SNAKE EAGLE	R-NT										1	
88	BATELEUR	G				1							
93	AFRICAN MARSH HARRIER	R-NT,W									1		
132	GREY KESTREL								2	2			
154	CRESTED FRANCOLIN		3	3	2			2	2	3	2	1	1
185	GREY CROWNED CRANE	R-NT,W,G								P	3	1	4
204	TEMMINCK'S COURSER	A,G									2		
212	KITTLITZ'S SANDPLOVER	RB	1			3		2	2				
222	BLACK-HEADED LAPWING	G					12		2				4
221	WATTLED LAPWING	W		2	2		1		5			2	4
223	SPUR-WINGED LAPWING	w,G					1						1
225	SENEGAL LAPWING	A,G	2	2	1			1				1	3
226	CROWNED LAPWING	G			4	2		4	2				6
236	COMMON SNIPE	P,W			2	1							
248	WOOD SANDPIPER	P,W			9	3		22	16				
271	BLUE-SPOTTED WOOD DOVE	f	2				1	2		1			
272	BLACK-BILLED WOOD DOVE						1			1			

ATLAS NO[a]			1 ARUA			2 CAMP GRASSLAND			3 FOOT OF ESCARPMENT			4 EUPHORBIA		
283	RED-EYED DOVE	f				2		2	1	2	4		1	4
284	AFRICAN MOURNING DOVE										3			
286	RING-NECKED DOVE	f	1	1	1	1			1	2	3	1	5	1
289	LAUGHING DOVE		10	5	8	3	1	6	1	6	11	7	4	15
302	ROSS'S TURACO	F			P									
305	EASTERN GREY PLANTAIN EATER	,								1				
308	GREAT SPOTTED CUCKOO	P												1
309	RED-CHESTED CUCKOO	AF			2					1	1			
320	DIDRIC CUCKOO				5			1		1			1	7
323	WHITE-BROWED COUCAL	,	4	2	8	2	2	1	2	2	3	1	8	7
325	SENEGAL COUCAL	f			1									
342	LONG-TAILED NIGHTJAR	A								1	2			
358	PALM SWIFT	Ae				5		2			2			1
368	BLUE-NAPED MOUSEBIRD	,	5		5	7			21	4	5	23	22	
369	SPECKLED MOUSEBIRD		18	1	1	6	3		1	4	5	3		3
373	GREY-HEADED KINGFISHER	A,f,w	14	3	10				3	2	1	2		3
375	WOODLAND KINGFISHER	A							1	2				
376	STRIPED KINGFISHER								2					
378	PYGMY KINGFISHER	fw								1				
380	MALACHITE KINGFISHER	W						1		1				
383	PIED KINGFISHER	W				3				1				
386	BLUE-BREASTED BEE-EATER	w				1	3							

ATLAS NO[a]			1 ARUA			2 CAMP GRASSLAND			3 FOOT OF ESCARPMENT			4 EUPHORBIA		
389	RED-THROATED BEE-EATER	W							1					
390	WHITE-THROATED BEE-EATER	A,f,Ae		25										
392	BLUE-CHEEKED BEE-EATER	P,Ae				3						10	4	
393	MADAGASCAR BEE-EATER	A,Ae			1									5
408	AFRICAN HOOPOE	p	1	1										
420	GREY HORNBILL		1							1	1			
433	YELLOW-FRONTED TINKERBIRD	f	1	1	1				1		5			
441	BLACK-BILLED BARBET		5	1	P							3	1	
443	DOUBLE-TOOTHED BARBET	f									1			
455	BLACK-THROATED HONEYGUIDE	f	1	1					1			1		
455	GREATER HONEYGUIDE	f			1						1			
456	LESSER HONEYGUIDE	f									2			
489	FLAPPET LARK	G	1		1	2	2		4	3	4	2	8	5
500	SAND MARTIN	P,W,Ae	8	1		67	10			4			389	
501	BANDED MARTIN	A,G,Ae						2						
505	STRIPED SWALLOW	w,Ae								2				
513	EURASIAN SWALLOW	P,w,Ae	62	33		34	1					1	12	
515	YELLOW WAGTAIL	P,w,G	10	12		15	19		22	16		10	21	
520	AFRICAN PIED WAGTAIL	w	1											
522	GRASSLAND PIPIT	G	2		1	4	4	6		2				1
528	RED-THROATED PIPIT	P,w							3					
529	YELLOW-THROATED LONGCLAW	G				11	2	1					1	3

ATLAS NOª			1 ARUA			2 CAMP GRASSLAND			3 FOOT OF ESCARPMENT			4 EUPHORBIA		
547	YELLOW-THROATED GREENBUL	f									4			
562	COMMON BULBUL	f	15	11	17	1		1	6	7	13	6	7	9
576	WHITE-BROWED ROBIN CHAT	f							1					1
586	SPOTTED MORNING THRUSH	,			2				1	7		1	5	1
589	WHITE-BROWED SCRUB ROBIN	,	2	1	1				2	3	2			
593	WHINCHAT	P	1	1		1	1		2	1		2		
594	NORTHERN WHEATEAR	P		1		2	1		6	3		3	1	
598	ISABELLINE WHEATEAR	P										1		
625	REED WARBLER	P,w	1			1	2			5		9	6	
638	RED-FACED CISTICOLA	w					2			2				
639	SINGING CISTICOLA		3	4								2		
640	WHISTLING CISTICOLA									1				
645	RATTLING CISTICOLA		13	6	18		2	3	5	7	14	3	15	17
647	WINDING CISTICOLA	w				1		2	2		2	2		1
655	ZITTING CISTICOLA	w, G	3	1	11	13	10	14	6	2	18	4	4	18
658	TAWNY-FLANKED PRINIA	f,w		2					1		2		3	1
664	BUFF-BELLIED WARBLER	f							2			2		
677	GREY-BACKED CAMAROPTERA	f	1	2	7	2		1	2	5	10	3	1	2
695	WILLOW WARBLER	P,f		1						2				
701	GREY-CAPPED WARBLER	f,w			1					2				
713	NORTHERN BLACK FLYCATCHER	,		1										P
746	WATTLE-EYE	f		1						1				

ATLAS NO[a]			1 ARUA			2 CAMP GRASSLAND			3 FOOT OF ESCARPMENT			4 EUPHORBIA		
751	BLACK-HEADED BATIS	f										1		
764	BLACK-LORED BABBLER	R-RR							7	6	2		6	
787	SCARLET-CHESTED SUNBIRD	f										1		2
790	BRONZE SUNBIRD	f									1			
801	BEAUTIFUL SUNBIRD				2						2			
803	RED-CHESTED SUNBIRD	R-RR,W	2	1	2				2	2	3			
815	GREY-BACKED FISCAL	A,f,w				4	3	4	3	4	4	1		
820	WOODCHAT SHRIKE	P				1	1		2	1				
831	BROWN-HEADED TCHAGRA		1		1									
833	BLACK-HEADED TCHAGRA												3	
836	NORTHERN PUFFBACK	F							2					
843	BLACK-HEADED GONOLEK	f	4	2	11	4	2	2	10	6	9	15	18	16
855	PIED CROW					2								
870	LESSER BLUE-EARED GLOSSY STARLING	,						1	4	1	4			
872	RUPPELL'S LONG-TAILED GLOSSY STARLING	,	1			3		1	3		7	3	7	2
881	GREY-HEADED SPARROW					3	2					2	2	6
895	LITTLE WEAVER				4									1
896	BLACK-NECKED WEAVER				2									
897	SPECTACLED WEAVER	f							2		1			
908	BLACK-HEADED WEAVER		1		19	12	12	21			6	10	10	20
910	YELLOW-BACKED WEAVER	W			3	20		3			4	3	7	14
923	CARDINAL QUELEA	A	p1						5	2			6	

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ATLAS NO[a]			1 ARUA			2 CAMP GRASSLAND			3 FOOT OF ESCARPMENT			4 EUPHORBIA		
925	RED-BILLED QUELEA	A	3					23		1				2	
930	NORTHERN RED BISHOP	G			5			10			15				7
937	GROSBEAK WEAVER	R-VU,w						1			1				
945	GREEN-WINGED PYTILIA	f,W			2										
963	AFRICAN FIREFINCH		9	17	6	8			8	6		2	6	1
962	BLACK-BELLIED FIREFINCH	R-NT,G	3											
974	RED-CHEEKED CORDON-BLEU	,	12	22	9				7	3		4	7	1
980	BRONZE MANNIKIN				1			2			26			
984	VILLAGE INDIGOBIRD				1						2			
985	PIN-TAILED WHYDAH	G			12	1	1				1			
No. of species including p[c]			43	36	45	42	35	31	54	54	57	40	41	42
AREA SPECIES TOTAL INCLUDING Ps								130						

Table B2. Birds recorded on the escarpment transect, and along its foot

ATLASNO[a]	SPECIES NAME[b]	Habitat[a] and related information	Temp	Start time	Observers	Date	5. ESCARPMENT			6. FOOT OF ESCARPMENT (3km)
			Mild	810	RS/DP	28-Feb	1			
			Mild	905	RS/DP	3-Mar		2		
			Mild	945	RS/MK	24-May			3	
			Mild	1400	RS/MK	23-May				1
28	HAMERKOP Scopus umbretta	w								1
32	ABDIM'S STORK Ciconia abdimii	A,G						92		
35	SADDLE-BILLED STORK Ephippiorhynchus senegalensis	R-VU,W							P	1
36	MARABOU STORK Leptoptilos crumeniferus	w					21	6		
75	BLACK KITE Milvus migrans	pA					6			
76	AFRICAN FISH EAGLE Haliaeetus vocifer	W						2		1
86	BROWN SNAKE EAGLE Circaetus cinereus	R-NT					1			
88	BATELEUR Terathopius ecaudatus	G					1		2	
94	EURASIAN MARSH HARRIER Circus	Pw						P		

ATLA SNO[a]	SPECIES NAME[b]			5. ESCARPMENT			6. FOOT OF ESCARPMENT (3km)
	aeruginosus						
113	RED-NECKED BUZZARD Buteo auguralis			2	2		
115	LESSER SPOTTED EAGLE Aquila pomarina	P			3		
120	BOOTED EAGLE Hieraaetus pennatus	P			P		
122	LONG-CRESTED EAGLE Lophaetus occipitalis	f		1			
125	MARTIAL EAGLE Polemaetus bellicosus	R-VU			P		
154	CRESTED FRANCOLIN Francolinus sephaena			3	7	3	3
271	BLUE-SPOTTED WOOD DOVE Turtur afer	f		1		4	2
283	RED-EYED DOVE Streptopelia semitorquata	f		1	1		1
286	RING-NECKED DOVE Streptopelia capicola	f		9	3	5	4
289	LAUGHING DOVE Streptopelia senegalensis			5	1	3	6
309	RED-CHESTED CUCKOO Cuculus solitarius	AF		1			2
319	KLAAS' CUCKOO Chrysococcyx klaas	f				2	1
320	DIDRIC CUCKOO Chrysococcyx caprius						5
323	WHITE-BROWED COUCAL Centropus superciliosus			1	4		4
530	RED-SHOULDERED CUCKOO SHRIKE Campephaga phoenicea					1	
358	PALM SWIFT Cypsiurus parvus	Ae		2	2		
363	WHITE-RUMPED SWIFT Apus caffer	Ae			6		
368	BLUE-NAPED MOUSEBIRD Urocolius macrourus			7	2		1
369	SPECKLED MOUSEBIRD Colius striatus			11		7	20
373	GREY-HEADED KINGFISHER Halcyon leucocephala	A,f,w			2	1	1

ATLAS NO[a]	SPECIES NAME[b]			5. ESCARPMENT			6.FOOT OF ESCARPMENT (3km)
375	WOODLAND KINGFISHER Halcyon senegalensis	A		1			1
376	STRIPED KINGFISHER Halcyon chelicuti			4	2		
378	PYGMY KINGFISHER Ceyx picta	fw		1			
380	MALACHITE KINGFISHER Corythornis cristata	W					2
393	MADAGASCAR BEE-EATER Merops superciliosus	A,Ae					2
420	GREY HORNBILL Tockus nasutus						1
433	YELLOW-FRONTED TINKERBIRD Pogoniulus chrysoconus	f		7	3	12	3
437	SPOTTED-FLANKED BARBET Tricholaema lachrymosa	R-RR		1	2		
441	BLACK-BILLED BARBET Lybius guifsobalito			3			1
455	BLACK-THROATED HONEYGUIDE Indicator indicator	f		1			
455	GREATER HONEYGUIDE Indicator indicator	f				3	3
477	GREY WOODPECKER Dendropicos goertae	f					1
489	FLAPPET LARK Mirafra rufocinnamomea	G		2	1	1	1
498	WHITE-HEADED SAW-WING Psalidoprocne albiceps	R-RR,f,Ae		4	3		3
499	PLAIN MARTIN Riparia paludicola	Ae				3	
500	SAND MARTIN Riparia riparia	P,W,Ae			3		
505	STRIPED SWALLOW Hirundo abyssinica	w,Ae			5		1
512	ANGOLA SWALLOW Hirundo angolensis	w,Ae				1	1
513	EURASIAN SWALLOW Hirundo rustica	P,w,Ae		5	20		
515	YELLOW WAGTAIL Motacilla flava	P,w,G		1	2		

ATLA SNO[a]	SPECIES NAME[b]			5. ESCARPMENT			6.FOOT OF ESCARPMENT (3km)
525	PLAIN-BACKED PIPIT Anthus leucophrys	G					2
547	YELLOW-THROATED GREENBUL Chlorocichla flavicollis	f		2	2	2	2
562	COMMON BULBUL Pycnonotus barbatus	f		55	32	28	10
576	WHITE-BROWED ROBIN CHAT Cossypha heuglini	f			11	2	3
578	SNOWY-HEADED ROBIN=CHAT Cossypha niveicapilla	F,w			2		
586	SPOTTED MORNING THRUSH Cichladusa guttata			1	1		3
589	WHITE-BROWED SCRUB ROBIN Cercotrichas leucophrys			8		10	3
595	PIED WHEATEAR Oenanthe pleschanka	P			P		
602	WHITE-FRONTED BLACK CHAT Myrmecocichla albifrons			1	P		
625	REED WARBLER Acrocephalus scirpaceus	P,w		2	3		
638	RED-FACED CISTICOLA Cisticola erythrops	w					1
645	RATTLING CISTICOLA Cisticola chiniana			1	1	5	20
655	ZITTING CISTICOLA Cisticola juncidis	w, G				1	1
658	TAWNY-FLANKED PRINIA Prinia subflava	f,w		2	4	4	
664	BUFF-BELLIED WARBLER Phyllolais pulchella	f		2			
677	GREY-BACKED CAMAROPTERA Camaroptera brachyura	f		16	25	27	15
686	GREEN-BACKED EREMOMELA Eremomela canescens				2		
695	WILLOW WARBLER Phylloscopus trochilus	P,f			P		
701	GREY-CAPPED WARBLER Eminia lepida	f,w			1		5

ATLA SNO[a]	SPECIES NAME[b]			5. ESCARPMENT		6.FOOT OF ESCARPMENT (3km)	
703	GARDEN WARBLER Sylvia borin	P,f		1			
714	PALE FLYCATCHER Melaenornis pallidus				1		
717	SPOTTED FLYCATCHER Muscicapa striata	P			P		
730	SEMI-COLLARED FLYCATCHER Ficedula semitorquata	P			1		
742	BLACK-AND-WHITE SHRIKE-FLYCATCHER Bias musicus	f		1	1		
746	WATTLE-EYE Platysteira cyanea	f		2	3		1
749	CHIN-SPOT BATIS Batis molitor	f			1		
764	BLACK-LORED BABBLER Turdoides melanops	R-RR		2			15
787	SCARLET-CHESTED SUNBIRD Chalcomitra senegalensis	f		5	1		1
794	COLLARED SUNBIRD Hedydipna collaris	F		1		1	
801	BEAUTIFUL SUNBIRD Cinnyris pulchella					2	
802	MARIQUA SUNBIRD Cinnyris mariquensis					2	
803	RED-CHESTED SUNBIRD Cinnyris erythrocerca	R-RR,W		7	3		2
811	YELLOW WHITE-EYE Zosterops senegalensis	f		1	6		
824	GREY-HEADED BUSH-SHRIKE Malaconotus blanchoti	,		2	2		
828	SULPHUR-BREASTED BUSH-SHRIKE Malaconotus sulfureopectus	f				1	
831	BROWN-HEADED TCHAGRA Tchagra australis			1			
833	BLACK-HEADED TCHAGRA Tchagra senegala			4	4		1

ATLAS NO[a]	SPECIES NAME[b]			5. ESCARPMENT		6. FOOT OF ESCARPMENT (3km)
841	TROPICAL BOUBOU Laniarius aethiopicus	f			2	
843	BLACK-HEADED GONOLEK Laniarius barbarus	f	4	3	4	9
870	LESSER BLUE-EARED GLOSSY STARLING Lamprotornis chloropterus	,	12	10	1	
872	RUPPELL'S LONG-TAILED GLOSSY STARLING Lamprotornis purpuropter	,				3
876	VIOLET-BACKED STARLING Cinnyricinclus leucogaster	A,f	6	1	1	
881	GREY-HEADED SPARROW Passer griseus					1
891	CHESTNUT-CROWNED SPARROW WEAVER Plocepasser superciliosus	,		4		
893	BAGLAFECHT WEAVER Ploceus baglafecht	R-RR			1	1
895	LITTLE WEAVER Ploceus luteolus		1		1	2
897	SPECTACLED WEAVER Ploceus ocularis	f		P		
908	BLACK-HEADED WEAVER Ploceus cucullatus					26
910	YELLOW-BACKED WEAVER Ploceus melanocephalus	W			2	5
922	RED-HEADED WEAVER Anaplectes rubriceps	FF	1			
930	NORTHERN RED BISHOP Euplectes franciscanus	G				5
937	GROSBEAK WEAVER Amblyospiza albifrons	R-VU,w				1
945	GREEN-WINGED PYTILIA Pytilia melba	f,W				2
963	AFRICAN FIREFINCH Lagonosticta rubricata		4	2	4	3
974	RED-CHEEKED CORDON-BLEU Uraeginthus bengalus	,	6	14	11	2

ATLAS NO[a]	SPECIES NAME[b]			5. ESCARPMENT			6.FOOT OF ESCARPMENT (3km)
980	BRONZE MANNIKIN Lonchura cucullata					6	
985	PIN-TAILED WHYDAH Vidua macroura	G		P	3		1
990	YELLOW-CROWNED CANARY Serinus canicollis			3			
619	CINNAMON BRACKEN WARBLER Bradypterus cinnamomeus	F		1	1		
No. of species including p[c]			55	59	41		56
AREA SPECIES TOTAL INCLUDING Ps					108		

Table B3. Transect counts, showing numbers of landbirds along the route of the proposed pipeline

ATLASNO[a]	SPECIES NAME[b]	Habitata and related information	Temp / Start time / Observer / Date	7 KABALE P/S Hot 1405 RS/DP 4-Mar 1	Warm 840 RS/MK 25-May 2	HOT 1025 RS/MK 27-May 3	8 KASEETA Hot 1120 RS/DP 4-Mar 1	Mild 845 RS/MK 26-May 2	Hot 1450 RS/MK 27-May 3	9 KABALE CULTIVATION Mild 845 RS/DP 4-Mar 1	Hot 1055 RS/MK 25-May 2	Mild 820 RS/MK 27-May 3	10 PIPELINE SOUTH Warm 1450 RS/DP 1-Mar 1	Mild 1139 RS/MK 24-May 2	Hot 1100 RS/MK 26-May 3
25	GREY HERON	R-NT,W						P							
26	BLACK-HEADED HERON	w								P		1			
36	MARABOU STORK	w		1											
71	EUROPEAN HONEY BUZZARD	P,F							1						
75	BLACK KITE	pA		2											
86	BROWN SNAKE EAGLE	R-NT					1	P							
86a	BLACK-CHESTED SNAKE EAGLE	,							P						
88	BATELEUR	G		1											
100	SHIKRA	f						2							
106	GREAT SPARROWHAWK	F													P

ATL ASN Ca	SPECIES NAME[b]	Habitat and related information		7 KABALE P/S			8 KASEETA			9 KABALE CULTIVATION			10 PIPELINE SOUTH		
109	LIZARD BUZZARD	f			P	4	1					P			
110a	STEPPE-BUZZARD			8						1					
116	TAWNY EAGLE	P,G											2		
120	BOOTED EAGLE	P					P			P					
122	LONG-CRESTED EAGLE	f					2			1			3		
154	CRESTED FRANCOLIN				2		1								
225	SENEGAL PLOVER	A,G					P								
268	AFRICAN GREEN PIGEON	F					3					3			
270	TAMBOURINE DOVE	F			1		3	3					1		3
271	BLUE-SPOTTED WOOD DOVE	f			4	1	2	2	3		3	5	1		3
283	RED-EYED DOVE	f			5				2			4			
286	RING-NECKED DOVE	f			1	1				2			1		
289	LAUGHING DOVE				1								1		
293	RED-HEADED LOVEBIRD	f					1								
305	EASTERN GREY PLANTAIN EATER	,			2		6	1				2			
309	RED-CHESTED CUCKOO	AF			1										
319	KLAAS' CUCKOO	f				1	1	P							1
320	DIDRIC CUCKOO				4	1	1								
323	WHITE-BROWED COUCAL				1		5			1	3	2			3
325	SENEGAL COUCAL	f									P				
358	PALM SWIFT	Ae			P		P	1			7	P			
368	BLUE-NAPED MOUSEBIRD			5	11	6									

ATL ASN Ca[a]	SPECIES NAME[b]	Habitat and related information	7 KABALE P/S			8 KASEETA			9 KABALE CULTIVATION			10 PIPELINE SOUTH		
369	SPECKLED MOUSEBIRD		9	8	5	2	2		2	4	8	1	1	3
373	GREY-HEADED KINGFISHER	A,f,w		1										
376	STRIPED KINGFISHER						P				1			P
385	LITTLE BEE-EATER	G							P	P				
390	WHITE-THROATED BEE-EATER	A,f,Ae	P				4		10			22		
392	BLUE-CHEEKED BEE-EATER	P,Ae	4											
394	EURASIAN BEE-EATER	Pf	P						P			2		
419	CROWNED HORNBILL	f							3					
422	BLACK AND WHITE CASQUEDE HORNBILL	,		5				1	1					
431	YELLOW-RUMPED TINKERBIRD	F					2	1						
433	YELLOW-FRONTED TINKERBIRD	f	3	2	1	2	1	4						
437	SPOTTED-FLANKED BARBET	R-RR		1										
441	BLACK-BILLED BARBET			1										
455	GREATER HONEYGUIDE	F		1										1
465	NUBIAN WOODPECKER								1					
477	GREY WOODPECKER	F					1	P	1		1			
498	WHITE-HEADED SAW-WING	R-RR,f,Ae					1	4		2				
500	SAND MARTIN	P,W,Ae	146			2390								
501	BANDED MARTIN	A,G,Ae								10				
504	MOSQUE SWALLOW	Ae						1						
505	STRIPED SWALLOW	w,Ae					1	1		2	1			

ATL ASN	SPECIES NAME[b]	Habitat and related information	7 KABALE P/S			8 KASEETA			9 KABALE CULTIVATION			10 PIPELINE SOUTH		
512	ANGOLA SWALLOW	w,Ae								2				
513	EURASIAN SWALLOW	P,w,Ae	7						16			7		
520	AFRICAN PIED WAGTAIL	W					2	1						
529	YELLOW-THROATED LONGCLAW	G		3								1		
538	LITTLE GREENBUL	F				1								
547	YELLOW-THROATED GREENBUL	F			2		4	6						
562	COMMON BULBUL	F	26	23	30	23	13	17	9	24	26	16	14	23
570	NIGHTINGALE	P										1		
576	WHITE-BROWED ROBIN CHAT	F	3	2		1				P	1	1	2	
578	SNOWY-HEADED ROBIN=CHAT	F,w	1				1	P						1
586	SPOTTED MORNING THRUSH			2	P									
589	WHITE-BROWED SCRUB ROBIN		2	3	1					2	3			3
612	AFRICAN THRUSH	F		5	2		P	3	1	4	3		2	1
621	MOUSTACHED WARBLER			5			2		1	P	5			3
625	REED WARBLER	P,w				2	1				3	1		
638	RED-FACED CISTICOLA	W		1	2	7	4	2	12	8	11	4	4	4
639	SINGING CISTICOLA		1											
640	WHISTLING CISTICOLA				3			2		2	1		P	3
645	RATTLING CISTICOLA			1			1						2	
650	CROAKING CISTICOLA	G		1	1									

ATLASN	SPECIES NAME[b]	Habitat and related information		7 KABALE P/S			8 KASEETA			9 KABALE CULTIVATION			10 PIPELINE SOUTH		
652	SIFFLING CISTICOLA									1					
658	TAWNY-FLANKED PRINIA	f,w		3	7	5	9	5	14	8	11	5	4	9	10
664	BUFF-BELLIED WARBLER	f						1	2						
677	GREY-BACKED CAMAROPTERA	f		3	15	12	7	11	8		5	3	1	10	7
695	WILLOW WARBLER	P,f					1			1					
701	GREY-CAPPED WARBLER	f,w			P				1		P				
713	NORTHERN BLACK FLYCATCHER	,							1	P		1			
714	PALE FLYCATCHER			1											
732	AFRICAN BLUE FLYCATCHER	f					1								
739	AFRICAN PARADISE FLYCATCHER	f							1						
746	WATTLE-EYE	f			1	1		P	2						
751	BLACK-HEADED BATIS	f		1	P	1						2			
761	BROWN BABBLER			2						12					
762	ARROW-MARKED BABBLER										7				
776	VIOLET-BACKED SUNBIRD	A,f					1								
781	GREEN-HEADED SUNBIRD	F					1								
787	SCARLET-CHESTED SUNBIRD	f		4	3		1	1	1	3					
790	BRONZE SUNBIRD	f			1	1									
794	COLLARED SUNBIRD	F		1											
796	OLIVE-BELLIED SUNBIRD	F				1	2	1	1		1				
802	MARIQUA SUNBIRD						1	1	2					1	

ATL ASN Code	SPECIES NAME[b]	Habitat and related information		7 KABALE P/S			8 KASEETA			9 KABALE CULTIVATION			10 PIPELINE SOUTH		
803	RED-CHESTED SUNBIRD	R-RR,W											3	1	
810	COPPER SUNBIRD	f,w		1		2	P	2		3		1			
811	YELLOW WHITE-EYE	f			2	1	2		1			1			
812	COMMON FISCAL	G													1
828	SULPHUR-BREASTED BUSH-SHRIKE	f			5	6		1			2				P
830	MARSH TCHAGRA	w													1
831	BROWN-HEADED TCHAGRA				4		1	2			2				
833	BLACK-HEADED TCHAGRA				3	1			P	4	2	4		2	5
836	NORTHERN PUFFBACK	F				1									
841	TROPICAL BOUBOU	f		7	11	10		1	1	12	8	10	2	5	6
843	BLACK-HEADED GONOLEK	f		5	8	2				2	1		1		
850	AFRICAN BLACK-HEADED ORIOLE	f				1									
851	AFRICAN GOLDEN ORIOLE	A,f			1										
853	DRONGO	,/F			P		P								
855	PIED CROW			P			P								
870	LESSER BLUE-EARED GLOSSY STARLING	,				1									
872	RUPPELL'S LONG-TAILED GLOSSY STARLING	,				2	P	P							
881	GREY-HEADED SPARROW			2	6	6	3	11	4	2		6		10	7
893	BAGLAFECHT WEAVER	R-RR			2	1			1	1	1	1			
895	LITTLE WEAVER				P										

ATL ASN Cat[a]	SPECIES NAME[b]	Habitata and related information		7 KABALE P/S			8 KASEETA		9 KABALE CULTIVATION			10 PIPELINE SOUTH		
896	BLACK-NECKED WEAVER						10							
897	SPECTACLED WEAVER	f			1		P		1					
907	VIEILLOT'S BLACK WEAVER	R-NT,R-RR,G-NT,G-RR,w	,				10	5		2	1			3
908	BLACK-HEADED WEAVER			6	46	17	25	6	6	1	15		14	12
910	YELLOW-BACKED WEAVER	W			5	4	2	2	9	7	7		9	3
915	COMPACT WEAVER	FF					2		2	3	12			1
924	RED-HEADED QUELEA	R-RR,A									11			
925	RED-BILLED QUELEA	A								40				
927	BLACK BISHOP	w					3	8		3	12		1	3
928	BLACK-WINGED RED BISHOP	w						1		1	8			
932	FAN-TAILED WIDOWBIRD	G							6					
935	RED-COLLARED WIDOWBIRD	G					1	1		1	7			
939	GREY-HEADED NEGROFINCH	FF					P	1						
944	GREY-HEADED OLIVEBACK	R-RR,f,w					1							
956	BROWN TWINSPOT	FF					2							
963	AFRICAN FIREFINCH				1	3	4		10	3	1			1
968	BLACK-RUMPED WAXBILL					3								
969	COMMON WAXBILL	w			2									
970	BLACK-CROWNED WAXBILL	f					P	8			6			1
974	RED-CHEEKED CORDON-BLEU		,		12	1	2			2	3	2	2	5

ATLASNa	SPECIES NAMEb	Habitat and related informationa		7 KABALE P/S			8 KASEETA			9 KABALE CULTIVATION			10 PIPELINE SOUTH		
976	ZEBRA WAXBILL							2							
980	BRONZE MANNIKIN				4		7	15	9		4	1	20	10	6
981	BLACK-AND-WHITE MANNIKIN							P							
984	VILLAGE INDIGOBIRD							1				P		2	
985	PIN-TAILED WHYDAH	G						4	1		1	5			
990	YELLOW-CROWNED CANARY					2	7			11					
991	AFRICAN CITRIL											1			
995	YELLOW-FRONTED CANARY							7	1		4	3		1	6
997	BRIMSTONE CANARY							P				P			
1007	CABANIS'S BUNTING	G						P		1					
No. of species including pc				30	56	43	32	65	46	37	40	49	19	25	32
AREA SPECIES TOTAL INCLUDING Ps									**144**						

Notes - a:Refers to bird artlas of Uganda   b: English and Scientific species names   c: Species present outside transect time

Table B4, Numbers of waterbirds at various sites along the shores of L. Albert

Atlas No	SPECIES NAME	Habitat and related information (Site / CODE)	One- hour counts						Transect (1km)				Other		
			Pad 3			KF Jetty			I km shore	Pad 2	Pad 2 - Jetty	Jetty - Terek Point	Lagoon Area	2km of Pad 3	Swamp< ESC
		Observers	RS/DP	RS/DP	RS/MK	RS/DP	RS/DP	RS/MK	RS/DP	RS/MK	RS/MK	RS/MK	RS/DP	DP	DP
		Start time	930	1700	1455	1430	1720	1110	730	900	935	1000	1730[a]	1200[b]	1000[c]
		Date	27-Feb	2-Mar	22-May	28-Feb	1-Mar	22-May	3-Mar	23-May	23-May	23-May	26-Feb	26-Feb	26-Feb
6	LONG-TAILED CORMORANT	W	3		15	7	6	25	8		2	12			
14	SQUACCO HERON	W	4	8	7	1	2	1	13				5		
17	CATTLE EGRET	G				10	13	7	31				15	1	
21	LITTLE EGRET	W	8	14	17	6	12	15	11			2		20	5
23	GREAT WHITE EGRET	R-VU,W			7										
22	INTERMEDIATE EGRET	W			1			1							3
24	PURPLE HERON	R-NT,W	1						1				1		

No.	Species	Status														
25	GREY HERON	R-NT,W		1	2		2	3	3	8		1				
26	BLACK-HEADED HERON	w		1	2	4		2	2	1	1			1		
27	GOLIATH HERON	R-NT,W													1	
28	HAMERKOP	w		2	2	10		3	2		5	2		1		
29	YELLOW-BILLED STORK	W			1											
30	AFRICAN OPEN-BILLED STORK	A,w,G		1	1	2	1		4	31	1	1				
36	MARABOU STORK	w		3		8	2	2	23	7	3	2	1	6		1
39	HADADA IBIS	w							3					1	2	
42	SACRED IBIS	W		2	7	4		4	2	14	2		4	7	6	2
53	KNOB-BILLED DUCK	W													1	
76	AFRICAN FISH EAGLE	W						1		1					2	
178	BLACK CRAKE	W					2		1		4					
185	GREY CROWNED CRANE	R-NT,W,G	,						2						2	
193	AFRICAN JACANA	W		3	2	1				5			1		2	
197	BLACK-WINGED STILT	p,W						7		15			5		3	
211	COMMON RINGED PLOVER	P,W		1				45	17	54						
212	KITTLITZ'S SANDPLOVER	W			5		2	8	7	13			24	41		
213	THREE-BANDED PLOVER	W			1											
216	WHITE-FRONTED SANDPLOVER	W						8	6	13			2			
217	LESSER SANDPLOVER	P,W							1	1						
223	SPUR-WINGED LAPWING	w,G		4	3	5	2	7	4	6	3	7	4	3	4	
229	LITTLE STINT	P,W		1				17	26	132						
234	RUFF	P,W													1	
236	COMMON SNIPE	P,W													2	
246	COMMON GREENSHANK	P,W			3			14	2	15			1			

No	Name	Status													
247	GREEN SANDPIPER	P,W								2					1
248	WOOD SANDPIPER	P,W		3	8		1	1		15			3	1	2
249	TEREK SANDPIPER	P,W								1					
250	COMMON SANDPIPER	P,W		2	9		3	12		30			4		
264	WHITE-WINGED TERN	P,W		1			1			1					
265	AFRICAN SKIMMER	R-VU,R-RR,A,W	,											1	
373	GREY-HEADED KINGFISHER	A,f,w				2					3	1			
380	MALACHITE KINGFISHER	W		1		2	1	1		1			2	1	
383	PIED KINGFISHER	W		2	2	3		1	2	6	1	7	1	1	
385	LITTLE BEE-EATER	G							1						
386	BLUE-BREASTED BEE-EATER	w											2		
520	AFRICAN PIED WAGTAIL	w									1				
625	EURASIAN REED WARBLER	P,w		1	4								1		
628	GREAT REED WARBLER	P,w		1											
630	GREATER SWAMP WARBLER	W				2									
631	LESSER SWAMP WARBLER	w		1											
720	SWAMP FLYCATCHER	W											2		
TL NO.SPECIES				22	17	17	19	21	18	27	9	9	13	17	12	6
TL NO.BIRDS				47	74	92	131	130	105	439	20	47	78	55	44	14

Notes

Pad2: Pad2 0r Kyakapere

Swamp<ESC: Swamp below Escarpment

SECTION 5: MAMMAL SURVEYS OF THE KINGFISHER FIELD DEVELOPMENT AREA AND PIPELINE ROUTE

5.1   INTRODUCTION

The mammal fauna in the Kingfisher proposed field development area remains poorly known since there have not been detailed studies on them in this area. This contrasts with the fairly comprehensive mammal occurrence and ecology information available for the areas in the exploration blocks north of the Kingfisher field development area. The known state of biodiversity for the Albertine region was reviewed in for example Kityo *et al.* (2003), Plumptre *et al.* (2003), Plumptre *et al.* (2004) and Plumptre *et al.* (2007). For this reason, in the Kingfisher field development area adjudging the ecosystem services of taxa such as mice, shrews and bats including for example being food for raptors, predators on invertebrates or even depredators on plants and other elements of the ecosystem could not be well evaluated.

The only more recent documentation on mammals of the Buhuka region comes from EIA and ESIA reports for the various Kingfisher wells and associated facilities (including the airstrip).

The Buhuka area has evolved through different types of land-use from being a controlled hunting area, a community wildlife area and then getting degazetted from any kind of protected area status.

The area of Buhuka, was first gazette as a Controlled Hunting area in 1963 (Uganda Game Preservation and Control Act- Cap. 226). This Act was repealed by the Uganda Wildlife Statute, 1996 (No. 14 of 1996) and creating the Buhuka Community Wildlife area. NEMA (2000) recommended the degazetement of Buhuka. Community Wildlife Area. CWAs (formerly known as Controlled Hunting Areas) are wildlife conservation areas that are jointly managed with the communities in the area. These may directly benefit through tourism and sustainable utilization of wildlife. Permitted activities in CWAs include tourism, wildlife consumptive utilization, commercial and sport hunting, and various kinds of mixed land use practices such as grazing and agricultural activities where appropriate.

Following Parliament of Uganda Business of Thursday, 2 May 2002, (www.parliament.go.ug/cmis/cmis/browser) the Minister of State for Tourism and Antiquities requested for the degazettement of *Buhuka* CWA, which has since lost the status of a protected area.

All studies leading to EIAs and ESIAs have documented the general absence of a healthy population of medium to large sized mammal species. They generally have recorded the presence of among the medium to larger sized mammals, Hippopotamus *Hippopotamus amphibius,* Common Bush Duiker *Sylvicapra grimmia,* Bushbuck *Tragelaphus scriptus* and Olive Baboon *Papio anubis.*

The Hippos being mostly amphibious could have survived in the area in large numbers, but given the big fishing community that use the Lake Albert waters in this area, they like the other species of mammals will more likely survive as relict populations.

At least one report has indicated the presence of the Spotted Hyena, but also observed that they probably also don't occur in the area in large numbers anymore given the local extirpation of species of wild mammals that would have served as prey

Other species of mammals that have been reported to occur in the area include Marsh Mongoose *Atilax paludinosus,* Slender Mongoose *Herpestes sanguineus,* Bunyoro Rabbit *Poelagus marjorita*, Mole Rat *Tachyoryctes ankoliae* and the Yellow Winged Bat *Lavia frons*

Although the Bunyoro Rabbit is not considered threatened by UICN, it is a species endemic to only a small part of Africa, implying that all areas where it occurs are important for conservation of the meta-population of this species.

The Buhuka area lies within the Albertine Rift, an area now globally recognized as an Ecoregion, part of the Eastern Afromontane Biodiversity Hotspot (Brooks *et al*. 2004) and an Endemic Bird Area. Extending from the northern tip of Lake Albert and Murchison Falls National Park to the southern tip of Lake Tanganyika and encompassing the mountains on either flank of the rift valley, the Albertine Rift covers about 313,000 km^2 (Plumptre *et al*. 2003; 2007). The Buhuka area previously accorded some level of protection by the escarpment in an enclave bounded by Lake Albert, today has Kabwoya Wildlife reserve to its North and Semliki Wildlife Reserve to its south while it remains public access and multiple use area by the local community.

The presence of small mammals is a key indicator of habitat quality (see for example http://www.mammal.org.uk/sites/default/files/LowDensityLiveTrapping.pdf and Mohammadi 2010), and so incorporating these species into a monitoring regime would inform about their population, their conservation and biodiversity in the project area. If included in a long term monitoring program, would allow identifying any trends and transformations within the habitat.

Because the area is already heavily human impacted the land cover is very much compromised and larger mammals that might have been present do no longer occur in the area in healthy populations. Two of the species previously reported for the Buhuka area (Hippopotamus and Spotted Hyena) are listed by IUCN as Vulnerable and Endangered respectively.

5.2   OBJECTIVES

This report is represents an updated version of the dry season surveys of the mammal surveys in the project area, representing surveys conducted to capture the dry season situation. The follow up study was conducted from mid May to capture the wet season situation. The study objectives included: -

- Identifying for mapping, quantifying and describing the habitats likely to host mammals of interest in the project area (indicator groups and SoCs), Particular attention being paid to bats, rodents and shrews but also any surviving medium to large sized mammals.
- Determining the occurrence and abundance of the mammal groups in the exploration area, using quantitative survey techniques, with particular focus on SoC.
- The identification of sensitive or unique habitats, which could suffer irreplaceable loss.
- Identifying and describing potential sources of risk to the biodiversity and ecosystem services of the project site, associated with the development;
- Evaluation of the extent of site-related impacts in terms of selected ecological indicators
- Identifying the potential direct, indirect and cumulative environmental impacts associated with the proposed project;

5.3   METHODS

Standard survey methods such as described in Wilson *et al.* (1996), were employed to survey the mammal fauna and those in Isabirye-Basuta and Kasenene (1987) and Claustinitzer & Kityo (2001) for the small mammals specifically. The Map below shows the location (red lines) where the trap-lines and net-lines for surveying rodents and shrews as well as bats respectively were set.

Map 1. Location of the trap-lines (red lines) that were used to survey for small mammals in the Buhuka flats

The trapping was largely restricted to areas that presented ample ground cover sufficient to hide the traps.

5.3.1   RODENTS AND INSECTIVORES

Rodents and insectivores were surveyed using Sherman traps which were deployed in 11 trap lines of 40 traps each in the Buhuka Flats and 80 traps each in the Bukona area. The trap lines were maintained for from 3 to 5 days in the Buhuka Flats and only 2 days in the Bukona area. Traps were baited using a mixture of peanut butter, maize floor, oat meal, bananas and margarine; this is a standard bait that has been used in many small mammals surveys (such as by Claustinitzer and Kityo (2001) and Isabirye-Basuta and Kasenene (1987)) . Traps were deployed 10 m apart and re-baited every evening, while checking, recovering and processing any captures was done in the morning.

5.3.2 BATS

Bats were surveyed using mist nets and acoustic methods (using the Anabat II and SM2 bat detectors). Mist nets were deployed in the area of the wetland below the escarpment and the area next to the airstrip while the Harp trap was deployed in the area next to the CNOOC camp. Bats surveys using the mist netting and acoustic techniques methods was interrupted or prevented on several nights by very strong winds characteristic of the Buhuka Flats.

Surveys started at dusk and continued till 10 pm on nights when this was possible. Because the areas are freely traversed by cattle, it was not possible to leave nets standing overnight.

5.3.3   Larger mammals

Surveys for larger mammals were largely opportunistic – looking for signs (spoors or fecal material), observation as well as information and interviews with local people. Interviews with local people were the main methods used through the pipeline route to gather information on which mammals still range in the area.

5.4   HABITAT TYPES

5.4.1   The Buhuka flats and escarpment

As was the case for the dry season survey campaign, lot of the area was not suitable for trapping for small mammals since the ground cover was still very sparse and in some isntances even less than the situation in the dry season.
Sparse ground cover would only expose our equipment to vandalism and would unlikely trap any small mammals which also tend to avoid very open areas. The open areas were heavily used for livestock grazing which could also have exposed our equipment to trampling by the livestock.

Fig 5.1 The very open landscape in the Buhuka flats in May 2014. This vegetation cover does not support many small mammals

Fig 5.2 Vegetation cover in areas along the base of the escarpment with some vertical structure but with a groundlevel vegetation cover that is still sparse

The area traversed by River Masika assumed to be a permanent wetland flowing through the area was mostly dried out at the time of the second survey campaign. The second survey campaign was executed too early in thenseason and therefore the landscape had not yet recovered back to wet season situation.

Fig 5.3 A net line through the seasonally flooded area of the Bukona survey area in the pipeline route

4.4.2   The Pipeline route

The pipeline route largely traverses human inhabited areas and farmland, while in some areas already designated as project stretches of some natural vegetation cover were established and

found suitable for surveying. Habitat surveys were conducted to evaluate their suitability for occupation by mammals and interviews were conducted with the local people to establish which medium to larger sized mammals may still range in the area. One general area however was identified in Bukona village (Fig 5.3) in which it was decided that small mammal sampling could be conducted. Several other locations have also been identified along the pipeline route in which some trapping effort could be deployed to assess small mammal community compositions and species presence.

4.5   RESULTS AND DISCUSSION

4.5.1   Small mammals (Rodents, shrews and bats)

The results of the second survey campaign returned 10 species (Table 5.1) overall of the non-volent small mammals (rodents and shrews) and in low levels of relative abundance. The levels of species richness in the different trapping areas (epresented by trap lines) also have very variable species richness, an observation that would only emphasize differential spatial habitat utilization. The Pygmy Mouse (*Mus* minutoides) and the Multi-mammate (*Mastomys hildebrandti*) are the more widely occurring species of small mammalsfrom all the survey locations. Five species have only been recorded in one survey location while the rest were recorded in more than one survey area.

Table 5.1: The rodent and shrew species recorded from the second survey campaign

| | | Trap lines | | | | | | | | Pipeline |
| | | Buhuka Flats | | | | | | | | Pipeline |
Order	Species	2	3	4	5	6	8	9	10	11
Insectivora	*Crocidura olivieri**				●	●				
Rodentia	*Aethomys hindei**			●						
	*Aethomys kaiseri**			●						
	*Arvicanthis niloticus**				●					
	*Grammomys dolichurus**	●				●				
	Lemniscomys striatus			●		●				●
	*Lophuromys sikapusi**						●			
	Mastomys natalensis		●	●					●	●
	Mus minutoides	●		●	●	●		●		
	*Oenomys hypoxanthus**					●				
Totals		**2**	**1**	**5**	**3**	**4**	**2**	**1**	**1**	**2**

Seven species (*) in Table 5.1 represent new additions to the species richnessfor the Buhuka flats. On the other hand, 3 species (Table 5.2) recorded in the first survey campaign have not been recorded in the second survey despite having surveyed in some of the same areas used in the first campaign.

Table 5.2: Comparison of species record between 1ˢᵗ and 2ⁿᵈ campaigns

Order	Species	survey 1	surey 2
Insectivora	*Crocidura jacksoni*	●	
	Crocidura olivieri		●
Rodentia	*Aethomys hindei*		●
	Aethomys kaiseri		●
	Arvicanthis niloticus		●
	Grammomys dolichurus		●
	Lemniscomys striatus	●	●
	Lophuromys sikapusi		●
	Mastomys hildebrandti	●	●
	Mus minutoides	●	●
	Mus triton	●	
	Oenomys hypoxanthus		●
	Rattus rattus	●	

The observations in Table 5.1 only go to confirm the trends in Fig 5.3 which overall suggested that several more species could have been recorded for the survey area. Only a small survey effort has so far been used in areas along the pipeline route (Trapline 11 in Table 5.1) and we so far have recorded only two species. It is very likely that several more species would be recorded with more survey effort.
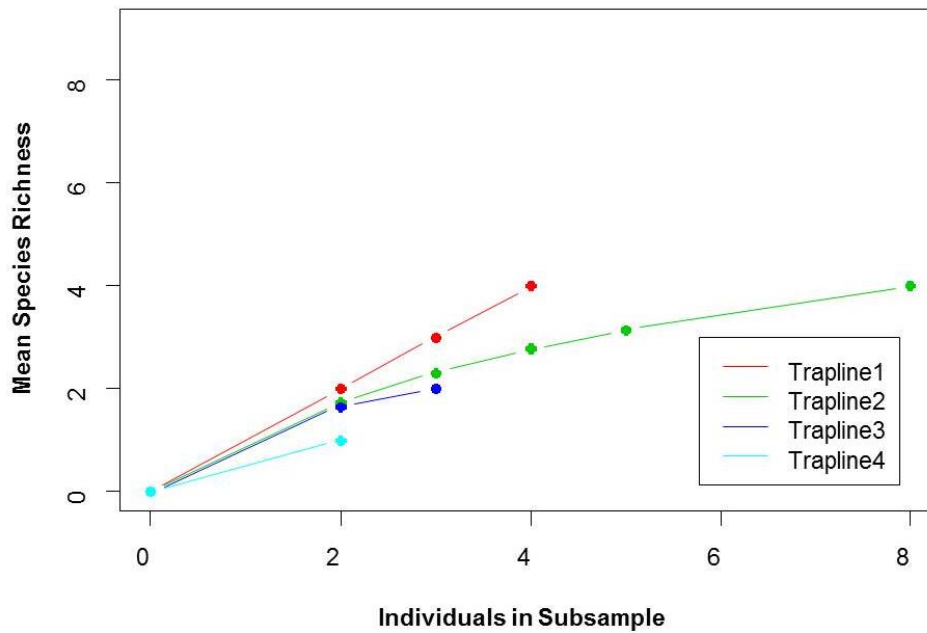
Fig. 5.3 Rarefaction curves for species of small mammals recorded in 4 trap-lines in the Buhuka area.

From the first survey campaign, 8 species were recorded from trapping methods while only six have been recorded from the second survey campaign. Four species recorded in the first campaign have not been recorded through the capture methods while two species recorded in the second survey campaign were not recorded in the first campaign.

Just like was the case in the first survey campaign, capture rates of micro-chiropteran bats evidently underestimate the species richness and relative abundance (as measured from number of bat passes) of micro-chiropteran bats that may utilize a given survey area. in mist nets could indicate relative abundance, low capture rates should never be construed to mean the absence or low levels of abundances of species in a particular area Tables 5.2 - 4). As noted in the first survey report, micro-chiropteran bats because of their echolocation abilities are able to avoid nets even from close range.

From the trapping effort, 2 species of fruit bat (*Epomophorus labiatus* and *Micropteropus pusillus*) have been recorded in the Buhuuka flats iwhile no fruit bats have b een recorded in the pipeline route as yet. The mist netting campaign that it the principal survey method used to capture bats it only used until 22:00hrs in the night and nets taken down. Although mega chiropteran bats can be captured in nets early in the evenin, more individuals tend to be capture much latter in the night. Because of safety reasons for the animals and and the equipment, nets could not be left out overnight. This could mean that several other species that are more active after 2200hrs would have been missed out of the surveys. The survey approach we used inevitably introduces a bias in surveying for bats; however it is a similar level of bias for all survey areas, and the Healthy and Safety restrictions were such that the survey teams were required to be back in camp by 2200hrs.

Table 5.4 shows different numbers of species recorded in different survey areas a factor that could reflfect only temporal but perhaps also truly spatial situations in habitat use of different bat species. Since bats fly, it is possible that they will differentially use a foraging area depending on temporal and spatial abundance of the food resource they depend on.

Table 5.2 Comprisons for bat species recorded from capture methods

Order	Family	Species	Buhuuka flats 1st survey	Buhuuka Flats 2nd survey	Pipeline route (Bukona)
Mega-Chiroptera	Pteropodidae	*Epomophorus labiatus*	●	●	
	Pteropodidae	Micropteropus pusilus		●	●
Micro-Chiroptera	Megadermatidae	*Lavia frons*	●	●	
	Nycteridae	*Nycteris hispida*	●	●	

Family	Species			
	Nycteris thebaica	●		●
Verspetilionidae	*Neoromicia nanus*	●		
	Neoromicia rueppeli	●		
	Scotophilus dingani	●		
	Scotophilus nux		●	●
Molosidae	*Chaerophon pumila*	●	●	
Total species		**8**	**6**	**3**

Mist netting only selectively samples the bat fauna of an area as many more species fly and forage way above where nets are extended. For this reason, trapping methods always need to be enhanced by acoustic monitoring methods. Results in Tables 5.2 compared to Tables 5.3-4 demonstrate the importance of this.

Table 5.3 Comparisons of results of Bat species recorded using acoustic monitoring techniques for the two survey campaigns.

Family	Species	Buhuuka combined 1st survey	Buhuuka combined 2nd survey	Combined 1st & 2nd Survey Buhuka Flats	Bukona (Pipeline route)
Megadermatidae	*Lavia frons*	●	●	●	●
Molosidae	*Chaerephon pumila*	●	●	●	
	Mops condylura	●	●	●	●
Verspertilionidae	*Kerivoula argentata*	●		●	
	Kerivoula argentata				●
	Kerivoula phalaena		●	●	●
	Miniopterus sp	●			
	Neoromicia cacpensis	●	●	●	●
	Neoromicia nanus	●	●	●	●
	Neoromicia ruepelli				●
	Neoromicia tenuipinis	●	●	●	
	Scotoecus albofuscus		●	●	
	Scotoecus argentata				●
	Scotoecus hirundo	●	●	●	●
	Scotophilus dingani	●	●	●	●
	Scotophilus nux				●
un-identified	Bat sp1	●		●	
	Bat sp2	●		●	
Total species		*12*	*10*	*13*	*11*

From acoustic survey techniques, calls for 13 species of micro-chiropteran bat species have now been recorded for the Buhuuka Flats while 11 species have so far been recorded in the one survey area visited in the pipeline route. These results may suggest that the Pipe line route area may have many more species than have been recorded so far.
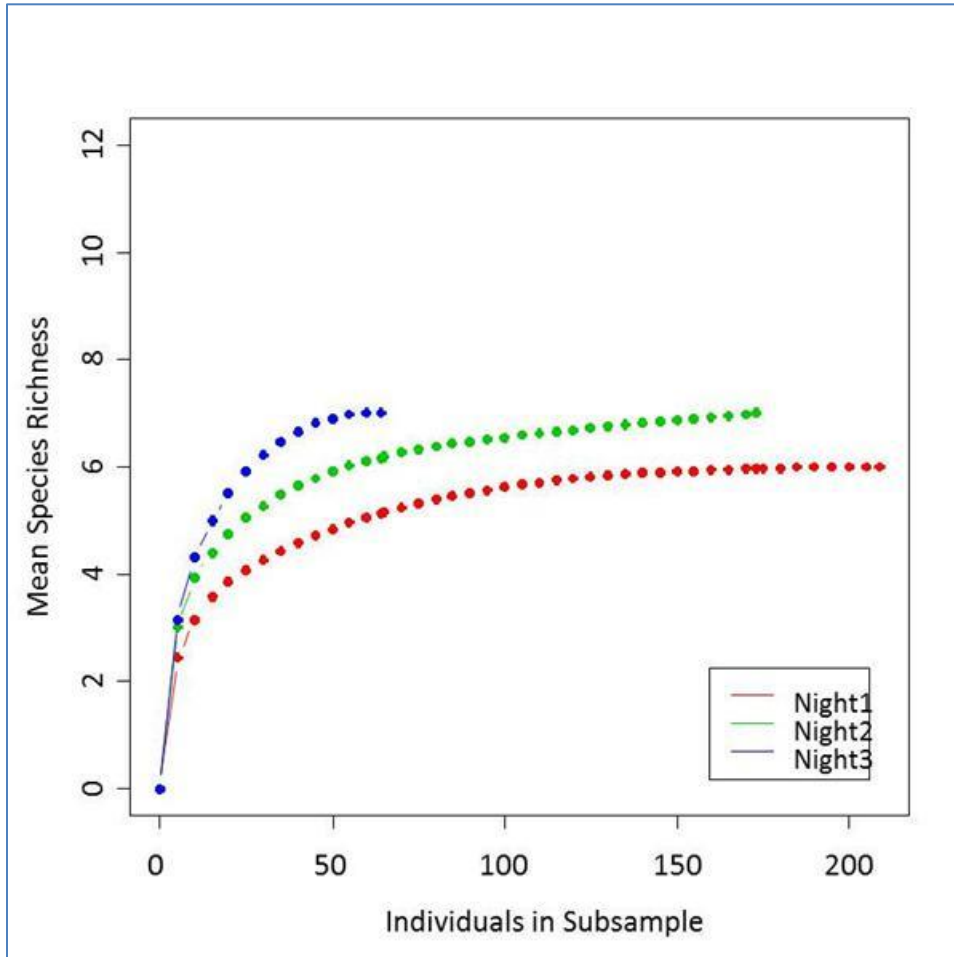
Fig 5.4 Rarefaction curves for positively identified bat species from the acoustic survey technique (from the 1st survey campaign).

Fig 5.4 compares summaries of bat activity inferred from number of passes recorded for different micro-chiropteran species in the Kingfisher field development project area in the Buhuka flats from the dry season (1st survey campaign). In comparison, Figs 5.5 & 5.6 summarise the results from the wet season (second survey campaign). Consistently the figures suggest that the full species richness is yet. The acoustic monitoring on all sampling days was started at dusk usually a few minutes before 19:00hrs and concluded by 22:00hr. In all cases therefore, the sampling efforts lasted for a similar length of time, the comparisons being made are therefore for equivalent sampling effort
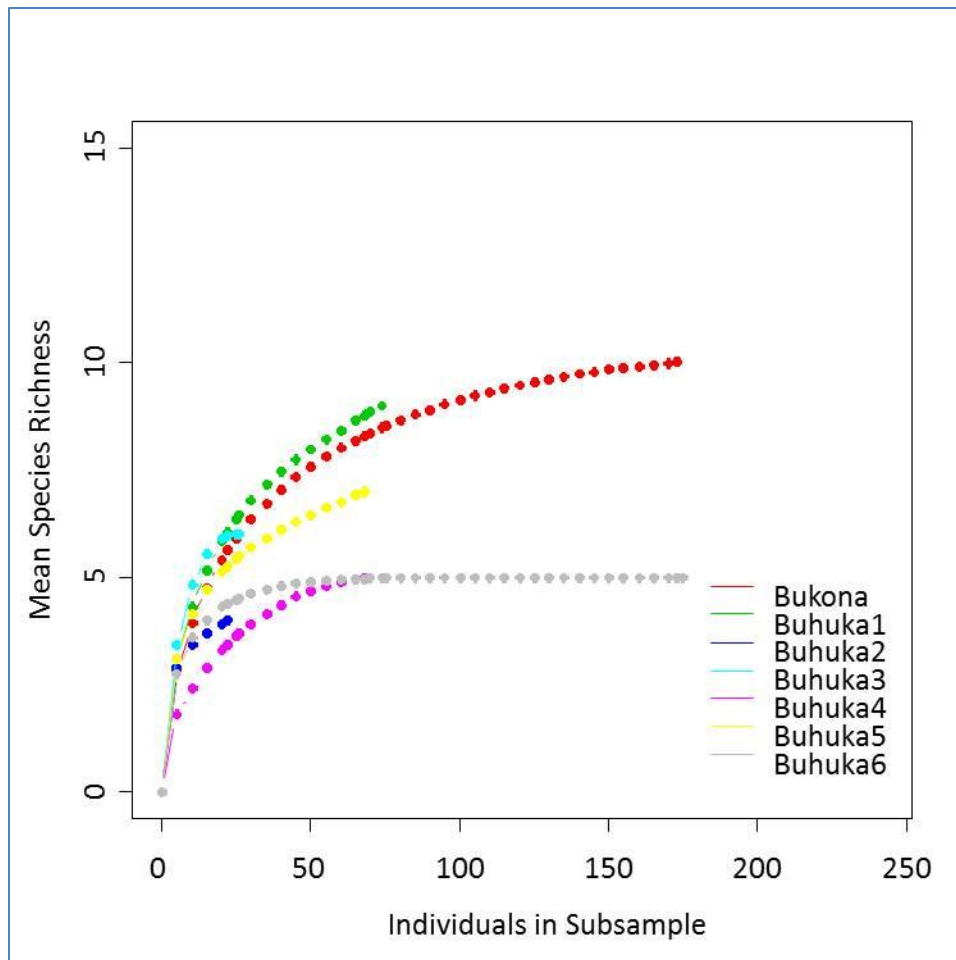
Fig 5.5 Rarefaction curves for bat surveys using acousting techniques in the wet season survey. (curves represent different survey nights).
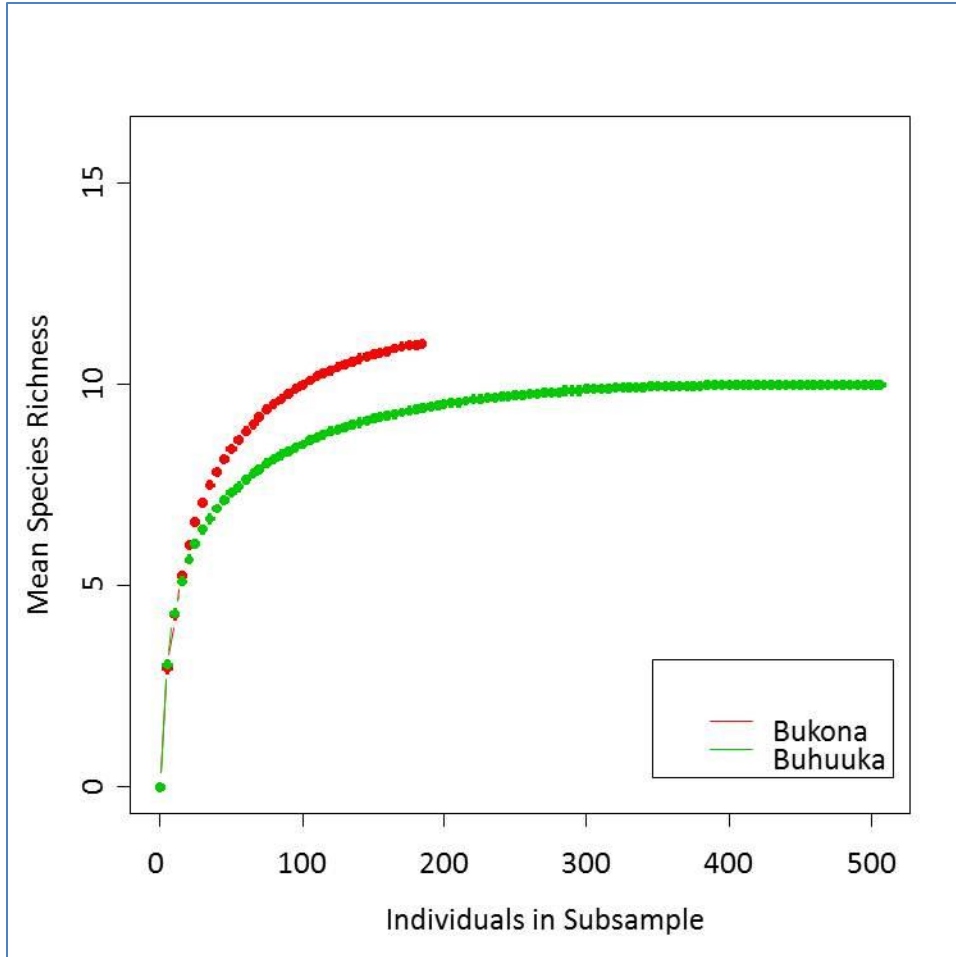
Fig 5.6 Rarefaction curves for bat surveys using acousting techniques in the Buhuka flats and the pipelinerouting in the wet season survey.

Well as number of bat passes may not be taken to represent relative abundance for species recorded, it can be safely used to conclude on the relative importance of a survey location either temporary or spatially for specific types of bats.

Table 5.4 Comparisons of results of Bat species recorded using acoustic monitoring techniques for the two survey campaigns.

	Pipeline route	Buhuka Flats					
Species	1st June Bukona	22-May	23-May	24-May	26-May	27-May	30-May
Chaerephon pumila		1.4		26.9			
Kerivoula argentata	4.3						
Kerivoula phalaena	1.6			11.5			
Lavia frons	0.5	1.4	36.4	7.7		1.5	
Mops condylura	2.2	6.8		11.5	2.7	16.2	4.5
Neoromicia cacpensis	4.9	8.2	4.5		2.7	1.5	25.6
Neoromicia nanus	16.3	4.5	31.8	34.6	82.7	29.4	49.6
Neoromicia ruepelli	1.9						
Neoromicia tenuipinis		4.5					
Scotoecus albofuscus		1.4				8.8	
Scotoecus argentata	1.9						
Scotoecus hirundo	8.2	5.5	27.3		9.3	38.2	14.5
Scotophilus dingani	53.8	31.8		7.7	2.7	4.4	5.8
Scotophilus nux	6.0						

In Table 5.4 the results suggest evidence that relative frequency of bats recorded in different survey areas is very varied. These results may indeed reflect of spatio-temporal importance of diferent survey areas for the different species. Overall thre species (*Scotophilus dingani, Scotoecus hirundo* and *Neoromicia nanus*) seemed to occur in srvey areas at higher levels of activity.

From the bat results it maybe concluded that the ultimate species richness is yet to be realized. For the non – volent small mammals will also likely yield several more species in the wetter part of the year when the ground vegetation cover recovers.

No species listed by IUCN have been recorded in the survey area. A number of cavity and/or cave roosting species (*Chaerephon pumila, Mops cpndylura, Scotophilus sppi*) have however been recorded. Bats with such roosting habits should be flagged as of high conservation significance since an impact on their preffered roost could result in very serious negative consequences for the long term survival of the species.

5.5.1 Other mammals

All components of the field development area (the flats, escarpment and the rest of pipeline route) have evidence of human impacts either as settlement, agriculture, livestock rearing and others. The natural habitat have therefore been greatly simplified and depleted of any significant populations of medium to large sized mammals.

Table 5.4 Medium to larger sized mammals recorded in the project area

| Common name | Species | Survey area and method | |
		Buhuka flats	Pipeline area
Hippopotamus	*Hippopotamus amphibia*	● *(interviews)*	
Bush Duiker	*Sylivicapra grimmia*	● *(interviews & dung)*	
Marsh Mongoose	*Atilax paludinosus*	● *(seen)*	
African Civet	*Civetta civetictis*	● *(seen)*	
Palm Civet	*Nandinia binotata*	● *(seen)*	
Small spotted Genet	*Geneta tigrina*	● *(seen)*	
Lesser Cane-rat	*Thryonomys gregorianus*	● *(seen feeding signs)*	
Vervet Monkey	*Cercopithecus aethiops*	● *(seen)*	
Red tailed Monkeys	*Cercopithecus ascanius*		● *(seen & interviews 36N 264573, 140735)*
Colobus monkey	*Colobus guereza*		● *(interviews Bitagata village)*
Stripped Ground Squirrel	*Xerus erythropus*		● *(seen 36N 264573, 141208)*

Table 5.4 list the species of medium to larger sized mammals that were reported (through interviews) or observed or recorded from signs as present in the project area. It was not possible to collect quantitative data on these except for a simple indication of their presence.

Of the species recorded so far, only Hippotamus are listed by IUCN as threatened, even for this species, there is no claim of presence of a healthy population. There are conflicting reports on the numbers of Hippos in the Lagoon, with numbers ranging from a few to as many as 50 being

reported. It is unlikely that there are many hippos in the lagoon since their grazing activity/pressure would be evident.

Five species of bats recorded (*Chaerephon pumila, Mops condylura, Miniopterus* sp, *Scotoecus hirundo* and *Scotophilus dingani*) are potentially cave or cavity roosting bats, but we did not during the first series of surveys discover any caves that it would be important to preserve. We shall continue to search for these along the escarpment in the following surveys.

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Appendices

Appendix 1. Dragonfly species recorded over the two survey periods

Species	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11
Acisoma panorpoides	1		1	1	1						1
Agriocnemis inversa	1			1							1
Anax imperator								1			
Bluet KD			1		1						
Brachythemis lacustris			1	1			1				1
Brachythemis leucosticta	1	1	1	1	1	1	1	1	1		1
Bradinopyga cornuta			1								
Ceriagrion glabrum	1	1		1			1	1		1	1
Chlorocnemis curta								1			
Crocothemis erythraea	1	1	1	1	1	1		1			
Diplocoides sp		1					1	1		1	
Elattoneura glauca	1										
Hemistigma albipuncta											1
Ictinogomphus ferox	1	1		1	1						1
Ischnura senegalensis			1					1			
Mesocnemis singularis	1										
Nesciothemis farinosa								1	1		1
Neurogomphus sp				1							
Neurogomphus sp 2				1				1			
Notogomphus sp				1							
Orthetrum caffrum							1	1		1	
Orthetrum chrysostigma				1			1	1			1
Orthetrum hintzi						1	1	1		1	1
Orthetrum julia	1			1	1	1	1	1	1	1	1
Orthetrum kirby											1

Species											
Orthetrum sp 1	1								1		
Orthetrum sp 2			1								1
Palpopleura lucia	1			1	1		1	1		1	1
Palpopleura portia					1	1	1				
Pantala flavescens		1	1								1
Phaon iridipennis	1						1	1			
Platycypha caligata	1				1			1			1
Proischnura subfurcata			1		1						
Pseudagrion hageni										1	
Pseudagrion kersteni	1		1		1			1	1	1	
Pseudagrion melanicterum	1							1		1	
Pseudagrion sp 1		1				1					
Pseudagrion sp 2						1					
Pseudagrion sublacteum			1								1
Trithemis annulata	1	1		1				1			
Trithemis arteriosa	1	1	1		1	1	1	1			1
Trithemis donaldsoni	1										
Trithemis nuptialis						1					
Urothemis asignata								1			
Urothemis edwardsi		1		1							
Zygonix sp											1

Appendix 2. Butterfly species recorded from the different sites surveyed with their corresponding habitat preferences over the two survey periods

Species	Ecotype	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12
Acleros ploetzi	f.					1	1	1	1		1		1
Acraea acerata	W								1	1			
Acraea alicia	W					1			1				
Acraea aurivilli	F								1		1		
Acraea egina	W								1				1
Acraea encedon	W					1	1	1	1	1			
Acraea eponina	W					1	1	1			1		1
Acraea jodutta	F					1							
Acraea johnstoni	f.					1							
Acraea lycoa	F	1											
Acraea macaria	F					1							
Acraea peneleos	F					1							
Acraea penelope	F					1							
Acraea pseudegina	W					1	1		1	1			
Acraea servona	F					1							
Acraea zetes	W							1					
Amauris niavius	W					1			1				
Amauris tartarea	f.	1				1		1	1				
Anthene amarah	O	1	1						1	1		1	1
Anthene larydas	F	1				1							
Anthene lunulata	W						1						
Appias epaphia	M											1	
Appias sabina	F												
Ariadne enotrea	F	1				1			1			1	
Axiocerces tjoane	O						1		1				

Species	Code	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
Azanus isis	F								1				
Azanus jesous	M	1				1		1				1	
Belenois aurota	M	1				1	1	1	1		1	1	1
Belenois crawshayi	F		1	1	1	1							
Belenois creona	M	1	1	1	1	1	1	1	1	1	1	1	1
Belenois solilucis	f.						1		1			1	
Belenois subeida	f.	1											
Belenois thysa	f.	1					1	1				1	
Bicyclus auricrudus	F	1	1							1			
Bicyclus funebris	F					1							
Bicyclus jefferyi	f.												
Bicyclus mandanes	F	1											
Bicyclus safitza	W	1					1	1	1	1	1		1
Bicyclus saussurei	F									1	1		
Bicyclus sophrosyne	f.	1											
Bicyclus vulgaris	W	1				1	1	1	1		1		
Borbo borbonica	M										1		
Borbo fallax	O												
Borbo perobscura	O												
Byblia anvatara	M	1	1	1		1		1	1			1	
Cacyreus lingeus	f.	1				1	1	1	1	1	1		1
Calleagris lacteus	F								1				
Catopsilia florella	M	1			1		1	1	1	1		1	
Celaenorrhinus galenus	F					1							
Charaxes etesipe	f.												
Charaxes fulvescens	F								1				
Charaxes jasius	O	1											
Charaxes pleione	f.					1			1				
Charaxes tiridates	F	1											
Charaxes varanes	W	1							1				

Species	Code	1	2	3	4	5	6	7	8	9	10	11	12
Charaxes zoolina	O	1								1			
Chondrolepis niveicornis	F						1						
Coeliades forestan	W												1
Colias electo	M								1				
Colotis antevippe	O	1	1	1	1	1	1	1	1		1	1	1
Colotis aurigineus	W	1				1	1	1					
Colotis auxo	W												
Colotis danae	W	1		1		1						1	
Colotis eucharis	W	1	1	1		1						1	
Colotis evagore	M	1	1			1					1	1	
Colotis protomedia	O	1				1			1				
Cupidopsis jobates	W					1							
Cymothoe herminia	F								1				
Danaus chrysippus	M	1	1		1	1		1	1	1	1	1	1
Dixeia orbona	W											1	
Dixeia pigea	W	1			1								
Eretis lugens	W					1	1	1	1	1	1	1	
Eretis umbra	O					1		1		1			
Eronia cleodora	O	1	1			1			1			1	
Euchrysops malathana	O				1								
Eurema brigitta	M	1				1	1				1	1	1
Eurema hecabe	M	1			1	1	1	1	1	1	1	1	1
Eurema regularis	W							1	1				
Eurema senegalensis	F					1							
Eurytela dryope	W	1				1	1	1	1		1		1
Eurytela hiarbas	f.					1			1				
Gegenes hottentota	O	1				1						1	
Gnophodes betsimena	F	1						1					
Graphium angolanus	M					1		1	1	1			
Graphium antheus	f.					1			1				

Graphium leonidas	M					1							
Hamanumida daedalus	W	1				1	1	1	1				
Harma theobene	F					1							
Henotesia perspicua	O						1	1					
Hypolimnas misippus	M												
Hypolimnas monteironis	F					1							
Hypolimnas salmacis	F	1				1			1				
Hypolycaena hatita	F					1							
Hypolycaena pachalica	O	1	1										
Hypolycaena philippus	W	1	1						1	1		1	
Junonia chorimene	O	1	1			1	1	1	1	1		1	1
Junonia hierta	M	1	1	1	1							1	
Junonia oenone	W	1	1	1	1	1	1	1	1	1	1		1
Junonia orithya	M		1	1	1			1				1	
Junonia sophia	W	1					1	1	1		1	1	
Junonia stygia	f.					1							
Junonia terea	W					1	1	1	1	1	1	1	1
Lachnocnema bibulus	W		1				1					1	
Leptosia nupta	F	1				1	1	1	1			1	
Leptosia wigginsi	F	1				1	1		1			1	
Leptotes pirithous	M				1		1			1	1		
Leptotes pulcher	S					1							
Melanitis leda	W	1											
Metisella willemi	f.						1				1		
Mylothris agathina	W					1		1	1	1		1	1
Mylothris chloris	W	1										1	
Mylothris ochracea	FL											1	
Mylothris rubricosta	S					1						1	
Mylothris rueppelli	f.	1											
Mylothris sjostedti	F	1										1	

Species	Code	1	2	3	4	5	6	7	8	9	10	11	12
Nepheronia argia	F							1					
Nepheronia buqueti	O	1	1	1	1		1					1	
Nepheronia thalassina	f.				1		1						
Neptidopsis ophione	f.	1			1		1						
Neptis melicerta	F						1						
Neptis saclava	W	1			1	1	1					1	1
Neptis serena	W	1			1	1	1	1	1			1	
Oboronia punctatus	F												
Papilio bromius	f.	1			1		1	1				1	
Papilio dardanus	W				1	1		1	1				
Papilio demodocus	M	1			1		1	1	1			1	1
Papilio phorcas	F						1						
Pardaleodes incerta	F	1			1	1	1			1			
Pelopidas mathias	M				1	1	1	1	1				1
Phalanta phalantha	M	1			1		1						
Precis pelarga	f.				1	1			1				
Pseudacraea lucretia	f.				1								
Pseudonacaduba sichela	W				1						1		
Salamis anacardii	f.	1	1		1		1					1	
Salamis cacta	F				1		1					1	
Salamis parhassus	f.	1					1						
Sallya boisduvali	M	1											
Sallya boisduvali	M	1											
Sarangesa laelius	W											1	
Sarangesa maculata	O												
Spialia spio	O	1			1		1	1		1			
Tirumala formosa	f.				1								
Tirumala petiverana	M				1						1	1	
Tuxentius cretosus	O	1					1	1					
Uranothauma	W				1	1	1		1			1	

falkensteini													
Vanessa cardui	M												1
Ypthima albida	f.	1				1	1	1		1	1		
Ypthima asterope	O							1					
Ypthima doleta	W										1		
Ypthimomorpha itonia	f.						1	1			1		
Zenonia zeno	f.					1	1	1	1				
Zizeeria knysna	W	1	1	1	1	1	1	1	1	1	1	1	
Zizina antanossa	W												
Zizula hylax	W	1		1	1		1				1		

Appendix 1: Amphibian diversity of Kingfisher – Buhuka flats, pipeline and refinery areas

Species	Authority	Common Name	IUCN Red List Status
Amietophrynus gutturalis	Power, 1927	Guttural Toad	LC
Amietophrynus regularis	Reuss, 1833	Common African toad	Least Concern (LC)
Amietophrynus vittatus	Boulenger, 1906	Lake Victoria Toad	Data Deficient (DD)
Amietophrynus sp.			
Afrixalus fulvovittatus	Frost, 1985	Banded Banana Frog	LC
Hyperolius kivuensis	Ahl, 1931	Kivu Ree Frog	LC
Hyperolius acuticeps	Ahl, 1931		LC
Hyperolius cinnamomeoventris	Bocage, 1866	Cinnamom-bellied red frog	LC
Hyperolius viridiflavus	Dumeril & Bibron, 1841	Common Reed Frog	LC
Kassina senegalensis	Girard, 1853	Senegal Land Frog	LC
Leptopelis sp.			
Amietia desaegri	Laurent, 1972		Lc
Ptychadena anchietae	Bocage, 1868	Anchieta's Ridged Frog	LC
Ptychadena christyi			
Ptychadena mascariensis cf nilotica	Duméril & Bibron, 1841		LC
Ptychadena porosissima	Steindachner, 1867	Grassland ridged Frog	LC
Ptychadena sp1			
Ptychadena sp2			
Hoplobatrachus occipitalis	Günther, 1858	Crown Bull Frog	LC
Phrynobatrachus mababiensis	FitzSimons, 1932	Mababe river frog	LC
Phrynobatrachus natalensis	Smith, 1849	Natal-dwarf Pddle frog	LC
Phrynobatrachus sp.			
Xenopus victorianus	Wagler, 1827	African Clawed frog	LC

Appendix 2: Reptilian diversity of Kingfisher – Buhuka flats, pipeline and refinery areas

Species	Authority	Common name	IUCN Status
Trionyx triunguis	Forsskål, 1775	Nile Soft-shelled Turtle	NE , Medtiterrenean subpopulation Critically Endangered C2a ver 2.3 (reported)
Pelusios subniger	Lacépède, 1788	East African Black Mud Turtle	Lr/Lc
Pelusios williamsi	Laurent 1965	Williams' African Mud Turtle	Lr/Lc
Pelusios rhodesianus	Hewitt, 1927	Mashona Hinged Terrapin	Lr/Lc
Hemidactylus brookii	Gray, 1845	Brook's House Gecko	NE
Agama agama	Linnaeus, 1758	Common Agama	Lc
Acanthocercus atricollis	Smith, 1849	Orange-headed Tree Agama	Lc
Chamaeleo laevigatus	Gray, 1863	Smooth chameleon	Lc
Chamaeleo gracilis	Hallowell, 1844	Graceful Chameleon	NE
Trachylepis maculilabris	Gray, 1845	Speckle-lipped Skink	LC
Trachylepis striata	Peters, 1844	African Striped Mabuya	NE
Gerrhosaurus major	Dumeril, 1851	Rough-scaled Plated Lizard	NE
Philopthamnus bequaerti	Schmldt, 1923	Uganda Green Snake	NE
Crotaphopeltis degeni	Boulenger, 1906)	Degen's Herald Snake	NE
Psammophis subtaeniatus	Peters, 1881	Stripped bellied sand snake	NE
Psammophis sudaniensis	Werner, 1919	Northern Striped Sand Snake	NE
Hapsidophrys smaragdina	Schlegel, 1837	Emeral Snake	NE
Varanus niloticus	Linnaeus, 1766	Nile Monitor	NE
Dendroaspis polylepis	Günther, 1864	Black Mamba	Low Risk/Least Concern (Reported)
Naja melanoleuca	Hallowell, 1857	Forest Cobra	Lc (Reported)
Crocodylus niloticus	Laurenti, 1768	Nile Crocodile	Lower Risk/least concern

Appendix B1. Results of transect counts in the kingfisher flats

ATLAS NO[a]	SPECIES NAME	Habitat[a] and related information	1 ARUA					2 CAMP GRASSLAND						
Temp			Warm	Hot	Warm	Cool	Mild	Mild	F.Hot	Mild	Hot	Mild	Hot	F.Hot
Start time			1505	1520	746	655	1325	720	1115	1003	955	1225	1600	945
Observers			RS/DP	RS/DP	RS/MK	RS/MK	RS/MK	RS/DP	RS/DP	RS/MK	RS/MK	RS/MK	RS/DP	RS/DP
Date			26 Feb	2 March	23 May	29-Oct	30-Oct	27 Feb	2 March	22 May	29 Oct	30 Oct	27 Feb	2 March
			1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**
14	SQUACCO HERON	W						6	3				4	4
17	CATTLE EGRET	G	10					4	21		3		5	
21	LITTLE EGRET	W										1	3	
22	INTERMEDIATE EGRET	W											2	3
25	GREY HERON	R-NT,W							1		1	1		2
26	BLACK-HEADED HERON	w		1	1			1				14	1	5
28	HAMERKOP	w	2		1	5	1	1	3			2	5	3
30	OPEN-BILLED STORK	A,w,G	3							1				
31	BLACK STORK	P,w	1	1										
35	SADDLE-BILLED STORK	R-VU,W										2		
36	MARABOU STORK	w	2	9				4	6	12	18	4	1	4
39	HADADA	w		2								4		2
42	SACRED IBIS	W						1	5	1			9	2
75	BLACK KITE	pA		4									2	
76	AFRICAN FISH EAGLE	W					2			1		2		
77	PALM-NUT VULTURE													
86	BROWN SNAKE EAGLE	R-NT												
88	BATELEUR	G					2		1					
90	AFRICAN HARRIER HAWK	f				1								
93	AFRICAN MARSH HARRIER	R-NT,W												
110	COMMON BUZZARD	P												
119	AFRICAN HAWK EAGLE										1			
125	MARTIAL EAGLE	R-VU												
132	GREY KESTREL					1								2
136	EURASIAN HOBBY	P				1								
143	COMMON QUAIL	p,												
154	CRESTED FRANCOLIN			3	3	6	3	2					2	2
185	GREY CROWNED CRANE	R-NT,W,G										2		
193	AFRICAN JACANA	W												
204	TEMMINCK'S COURSER	A,G												
212	KITTLITZ'S SANDPLOVER	RB	1							3	2	6	2	2
222	BLACK-HEADED LAPWING	G								12	16	7		
221	WATTLED LAPWING	W			2		2	2	1					5
223	SPUR-WINGED LAPWING	w,G							1					
225	SENEGAL LAPWING	A,G	2	2	1								1	

#	Species	Code	1 ARUA					2 CAMP GRASSLAND						
226	CROWNED LAPWING	G						4	2				4	2
236	COMMON SNIPE	P,W						2	1		1			
246	COMMON GREENSHANK	P,W										1		
248	WOOD SANDPIPER	P,W						9	3			3	22	16
250	COMMON SANDPIPER	P,W												
271	BLUE-SPOTTED WOOD DOVE	f	2		1	2	1						2	
272	BLACK-BILLED WOOD DOVE				1									
274	NAMAQUA DOVE					1								
283	RED-EYED DOVE	f					1	2		2	1	3	1	2
284	AFRICAN MOURNING DOVE													
286	RING-NECKED DOVE	f	1	1	1	4		1			2		1	2
289	LAUGHING DOVE		10	5	8	13	8	3	1	6	4	4	1	6
302	ROSS'S TURACO	F			P									
305	EASTERN GREY PLANTAIN EATER	,												1
308	GREAT SPOTTED CUCKOO	P												
309	RED-CHESTED CUCKOO	AF			2									1
319	KLAAS' CUCKOO	f												
320	DIDRIC CUCKOO				5		1			1				1
323	WHITE-BROWED COUCAL	,	4	2	8	8	3	2	2	1		1	2	2
325	SENEGAL COUCAL	f			1									
342	LONG-TAILED NIGHTJAR	A												1
358	PALM SWIFT	Ae						5		2	2			
368	BLUE-NAPED MOUSEBIRD	,	5		5	2	9	7					21	4
369	SPECKLED MOUSEBIRD		18	1	1		5	6	3			2	1	4
373	GREY-HEADED KINGFISHER	A,f,w	14	3	10	13	5					1	3	2
375	WOODLAND KINGFISHER	A											1	
376	STRIPED KINGFISHER												2	
378	PYGMY KINGFISHER	fw												1
380	MALACHITE KINGFISHER	W								1				
383	PIED KINGFISHER	W						3						1
385	LITTLE BEE-EATER	G					1							
386	BLUE-BREASTED BEE-EATER	w						1	3		6			
389	RED-THROATED BEE-EATER	W				1							1	
390	WHITE-THROATED BEE-EATER	A,f,Ae		25		21	12							
392	BLUE-CHEEKED BEE-EATER	P,Ae					1		3			3		
393	MADAGASCAR BEE-EATER	A,Ae			1									
398	EUROPEAN ROLLER	P											1	
408	AFRICAN HOOPOE	p	1	1										
420	GREY HORNBILL		1											1
433	YELLOW-FRONTED TINKERBIRD	f	1	1	1								1	
441	BLACK-BILLED BARBET		5	1	P									
443	DOUBLE-TOOTHED BARBET	f												
455	GREATER HONEYGUIDE	f	1	1	1								1	
456	LESSER HONEYGUIDE	f												
489	FLAPPET LARK	G	1		1	1		2	2				4	3
500	SAND MARTIN	P,W,Ae	8	1				67	10		265	193		4
501	BANDED MARTIN	A,G,Ae							2					
505	STRIPED SWALLOW	w,Ae												2
513	EURASIAN SWALLOW	P,w,Ae	62	33			8	34	1		113	83		
515	YELLOW WAGTAIL	P,w,G	10	12		1	2	15	19			6	22	16
520	AFRICAN PIED WAGTAIL	w	1											
522	GRASSLAND PIPIT	G	2		1			4	4	6	1	1		2

No.	Species		1 ARUA					2 CAMP GRASSLAND						
528	RED-THROATED PIPIT	P,w											3	
529	YELLOW-THROATED LONGCLAW	G						11	2	1				
547	YELLOW-THROATED GREENBUL	f												
549	LEAF-LOVE	F												
562	COMMON BULBUL	f	15	11	17	14	9	1		1	5	2	6	7
576	WHITE-BROWED ROBIN CHAT	f											1	
586	SPOTTED MORNING THRUSH	,			2	1	1						1	7
588	BROWN-BACKED SCRUB-ROBIN	f				2								
589	WHITE-BROWED SCRUB ROBIN	,	2	1	1		2						2	3
593	WHINCHAT	P	1	1			2	1	1		1		2	1
594	NORTHERN WHEATEAR	P		1				2	1				6	3
598	ISABELLINE WHEATEAR	P												
625	REED WARBLER	P,w	1					1	2					5
638	RED-FACED CISTICOLA	w							2					
639	SINGING CISTICOLA		3	4										
640	WHISTLING CISTICOLA													
645	RATTLING CISTICOLA		13	6	18	30	12		2	3		5	5	7
647	WINDING CISTICOLA	w						1	2	8			2	
655	ZITTING CISTICOLA	w, G	3	1	11	10	5	13	10	14	22	22	6	2
658	TAWNY-FLANKED PRINIA	f,w		2		2							1	
664	BUFF-BELLIED WARBLER	f											2	
677	GREY-BACKED CAMAROPTERA	f	1	2	7	4		2		1	1		2	5
695	WILLOW WARBLER	P,f		1										2
701	GREY-CAPPED WARBLER	f,w			1									
713	NORTHERN BLACK FLYCATCHER	,		1		1								
717	SPOTTED FLYCATCHER	P					1							
746	WATTLE-EYE	f		1										1
751	BLACK-HEADED BATIS	f												
762	ARROW-MARKED BABBLER													
764	BLACK-LORED BABBLER	R-RR											7	6
787	SCARLET-CHESTED SUNBIRD	f				2	1							
790	BRONZE SUNBIRD	f												
796	OLIVE-BELLIED SUNBIRD	F												
801	BEAUTIFUL SUNBIRD				2	5	6				2			
803	RED-CHESTED SUNBIRD	R-RR,W	2	1	2								2	2
815	GREY-BACKED FISCAL	A,f,w						4	3	4	3	3	3	4
818	RED-BACKED SHRIKE	P				1								
820	WOODCHAT SHRIKE	P						1	1				2	1
831	BROWN-HEADED TCHAGRA		1		1									
833	BLACK-HEADED TCHAGRA													
836	NORTHERN PUFFBACK	F											2	
843	BLACK-HEADED GONOLEK	f	4	2	11	11	6	4	2	2	1	3	10	6
855	PIED CROW							2						
870	LESSER BLUE-EARED GLOSSY S	,				11	3			1			4	1
872	RUPPELL'S LONG-TAILED GLOSS	,	1					3		1			3	
881	GREY-HEADED SPARROW						1			3	2	3	3	
895	LITTLE WEAVER				4	1	1							
896	BLACK-NECKED WEAVER				2									
897	SPECTACLED WEAVER	f				1							2	
908	BLACK-HEADED WEAVER		1		19	2		12	12	21		16		
910	YELLOW-BACKED WEAVER	W			3			20		3	21	8		
923	CARDINAL QUELEA	A	p1										5	2

Code	Name	Status	1 ARUA					2 CAMP GRASSLAND						
924	RED-HEADED QUELEA	R-RR,A				1								
925	RED-BILLED QUELEA	A	3			29	28			23	50	2		1
930	NORTHERN RED BISHOP	G			5	4	10			10	6	15		
937	GROSBEAK WEAVER	R-VU,w								1				
945	GREEN-WINGED PYTILIA	f,W			2									
959	RED-BILLED FIREFINCH	R-NT,f				2	9				4	1		
963	AFRICAN FIREFINCH		9	17	6			8					8	6
962	BLACK-BELLIED FIREFINCH	R-NT,G	3											
969	COMMON WAXBILL	w					2							
974	RED-CHEEKED CORDON-BLEU	,	12	22	9	5	10				4	1	7	3
980	BRONZE MANNIKIN				1	1	5			2	5	1		
981	BLACK-AND-WHITE MANNIKIN													
984	VILLAGE INDIGOBIRD				1		2							
985	PIN-TAILED WHYDAH	G			12	3	18	1	1		1			
	No. birds		**243**	**183**	**193**	**224**	**201**	**275**	**140**	**141**	**573**	**429**	**221**	**185**
	No.spp		**43**	**36**	**45**	**39**	**39**	**42**	**35**	**31**	**31**	**37**	**54**	**54**
	New species		**43**	**10**	**19**	**12**	**8**	**42**	**7**	**10**	**4**	**6**	**54**	**19**
	Cummulative species		**43**	**53**	**72**	**84**	**92**	**42**	**49**	**59**	**63**	**69**	**54**	**73**
	Area species total including Ps											**153**		
	Notes-													
	a: Refers to Bird artlas of Uganda													

3 FOOT OF ESCARPMENT			4 EUPHORBIA				
Mild	Warm	Warm	Hot	Mild	Mild	Mild	F.Hot
813	810	855	1030	0815	1557	1440	1530
RS/MK	RS/MK	RS/MK	RS/DP	RS/DP	RS/MK	RS/MK	RS/MK
22 May	29 Oct	31-Oct	27-Feb	2 MARC	22 May	29-Oct	30-Oct
3	**4**	**5**	**1**	**2**	**3**	**4**	**5**
P				8			
1	3	1		1	4	1	3
4	2				3	1	1
		2	5	4	1	2	5
1							
	1				1		
1				1			
				1			
	1						
			1				
		1					
						1	1
							1
2	2						
						2	
3	2		2	1	1		1
P			3	1	4		
						1	
			2				
2	2	4			4		
				2	4		
					1		
			1		3		

3 FOOT OF ESCARPMENT			4 EUPHORBIA				
			6				
	1						
	1	1					
1	4	2					
1							
4	4			1	4		
3							
3	4		1	5	1		
11	3	2	7	4	15	2	8
					1		
1	1						
	1						
	2			1	7		3
3	1		1	8	7	2	4
2							
2					1	1	1
5	6	1	23	22			
5	6	2	3		3	1	3
1			2		3	2	
2							
1							
							1
	1	1				7	1
			10	4		3	3
					5		
1							
5	3					3	1
			3	1		1	2
1							
1			1				
2							
4			2	8	5		
		1		389		2	
						3	
	814	13	1	12		14	61
		1	10	21			1
					1		

3 FOOT OF ESCARPMENT			4 EUPHORBIA				
	4			1	3	3	3
4							
	2						
13	6	11	6	7	9	17	9
		3			1	1	
	2		1	5	1	1	
	2	1				2	
2							
	1	1	2				1
			3	1			
			1				
			9	6			
2							
			2				
1							
14	10	6	3	15	17	19	10
2	2	5	2		1		1
18	18	9	4	4	18	18	16
2				3	1		
			2				
10	5	9	3	1	2	3	1
		2					
2	1	1					1
					P		
	2	2					
	1						
	4		1				
						1	
2				6			
			1		2	3	1
1	1						
	1						
2		4				4	1
3							
4	2		1			1	
			3				
9	2	1	15	18	16	7	7
							1
4	2						
7	6	2	3	7	2		
			2	2	6	4	4
	1	1			1		
1							
6		3	10	10	20	1	3
4	5	11	3	7	14	15	8
			6				

3 FOOT OF ESCARPMENT			4 EUPHORBIA				
				2		16	16
15	8	3			7	2	5
1							
	4	5				1	3
			2	6	1		
	7	3	4	7	1		6
26	36	14				3	
		5					
2		1					
1		3					1
231	**1000**	**138**	**158**	**618**	**202**	**171**	**199**
55	**48**	**37**	**40**	**41**	**41**	**38**	**38**
22	**13**	**2**	**40**	**14**	**12**	**11**	**5**
95	**108**	**110**	**40**	**54**	**66**	**77**	**82**

ATLASNO[b]	SPECIES NAME[c]	Habitata and related information	5. ESCARPMENT					6.Escarpment South		
		Temp	Mild	Mild	Mild	F.hot	Mild	Mild	Cool	Cool
		Start time	0810	0905	0945	1700	1230	1400	652	643
		Observers	RS/DP	RS/DP	RS/MK	RS/MK	RS/MK	RS/MK	RS/MK	RS/MK
		Date	28 FEB	3 MARCH	24 may	28 Oct	31 Oct	23 May	30-Oct	31-Oct
			1	2	3	4	5	1	2	3
26	BLACK-HEADED HERON Ardea melanocephala	**w**								2
28	HAMERKOP Scopus umbretta	w						1		
32	ABDIM'S STORK Ciconia abdimii	A,G		92						
35	SADDLE-BILLED STORK Ephippiorhynchus senegalensis	R-VU,W			P			1		
36	MARABOU STORK Leptoptilos crumeniferus	w	21	6						
39	HADADA IBIS Bostrychia hagedash	w							3	
75	BLACK KITE Milvus migrans	pA	6							
76	AFRICAN FISH EAGLE Haliaeetus vocifer	W		2				1	1	2
86	BROWN SNAKE EAGLE Circaetus cinereus	R-NT	1							
88	BATELEUR Terathopius ecaudatus	G	1		2					
94	EURASIAN MARSH HARRIER Circus aeruginosus	Pw		P						
110	COMMON BUZZARD Buteo buteo	p					1		1	
113	RED-NECKED BUZZARD Buteo auguralis		2	2						
115	LESSER SPOTTED EAGLE Aquila pomarina	P		3			1			
117	WAHLBERG'S EAGLE Aquila wahlbergi									1
120	BOOTED EAGLE Hieraaetus pennatus	P		P						
122	LONG-CRESTED EAGLE Lophaetus occipitalis	f	1							
125	MARTIAL EAGLE Polemaetus bellicosus	R-VU		P						
154	CRESTED FRANCOLIN Francolinus sephaena		3	7	3		2	3	8	11

No	Species	Code	5. ESCARPMENT					6.Escarpment South		
155	SCALY FRANCOLIN Francolinus squamatus						1			
268	AFRICAN GREEN PIGEON Treron calva	F					1			
270	TAMBOURINE DOVE Turtur tympanistria	F								1
271	BLUE-SPOTTED WOOD DOVE Turtur afer	f	1		4	4	3	2	2	4
284	AFRICAN MOURNING DOVE						1			
283	RED-EYED DOVE Streptopelia semitorquata	f	1	1				1	1	2
286	RING-NECKED DOVE Streptopelia capicola	f	9	3	5	5	1	4	2	3
289	LAUGHING DOVE Streptopelia senegalensis		5	1	3	2	1	6	15	6
293	RED-HEADED LOVEBIRD Agapornis pullaria	f							2	
305	EASTERN GREY PLANTAIN EATER Crinifer zonurus						1			
309	RED-CHESTED CUCKOO Cuculus solitarius	AF	1					2	1	
319	KLAAS' CUCKOO Chrysococcyx klaas	f			2	3		1		
320	DIDRIC CUCKOO Chrysococcyx caprius							5		2
323	WHITE-BROWED COUCAL Centropus superciliosus		1	4		1	3	4	5	7
530	RED-SHOULDERED CUCKOO SHRIKE Campephaga phoenicea						1			
358	PALM SWIFT Cypsiurus parvus	Ae	2	2						
363	WHITE-RUMPED SWIFT Apus caffer	Ae		6						
368	BLUE-NAPED MOUSEBIRD Urocolius macrourus		7	2			4	1		7
369	SPECKLED MOUSEBIRD Colius striatus		11		7	5	3	20	7	6
373	GREY-HEADED KINGFISHER Halcyon leucocephala	A,f,w		2	1			1	1	2
375	WOODLAND KINGFISHER Halcyon senegalensis	A	1					1	1	2
376	STRIPED KINGFISHER Halcyon chelicuti		4	2						
378	PYGMY KINGFISHER Ceyx picta	fw	1							P
380	MALACHITE KINGFISHER Corythornis cristata	W					1	2		2
385	LITTLE BEE-EATER Merops pusillus	G								2
389	RED-THROATED BEE-EATER Merops bullocki	f							3	3
393	MADAGASCAR BEE-EATER Merops superciliosus	A,Ae						2		
408b	EURASIAN HOOPOE Upupa africana									1
419	CROWNED HORNBILL Tockus alboterminatus	f								P
420	GREY HORNBILL Tockus nasutus							1		

			5. ESCARPMENT					6.Escarpment South		
433	YELLOW-FRONTED TINKERBIRD Pogoniulus chrysoconus	f	7	3	12	4	4	3	2	P
437	SPOTTED-FLANKED BARBET Tricholaema lachrymosa	R-RR	1	2			1			
441	BLACK-BILLED BARBET Lybius guifsobalito		3					1	1	2
455	GREATER HONEYGUIDE Indicator indicator	f	1		3	1	1	3	1	2
477	GREY WOODPECKER Dendropicos goertae	f						1		
489	FLAPPET LARK Mirafra rufocinnamomea	G	2	1	1			1		
497	BLACK SAW-WING Psalidoprocne holomelas	Ae								1
498	WHITE-HEADED SAW-WING Psalidoprocne albiceps	R-RR,f,Ae	4	3				3		
499	PLAIN MARTIN Riparia paludicola	Ae			3					
500	SAND MARTIN Riparia riparia	P,W,Ae		3			1			P
505	STRIPED SWALLOW Hirundo abyssinica	w,Ae		5			2	1		
512	ANGOLA SWALLOW Hirundo angolensis	w,Ae			1			1		
513	EURASIAN SWALLOW Hirundo rustica	P,w,Ae	5	20			9			71
515	YELLOW WAGTAIL Motacilla flava	P,w,G	1	2					2	7
522	GRASSLAND PIPIT Anthus novaeseelandiae	G								2
525	PLAIN-BACKED PIPIT Anthus leucophrys	G						2		
547	YELLOW-THROATED GREENBUL Chlorocichla flavicollis	f	2	2	2	5	1	2	2	2
562	COMMON BULBUL Pycnonotus barbatus	f	55	32	28	27	22	10	25	20
576	WHITE-BROWED ROBIN CHAT Cossypha heuglini	f		11	2			3	3	2
578	SNOWY-HEADED ROBIN=CHAT Cossypha niveicapilla	F,w		2		3				
586	SPOTTED MORNING THRUSH Cichladusa guttata		1		1			3		1
589	WHITE-BROWED SCRUB ROBIN Cercotrichas leucophrys		8		10	5	3	3	4	2
588	BROWN-BACKED SCRUB-ROBIN Cercotrichas hartlaubi 743	f							2	
595	PIED WHEATEAR Oenanthe pleschanka	p		P						
602	WHITE-FRONTED BLACK CHAT Myrmecocichla albifrons		1	P			1			
612	AFRICAN THRUSH Turdus pelios 801	f				1				
619	CINNAMON BRACKEN WARBLER Bradypterus cinnamomeus	F	1	1						
625	REED WARBLER Acrocephalus scirpaceus	P,w	2	3						2
628	GREAT REED WARBLER Acrocephalus arundinaceus	P,w								1
638	RED-FACED CISTICOLA Cisticola erythrops	w						1		

#	Species	Code	5. ESCARPMENT					6.Escarpment South		
645	RATTLING CISTICOLA Cisticola chiniana		1	1	5		2	20	20	16
655	ZITTING CISTICOLA Cisticola juncidis	w, G			1			1	1	1
658	TAWNY-FLANKED PRINIA Prinia subflava	f,w	2	4	4	1	3		1	2
663	RED-WINGED GREY WARBLER Drymocichla incana 874	w						4		
664	BUFF-BELLIED WARBLER Phyllolais pulchella	f	2							
667	YELLOW-BREASTED APALIS Apalis flavida	f								1
677	GREY-BACKED CAMAROPTERA Camaroptera brachyura	f	16	25	27	13	18	15	11	15
686	GREEN-BACKED EREMOMELA Eremomela canescens			2						
695	WILLOW WARBLER Phylloscopus trochilus	P,f		P			1			
701	GREY-CAPPED WARBLER Eminia lepida	f,w		1				5	1	
703	GARDEN WARBLER Sylvia borin	P,f	1			5	1			
714	PALE FLYCATCHER Melaenornis pallidus			1						
717	SPOTTED FLYCATCHER Muscicapa striata	P		P						P
730	SEMI-COLLARED FLYCATCHER Ficedula semitorquata	P		1						
742	BLACK-AND-WHITE SHRIKE-FLYCATCHER Bias musicus	f	1	1						
746	WATTLE-EYE Platysteira cyanea	f	2	3		4	1	1		1
749	CHIN-SPOT BATIS Batis molitor	f		1						
751	BLACK-HEADED BATIS Batis minor	f								P
762	ARROW-MARKED BABBLER Turdoides jardineii						6		10	17
764	BLACK-LORED BABBLER Turdoides melanops	R-RR	2					15		
787	SCARLET-CHESTED SUNBIRD Chalcomitra senegalensis	f	5	1		6	2	1		
794	COLLARED SUNBIRD Hedydipna collaris	F	1		1					
769	OLIVE-BELLIED SUNBIRD Cinnyris chloropygia	F				4			1	
801	BEAUTIFUL SUNBIRD Cinnyris pulchella				2		7		3	4
802	MARIQUA SUNBIRD Cinnyris mariquensis				2				1	
803	RED-CHESTED SUNBIRD Cinnyris erythrocerca	R-RR,W	7	3		3		2		
811	YELLOW WHITE-EYE Zosterops senegalensis	f	1	6						
818	RED-BACKED SHRIKE Lanius collurio	P								1
824	GREY-HEADED BUSH-SHRIKE Malaconotus blanchoti	,	2	2						
828	SULPHUR-BREASTED BUSH-SHRIKE Malaconotus sulfureopectus	f			1					

#	Species			5. ESCARPMENT					6.Escarpment South		
831	BROWN-HEADED TCHAGRA Tchagra australis			1			1	1			1
833	BLACK-HEADED TCHAGRA Tchagra senegala				4	4			1	1	
836	NORTHERN PUFFBACK Dryoscopus gambensis							1			
841	TROPICAL BOUBOU Laniarius aethiopicus	f				2					
843	BLACK-HEADED GONOLEK Laniarius barbarus	f		4	3	4	1	3	9	9	8
855	PIED CROW Corvus albus							2			
870	LESSER BLUE-EARED GLOSSY STARLING Lamprotornis chloropterus	,		12	10	1	2	2		13	5
872	RUPPELL'S LONG-TAILED GLOSSY STARLING Lamprotornis purpu	,							3		
876	VIOLET-BACKED STARLING Cinnyricinclus leucogaster	A,f		6	1	1	1				
881	GREY-HEADED SPARROW Passer griseus								1		1
891	CHESTNUT-CROWNED SPARROW WEAVER Plocepasser superciliosi	,			4						
893	BAGLAFECHT WEAVER Ploceus baglafecht	R-RR				1	3		1		
895	LITTLE WEAVER Ploceus luteolus			1		1			2		
897	SPECTACLED WEAVER Ploceus ocularis	f			P						P
908	BLACK-HEADED WEAVER Ploceus cucullatus							1	26	6	9
910	YELLOW-BACKED WEAVER Ploceus melanocephalus	W				2	2		5		
922	RED-HEADED WEAVER Anaplectes rubriceps	FF		1							
925	RED-BILLED QUELEA Quelea quelea	A								13	22
930	NORTHERN RED BISHOP Euplectes franciscanus	G							5	1	
937	GROSBEAK WEAVER Amblyospiza albifrons	R-VU,w							1	1	3
945	GREEN-WINGED PYTILIA Pytilia melba	f,W							2		
959	RED-BILLED FIREFINCH	R-NT,f					4			10	9
963	AFRICAN FIREFINCH Lagonosticta rubricata			4	2	4			3		
967	CRIMSON-RUMPED WAXBILL Estrilda rhodopyga										P
969	COMMON WAXBILL Estrilda astrild	w									3
974	RED-CHEEKED CORDON-BLEU Uraeginthus bengalus	,		6	14	11	12	6	2	14	2
980	BRONZE MANNIKIN Lonchura cucullata					6	7	2		5	
985	PIN-TAILED WHYDAH Vidua macroura	G			P	3	2		1	4	8
990	YELLOW-CROWNED CANARY Serinus canicollis				3						
995	YELLOW-FRONTED CANARY Serinus mozambicus							1			

	5. ESCARPMENT					6.Escarpment South		
No. birds	251	317	175	142	124	219	225	310
No. Species	55	59	41	35	37	56	45	60
New species	55	23	14	8	4	56	15	20
Species accumulation	55	78	92	100	104	56	71	91
Area species including Ps	139							

Appendix B3. Results of transect count along the pipeline route

ATLASNO[a]	SPECIES NAME	Habitata and related information	7 KABALE P/S					8 KASEETA					9 KABALE CULTIVATION					
Temp			Hot	Warm	HOT	Mild	F.hot	Hot	Mild	Hot	Cool	F.hot	Mild	Hot	Mild	Cool	Hot	Warm
Start time			1405	840	1025	1050	1330	1120	845	1450	1005	1155	845	1055	820	755	940	1450
Observers			RS/DP	RS/MK	RS/MK	RS/MK	RS/MK	RS/DP	RS/MK	RS/MK	RS/MK	RS/MK	RS/DP	RS/MK	RS/MK	RS/MK	RS/MK	RS/DP
Date			04-Mar	25-May	27-May	01-Nov	02-Nov	04-Mar	26-May	27-May	02-Nov	02-Nov	04-Mar	25-May	27-May	01-Oct	01-Oct	01-Mar
			1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1
25	GREY HERON	R-NT,W						P										
26	BLACK-HEADED HERON	w											P		1			
28	HAMERKOP	w				1	1				1					4		
36	MARABOU STORK	w	1			1												
39	HADADA IBIS	w					3				1							
71	EUROPEAN HONEY BUZZARD	P,F							1									
75	BLACK KITE	pA	2				2											
86	BROWN SNAKE EAGLE	R-NT						1	P									
87	WESTERN BANDED SNAKE EAGLE	R-VU,F								1								
86a	BLACK-CHESTED SNAKE EAGLE								P									
88	BATELEUR	G	1			1												
100	SHIKRA	f						2										
106	GREAT SPARROWHAWK	F																
109	LIZARD BUZZARD	f		P	4			1			3	3			P	1		
110a	STEPPE-BUZZARD		8										1					
115	LESSER SPOTTED EAGLE	P														1		
116	TAWNY EAGLE	P,G									2							
117	WAHLBERG'S EAGLE	A,f																
120	BOOTED EAGLE	P						P					P					
122	LONG-CRESTED EAGLE	f						2					1					2
136	EURASIAN HOBBY	P														1		
154	CRESTED FRANCOLIN			2				1										
155	SCALY FRANCOLIN	F										1						
225	SENEGAL PLOVER	A,G						P										
250	COMMON SANDPIPER	P,W				1												
268	AFRICAN GREEN PIGEON	F							3		1				3	2		
270	TAMBOURINE DOVE	F		1		3	1	3	3	2	1							
271	BLUE-SPOTTED WOOD DOVE	f		4	1	2	3	2	2	3	4	1		3	5	4	6	1
283	RED-EYED DOVE	f		5		12	6			2	5	1			4	7	4	
286	RING-NECKED DOVE	f		1	1								2			1	1	1
289	LAUGHING DOVE			1														
293	RED-HEADED LOVEBIRD	f						1										
305	EASTERN GREY PLANTAIN EATER			2		3	4	6	1	5					2			
307	LEVAILLANT'S CUCKOO	A,f					1											
309	RED-CHESTED CUCKOO	AF		1														

#	Species	Code	7 KABALE P/S					8 KASEETA					9 KABALE CULTIVATION					
319	KLAAS' CUCKOO	f			1	1		1	P	2	2						2	
320	DIDRIC CUCKOO			4	1			1										
321	YELLOWBILL	F				1												
323	WHITE-BROWED COUCAL			1				5			5	1	1	3	2	3		
325	SENEGAL COUCAL	f												P				
358	PALM SWIFT	Ae		P			2	P	1	1	2			7	P			
368	BLUE-NAPED MOUSEBIRD		5	11	6	2												
369	SPECKLED MOUSEBIRD		9	8	5	11	12	2	2		3	4	2	4	8	5	3	1
373	GREY-HEADED KINGFISHER	A,f,w		1														
376	STRIPED KINGFISHER							P							1			
385	LITTLE BEE-EATER	G											P	P				
390	WHITE-THROATED BEE-EATER	A,f,Ae	P					4			9	3	10				1	22
392	BLUE-CHEEKED BEE-EATER	P,Ae	4															
394	EURASIAN BEE-EATER	Pf	P				12					4	P			3	5	2
401	BROAD-BILLED ROLLER	A,f,w									1							
419	CROWNED HORNBILL	f											3			3		
422	BLACK AND WHITE CASQUEDE HORNBILL			5					1	2	3		1			2	4	
431	YELLOW-RUMPED TINKERBIRD	F						2	1									
433	YELLOW-FRONTED TINKERBIRD	f	3	2	1	6	1	2	1	4	2	1						
437	SPOTTED-FLANKED BARBET	R-RR		1														
441	BLACK-BILLED BARBET			1														
455	GREATER HONEYGUIDE	f		1														
465	NUBIAN WOODPECKER								1									2
477	GREY WOODPECKER	f			1			P					1		1			
473	CARDINAL WOODPECKER										1							
498	WHITE-HEADED SAW-WING	R-RR,f,Ae						1	4		1	2		2				
500	SAND MARTIN	P,W,Ae	146			2		2390			60	203						2
501	BANDED MARTIN	A,G,Ae											10					
504	MOSQUE SWALLOW	Ae									1	1						
505	STRIPED SWALLOW	w,Ae		1							1			2	1			
512	ANGOLA SWALLOW	w,Ae												2				
513	EURASIAN SWALLOW	P,w,Ae	7			8	4				6	7	16			1	14	7
520	AFRICAN PIED WAGTAIL	w				3			2	1	5	1						
529	YELLOW-THROATED LONGCLAW	G		3														1
538	LITTLE GREENBUL	F							1									
547	YELLOW-THROATED GREENBUL	f			2				4	6	4	8						
562	COMMON BULBUL	f	26	23	30	25	28	23	13	17	14	13	9	24	26	4	16	16
570	NIGHTINGALE	P																1
576	WHITE-BROWED ROBIN CHAT	f	3	2		1	2		1					P	1	1	3	1
578	SNOWY-HEADED ROBIN=CHAT	F,w	1				2		1	P	1							
586	SPOTTED MORNING THRUSH			2	P													
588	BROWN-BACKED SCRUB-ROBIN	f															2	2
589	WHITE-BROWED SCRUB ROBIN		2	3	1	1	2				2	1		2	3			
593	WHINCHAT Saxicola rubetra	P															1	
612	AFRICAN THRUSH	f		5	2			P	3				1	4	3			
621	MOUSTACHED WARBLER			5			1		2		4		1	P	5	5	1	
625	REED WARBLER	P,w						2	1						3			1
638	RED-FACED CISTICOLA	w		1	2		3	7	4	2	10	4	12	8	11	7	4	4
639	SINGING CISTICOLA		1													1		
640	WHISTLING CISTICOLA				3	2	1				2	1		2	1	3	3	
645	RATTLING CISTICOLA			1					1									

#	Species	St	7 KABALE P/S					8 KASEETA					9 KABALE CULTIVATION					
650	CROAKING CISTICOLA	G		1	1	1												
652	SIFFLING CISTICOLA													1				
658	TAWNY-FLANKED PRINIA	f,w	3	7	5	6	2	9	5	14	4	7	8	11	5	12	4	4
664	BUFF-BELLIED WARBLER	f						1		2								
677	GREY-BACKED CAMAROPTERA	f	3	15	12	3	3	7	11	8	6	1		5	3	3	2	1
695	WILLOW WARBLER	P,f				1		1					1			1		
701	GREY-CAPPED WARBLER	f,w		P						1		1		P				
703	GARDEN WARBLER	P,f																
713	NORTHERN BLACK FLYCATCHER	,						1		2			P		1	1		
714	PALE FLYCATCHER		1															
732	AFRICAN BLUE FLYCATCHER	f			1													
739	AFRICAN PARADISE FLYCATCHER	f							1									
742	BLACK-AND-WHITE SHRIKE-FLYCATCHER	f								1								
746	WATTLE-EYE	f		1	1	1		P	2	2								
751	BLACK-HEADED BATIS	f	1	P	1											2		1
761	BROWN BABBLER		2										12					
762	ARROW-MARKED BABBLER						5					5			7	3	7	
776	VIOLET-BACKED SUNBIRD	A,f						1										
781	GREEN-HEADED SUNBIRD	F						1										
787	SCARLET-CHESTED SUNBIRD	f	4	3		3	2	1	1	1	2		3			2	1	
790	BRONZE SUNBIRD	f		1	1													
794	COLLARED SUNBIRD	F	1															
796	OLIVE-BELLIED SUNBIRD	F			1			2	1	1	3					1		
802	MARIQUA SUNBIRD				1			1		2								
803	RED-CHESTED SUNBIRD	R-RR,W																3
808	VARIABLE SUNBIRD	f									1					1		
810	COPPER SUNBIRD	f,w	1		2	3		P	2	2	1		3		1	3	4	
811	YELLOW WHITE-EYE	f		2	1			2		1					1		2	
812	COMMON FISCAL	G																
828	SULPHUR-BREASTED BUSH-SHRIKE	f		5	6	6	2	1			5			2				
830	MARSH TCHAGRA	w														2		
831	BROWN-HEADED TCHAGRA			4			2	1	2					2		3	2	
833	BLACK-HEADED TCHAGRA			3	1		1		P				4	2	4			
836	NORTHERN PUFFBACK	F			1	1												
841	TROPICAL BOUBOU	f	7	11	10	4	5		1	1	3		12	8	10	10	4	2
843	BLACK-HEADED GONOLEK	f	5	8	2	4	5						2	1		2		1
850	AFRICAN BLACK-HEADED ORIOLE	f		1														
851	AFRICAN GOLDEN ORIOLE	A,f		1														
853	DRONGO	,/F		P				P										
855	PIED CROW		P					P										
870	LESSER BLUE-EARED GLOSSY STARLING	,			1	1												
872	RUPPELL'S LONG-TAILED GLOSSY STARLING	,			2			P	P									
881	GREY-HEADED SPARROW		2	6	6	8	12	3	11	4	6	7	2		6	1	5	
889	SPECKLED-FRONTED WEAVER																	
893	BAGLAFECHT WEAVER	R-RR		2	1	1					1		1	1	1		2	
895	LITTLE WEAVER			P														
896	BLACK-NECKED WEAVER							10										
897	SPECTACLED WEAVER	f		1				P					1					
937	GROSBEAK WEAVER	R-VU,w									1							2
907	VIEILLOT'S BLACK WEAVER	R-NT,R-R,						10	5					2	1			
908	BLACK-HEADED WEAVER		6	46	17	2		25	6	22			6	1	15	22	9	

No	Species	Code	7 KABALE P/S					8 KASEETA					9 KABALE CULTIVATION					
910	YELLOW-BACKED WEAVER	W		5	4	6	11	2	2	9	10	2	7	7	9			
915	COMPACT WEAVER	FF						2			1	1	2	3	12		5	
924	RED-HEADED QUELEA	R-RR,A													11	5	1	
925	RED-BILLED QUELEA	A									1			40		6		
927	BLACK BISHOP	w							3	8	3	4		3	12	6	1	
928	BLACK-WINGED RED BISHOP	w								1				1	8	2		
932	FAN-TAILED WIDOWBIRD	G											6					
935	RED-COLLARED WIDOWBIRD	G							1	1				1	7			
939	GREY-HEADED NEGROFINCH	FF							P	1								1
944	GREY-HEADED OLIVEBACK	R-RR,f,w							1									
956	BROWN TWINSPOT	FF							2			1				3		
959	RED-BILLED FIREFINCH	R-NT,f									1							2
962	BLACK-BELLIED FIREFINCH	R-NT,G				2										3	1	
963	AFRICAN FIREFINCH			1	3				4				10	3	1			
968	BLACK-RUMPED WAXBILL				3							1						
969	COMMON WAXBILL	w		2														1
970	BLACK-CROWNED WAXBILL	f						P	8		7	5			6	4		
974	RED-CHEEKED CORDON-BLEU	,		12	1	2	3		2			4		2	3		2	2
976	ZEBRA WAXBILL								2									
980	BRONZE MANNIKIN			4		2	1	7	15	9	3	17		4	1	13	4	20
981	BLACK-AND-WHITE MANNIKIN								P		3					1		
984	VILLAGE INDIGOBIRD								1						P			
985	PIN-TAILED WHYDAH	G				2	3		4	1	2			1	5	2		
990	YELLOW-CROWNED CANARY				2			7					11					
991	AFRICAN CITRIL														1			
995	YELLOW-FRONTED CANARY					4	3		7	1	7	6		4	3	4	9	
997	BRIMSTONE CANARY					2		P							P	2	1	
1005	AFRICAN GOLDEN-BREASTED BUNTING					2									1			
1007	CABANIS'S BUNTING	G						P					1					
	No.individuals		255	239	149	154	152	2485	196	133	255	331	153	178	218	179	149	91
	No.Spp		30	56	43	43	36	32	65	46	53	37	37	40	49	48	43	19
	New spp		30	42	13	9	4	32	48	12	12	4	37	24	13	10	6	19
	Cummulative no.species		30	73	86	95	99	32	80	92	104	108	37	61	74	84	90	19
	Area species total inluding Ps										166							
	Notes- a: Refers to Bird artlas of Uganda																	

	10 PIPELINE SOUTH		
Mild	Hot	F.hot	Cool
1139	1100	1400	1525
RS/MK	RS/MK	RS/MK	RS/MK
24-May	26-May	01-Nov	01-Nov
2	3	4	5
			1
	P		
2			
		2	
			1
3			
1	3		
	3	2	2
			7
1			
		2	
			3
		1	

10 PIPELINE SOUTH			
	1		
	3		
1	3	4	
	P		
		10	
			1
		1	
	1		
		10	220
		23	125
		2	
14	23	14	8
2			
	1		
	3		1
2	1		
	3		
4	4	1	2
P	3	5	5
2			

10 PIPELINE SOUTH			
9	10	6	6
10	7	4	
		1	
		3	
		1	
			3
1		1	
1			
	1	1	
	P		
	1		
		1	1
2	5		
5	6		2
10	7	4	5
			2
		1	
	3		
14	12	14	8

10 PIPELINE SOUTH			
3			2
	1		
1	3	2	1
	1		
		3	
	1	1	
2	5		
10	6	11	1
2			
1	6	2	2
			1
103	127	133	410
25	32	29	24
15	15	12	7
30	45	57	64

Appendix B4. Results of water bird counts from February to October 2014 along L.Albert shores and inland

ATLAS No.	SPECIES NAME	CODE	Pad 3				KF Jetty					I km shore	Pad 2	Pad 2 - Jetty
			RS/DP	RS/DP	RS/MK	RS/MK	RS/DP	RS/DP	RS/DP	RS/MK	RS/MK	RS/DP	RS/MK	RS/MK
			930	1700	1455	1610	1430	1720	1110	1108	1000	730	900	935
			27-Feb	02-Mar	22-May	29-Oct	28-Feb	01-Mar	22-May	29-Oct	31-Oct	03-Mar	23-May	23-May
6	LONG-TAILED CORMORANT Phalacrocorax africanus	W	3		15		7	6	25		1	8		2
14	SQUACCO HERON Ardeola ralloides	W	4	8	7	3	1	2	1			13		
17	CATTLE EGRET Bubulcus ibis	G					10	13	7			31		
21	LITTLE EGRET Egretta garzetta	W	8	14	17		6	12	15	1	1	11		
23	GREAT WHITE EGRET Egretta alba	R-VU,W			7									
22	INTERMEDIATE EGRET Egretta intermedia	W			1				1					
24	PURPLE HERON Ardea purpurea	R-NT,W	1									1		
25	GREY HERON Ardea cinerea	R-NT,W	1	2		1	2	3	3	1	2	8		1
26	BLACK-HEADED HERON Ardea melanocephala	w	1	2	4	6		2	2	10	14	1	1	
27	GOLIATH HERON Ardea goliath	R-NT,W												
28	HAMERKOP Scopus umbretta	w	2	2	10	7		3	2	6	9		5	2
29	YELLOW-BILLED STORK Mycteria ibis	W		1										
30	AFRICAN OPEN-BILLED STORK Anastomus lamelligerus	A,w,G	1	1	2		1		4			31	1	1
36	MARABOU STORK Leptoptilos crumeniferus	w	3		8	1	2	2	23	2		7	3	2
39	HADADA IBIS Bostrychia hagedash	w							3		3			
42	SACRED IBIS Threskiornis aethiopica	W	2	7	4			4	2			14	2	
50	EGYPTIAN GOOSE Alopochen aegyptiacus	W,G									2			
53	KNOB-BILLED DUCK Sarkidiornis melanotos	W												
76	AFRICAN FISH EAGLE Haliaeetus vocifer	W					1		1	1				
178	BLACK CRAKE Amaurornis flavirostris	W			2	4		1				4		
185	GREY CROWNED CRANE Balearica regulorum	R-NT,W,G							2	2				
193	AFRICAN JACANA Actophilornis africana	W	3	2	1	2						5		
197	BLACK-WINGED STILT Himantopus himantopus	p,W					7					15		
207	COLLARED PRATINCOLE Glareola pratincola	W									1			
211	COMMON RINGED PLOVER Charadrius hiaticula	P,W	1				45	17		62	85	54		
212	KITTLITZ'S SANDPLOVER Charadrius pecuarius	W		5			2	8	7	60	70	13		24
213	THREE-BANDED PLOVER Charadrius tricollaris	W		1										
216	WHITE-FRONTED SANDPLOVER Charadrius marginatus	W					8	6		3	3	13		
217	LESSER SANDPLOVER Charadrius mongolus	P,W						1				1		
220	GREY PLOVER Pluvialis squatarola	P,W												
223	SPUR-WINGED LAPWING Vanellus spinosus	w,G	4	3	5	3	2	7	4	5		6	3	7
229	LITTLE STINT Calidris minuta	P,W	1				17	26		66	60	132		
234	RUFF Philomachus pugnax	P,W												
236	COMMON SNIPE Gallinago gallinago	P,W												
246	COMMON GREENSHANK Tringa nebularia	P,W		3			14	2		2		15		
247	GREEN SANDPIPER Tringa ochropus	P,W										2		
248	WOOD SANDPIPER Tringa glareola	P,W	3	8		1	1	1		1	3	15		

No.	Species	Status												
249	TEREK SANDPIPER Xenus cinereus	P,W										1		
250	COMMON SANDPIPER Actitis hypoleucos	P,W	2	9		5	3	12		14	30	30		
257	LESSER BLACK-BACKED GULL Larus fuscus	P,W								1				
259	GULL-BILLED TERN Gelochelidon nilotica	P,W				2								
264	WHITE-WINGED TERN Chlidonias leucopterus	P,W	1				1					1		
265	AFRICAN SKIMMER Rynchops flavirostris	R-VU,R-RR,A ,												
326	BLUE-HEADED COUCAL Centropus monachus	w												
373	GREY-HEADED KINGFISHER Halcyon leucocephala	A,f,w			2	1							3	1
380	MALACHITE KINGFISHER Corythornis cristata	W	1		2	3	1	1		1		1		
383	PIED KINGFISHER Ceryle rudis	W	2	2	3	5		1	2	1		6	1	7
386	BLUE-BREASTED BEE-EATER Merops variegatus	w												
520	AFRICAN PIED WAGTAIL Motacilla aguimp	w											1	
625	EURASIAN REED WARBLER Acrocephalus scirpaceus	P,w	1	4										
628	GREAT REED WARBLER Acrocephalus arundinaceus	P,w	1											
630	GREATER SWAMP WARBLER Acrocephalus rufescens	W			2	1				1				
631	LESSER SWAMP WARBLER Acrocephalus gracilirostris	w	1											
648	CARRUTHERS' CISTICOLA Cisticola carruthersi	w												
720	SWAMP FLYCATCHER Muscicapa aquatica	W												
	NO.SPECIES		22	17	17	15	19	21	17	19	14	27	9	9
	NO.BIRDS		47	74	92	45	131	130	104	240	284	439	20	47

(1km)		Other		
Jetty - Terek Point		Lagoon Area	2km of Pad 3	Swamp below escarpment
RS/MK	RS/MK	RS/DP	DP	DP
1000	1645	1730[a]	1200[b]	1000[c]
23-May	30-Oct	26-Feb	26-Feb	26-Feb
12	2			
		5		
		15	1	
2	5		20	5
				3
		1		
	2			
	6	1		
			1	
	5	1		
1		6		1
	3	1	2	
4		7	6	2
			1	
		2		
	1			
			2	
1	1		2	
5	3		3	
	1			
	42			
41				
2				
	1			
4	4	3	4	
	24			
		1		
		2		
1	3			
				1
		3	1	2

	31	4		
	3			
	1			
			1	
	2			
2		1		
1	2	1		
2				
		1		
	5			
	1			
2				
13	21	17	12	6
78	147	55	44	14

ECOLOGICAL BASELINE REPORT FOR THE DRY AND WET SEASON SURVEYS IN THE KINGFISHER FIELD DEVELOPMENT AND PIPELINE ROUTE AREAS

A report prepared for China National Offshore Oil Corporation (CNOOC) Uganda Ltd.

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SECTION 1: ECOLOGICAL BASELINE OF VEGETATION AND FLORA FOR KINGFISHER FIELD DEVELOPMENT PROJECT

1. **General introduction and background**
1.1 Introduction

This report presents the findings of a baseline environment report meant to feed into and inform the Environmental Social Impact Assessment (ESIA) for a proposed construction of a Central Processing Facility (CPF) in Kingfisher oil prospecting blocks in western Uganda. The report is a result of desk-based studies and field work conducted in the project area. The first survey was made to the project area in Feb ending to early March 2014. This was a dry season. The second survey was made in May through June 2014 at only beginning of a wet season. The third survey was conducted in November 2014 which was a wet season. The results reported here are hence reflecting vegetation and flora of both dry and beginning of a wet season.

1.2   General survey area

The survey area lies in mid-western Uganda on the south-eastern shore end of Lake Albert. The area lies in Buhuka Parish, Kyangwali Sub-county, Hoima District, Western Uganda, within the Albertine Rift region, though outside any protected area. Climate of the area is equatorial with two wet seasons and a dry season. The area supports a range of habitats including open savanna grassland, wooded grassland, bushland, bushed grassland, thicket, woodland and wetlands (described in accordance with the most detailed and cited botanical classification by Langdale-Brown *et al*. 1964 on such a scale). These habitats are important for biodiversity conservation as they are habitats for a wide range of organisms and for providing essential ecosystem services. Such ecosystem services include stabilization of soils, especially along the fragile escarpment owing to its steep slope; control of flooding in the floodplains; carbon sequestration; nutrient cycling; acting as water catchment areas, thus influencing the hydrology of the area; and local climate moderation.

The baseline surveys were conducted to cover the area in which the Central Processing Facility (CPF) where the oil, gas and water in the well fluids will be separated, and the pipeline by which crude oil from the CPF will be pumped to Kabaale by pipeline.

1.3   Purpose of study

This study was aimed at setting out the dry and wet seasons of the year ecological baseline for the project area in order to provide a basis for assessment of the likely impacts of the proposed activities in the area. To this end this report will provide information about description of the general environmental baseline focusing on:
1. designated sites and protected areas
2. vegetation types and flora

3. conservation status of species – internationally and nationally important species and habitats
4. alien invasive species

2.   STUDY METHODS
2.1 INTRODUCTION

In this section, information is provided on the data sources used for the literature reviews of the baseline environment, as well as the methods used for the actual field surveys and any subsequent analysis required for the vegetation and flora.

The first baseline surveys were conducted during the dry season beginning 25th February till 8th March 2014. During this visit, an effort was made to become familiar with the project areas with the help of CNOOC staff, particularly the Community Liaison Officers (CLO). The plains and base of the escarpment were visited while based at the CNOOC camp in the valley. The pipeline route was scope-visited basing in Hoima. During these preliminary visits, the areas with natural vegetation were identified and waypoints recorded. The second baseline surveys were conducted in the earlier-to-mid part of the wet season, from 28th May through 16th June, whilethe third was conducted from 10th to 18th Nov 2014. During all the three campaigns, detailed surveys were conducted along transects in the flood plains, the escarpment and along the proposed pipeline route. In total of 13 transects with 150 plots were sampled for vegetation and flora in the Flats, 40 plots on 7 transects on the escarpment and 153 plots on 23 transects along the pipeline beyond the escarpment on the Plateau (Table 1.1, and Fig. 1.1). In all cases, the main vegetation types in the valley, escarpment and along the pipeline route were surveyed. Along the pipleline route, relic areas that were deemed natural or near-natural were selected for survey, as most of it was under cultivation and settlement. Fig. 1.1 shows placement of the transects and plots in the project area.

Table 1.1 Distribution of transects and plots surveyed during the three campaigns in the project area

Block	Number of transects	Number of plots
Flats	13	150
Escarpment	7	40
Plateau	23	153
TOTAL	**43**	**343**

Fig. 1.1 Location of survey plots in the Buhuka valley Flats (top), the Escarpment (second) and parts of the pipeline on the Plateau (third and fourth)

2.2 FLORA AND HABITAT SURVEYS

2.2.1 Existing Data Sources

A desk-based search was made of the literature available about the vegetation and flora of the project area from the rift valley, escarpment and beyond. Published literature relating to the baseline environment of the survey area was reviewed and compiled to provide a data source on the survey area. The data thus obtained was later ground thruthed during field surveys. The conservation status of the vegetation and flora were reviewed. The published IUCN (2014) Redlist and Kalema & Beentje (2012) were used for conservation status of species. This was intended to identify beforehand the unique, threatened, rare and other cases of conservation concern species and habitats known to occur in the area of the proposed pipeline and Central Processing Facility activities. The data sources used included Langdale-Brown *et al.* (1964), Plumptre *et al.* (2003, 2007), IUCN (2014).

The distribution of vegetation types identified during the desk based study complemented by Google Earth satellite imagery covering the same area were the basis for identification of tentative sample sites to cover the whole range and its habitat heterogeneity. These were later ground truthed by making a visit to sample areas with the Community Liaison Officer. In the process, the variation in habitat structure and composition by the dominant species of plants were noted, and the suitability of the tentative survey points evaluated.

2.2.2 Sampling techniques

The whole project area was conveniently divided into three main blocks, the Flats in the valley, the Escarpment and the areas beyond the escarpment, here referred to as the Plateau. A total of 343 plots along 43 transects were selected and sampled. These were chosen to provide representative coverage of the vegetation types identified within the project area during the desk based study and initial reconnaissance of the study area.

The greatest biological diversity in an area is associated with the maximum perceivable environmental gradients and therefore sampling along the steepest environmental gradient detects the maximum number of species in a given area (Wessels *et al.* 1998). Topographical sequences and changes in soil types are very important (Currie 1991). Accordingly, in each survey area, the main plant communities, which can be partly explained by topographical and soil variations, were identified. Sampling was then done along these gradsects (after Gillison and Brewer, 1985), taking into consideration the variation in such aspects as slope, observable indicators of soil moisture and soil type, as well as the plant community assemblages.

The gradsects were selected to represent the key Areas of Interest (AIO), viz: the Central Processing Facility (CPF), Construction Camp, Spoil Area, Well Pads, Contractors' Camp, Parking Lot, Existing Camp, Permanent Camp, Airstrip, Borrow Pit, Pipeline Route, as well as the

Refinery Area. At each sample site, the best observable gradsect was determined along which the plants were surveyed, traversing the main plant communities. All species of plants present were identified and recorded by slowly walking along the gradsect. The relative abundance of the plant species was assessed using the DAFOR scale where D=Dominant; A=Abundant; F=Frequent; O=Occasional; R=Rare, which is a quick though subjective method of assessing relative abundance (Kent & Coker 1992).

Azonal habitats believed to be unique within a given area were sampled. These included such areas as shallow depressions, old termite mounds, drainage channels, and others. This sampling regime was chosen with a view of capturing as wide a range of the vegetation types and species (Gillison & Brewer 1985, Økland 1990, Austin & Heylingers 1989 in Wessels *et al.* 1998, de Blois *et al.* 2002) in the area as possible.

The general vegetation type in each of the selected sites was characterized. This characterization was based on the floristic and landscape features observed in the different habitat types. Dominant species of plants in the woody and herbaceous layers were identified and used for this purpose. The general terrain and proximity to important features such as the lake or streams were noted. From this sampling, species of conservation concern and invasive species occurring in the area were identified and the geographical coordinates of their areas of occurrence recorded.

The plants that could not easily be identified in the field were collected as vouchers for subsequent identification and deposition in the Makerere University Herbarium (MHU). Geographical coordinates and altitude were recorded at every point of change in the vegetation communities.

2.2.3   Analysis of findings

The relative abundance of the species at each survey site was estimated using the DAFOR scale (see Kent & Coker 1992). In order to estimate the relative abundance of a species over the total area surveyed, a species was assigned a score of 5 for D, 4 for A, 3 for F, 2 for O and 1 for R in each of the surveyed sites where it occurred. In order to estimate the mean relative abundance of the species, these scores were summed up across all the sample points where the species occurred and the total divided by the total number of sample plots surveyed.

2.2.4 Limitations

The second visit was made at a time when the vegetation had not satisfactorily recovered from the previous dry spell. The surveys were separated by only about two months. The herbaceous vegetation was still far from reaching flowering stage. Consequently, a number plant species in the field layer, especially grasses, which are a key constituent element of the vegetation in the area, could not be confidently determined in the field, or even in the herbarium. An attempt was made to make good of this constraint by conducting a third survey campaign. This was a truly wet season, and it was possible to determine many of the herbaceous species of plants.

In a few cases, access limited the areas that could be sampled. The escarpment area was extremely steep in many places and it was not practical to access some of the very natural habitats. However effort was made to survey some areas along the escarpment as may be seen in Fig. 1.1.

3. BASELINE FINDINGS

The findings presented in this report are reflecting the study conducted during all the three planned surveys. This was during the end of the dry season, the earlier part of the wet season and mid of a later wet season of the year. The findings and conclusions presented here are hence providing a holistic picture of the range of vegetation and flora attributes in the project area, from the whole span of seasonal variations in the year.

3.1 DESK REVIEWS

Langdale-Brown *et al*. (1964) identified the following vegetation categories in the area:

a) Dry *Hyparrhenia* Grass Savanna/Undifferentiated deciduous Thicket (Q3/V1) in the valley
b) *Themeda-Chloris* Grass Savanna (Q4) in the valley
c) Dry *Combretum-Hyparrhenia* Savanna (N2) on the escarpment
d) Moist *Combretum-Terminalia-Albizia-Hyparrhenia rufa* Savanna/Medium Altitude Forest/Savanna Mosaic (K/F2) beyond the escarpment along the pipeline
e) Moist *Combretum-Terminalia-Albizia-Hyparrhenia rufa* Savanna (K) beyond the escarpment along the pipeline
f) *Cynometra-Celtis* Medium Altitude Moist Semi-deciduous Forest (D2) beyond the escarpment along the pipeline

In 2009, Plumptre *et al*. identified a total of 167 plant species in the adjacent Kabwoya Wildlife Reserve, which is in the same ecosystem landscape as the flats of this project area. They also report some human activities with impact on the vegetation and flora of the area that include grazing by cattle and charcoal burning. The National Biomass study of 2002 reports Grassland and Subsistence cultivation as common land uses in the area (Forest Department 2002).

The Bugoma Central Forest Reserve was identified by NEMA (2009) as one of the areas in the Albertine Rift area that are species rich. Plumptre *et al*. (2007) found the Murchison Falls National Park – Budongo–Bugoma–Kagombe–Itwara Forest Reserves – Semliki/Toro Wildlife Reserve corridor as important for biodiversity as a whole.

Kalema & Beentje (2012) provide information about broad distribution of tree species in Uganda and beyond. This, together with the IUCN redlists, were used to identify species that are threatened and those of restricted range. Kalema (2005) compiled a list of species of plants known from Semliki Wildlife Reserve. Although a number of species have not been recorded from the project area, these are mainly not of conservation concern.

3.2 HABITATS/VEGETATION TYPES

The following broad vegetation types were identified:

i) Wooded Grassland with *Acacia sieberiana*
ii) Woodland

iii)   Thicket-Grassland mosaic with *Azima, Euphorbia, Acacia*
iv)   Open Grassland with *Cynodon, Sporobolus*
v)   Bushed Grassland
vi)   Bushland and Shrubland of *Acacia, Acalypha*
vii)   Wetland of *Phragmites, Typha, Cyperus* and seasonally flooded grassland (floodplains) of *Sporobolus pyramidalis, Cynodon dactylon*

The various vegetation types are discussed further below and a map showing their distribution in the project area is provided in Appendix I.

3.2.1 Wooded Grassland

These are habitats with a dominance of grasses in the herbaceous layer, and a canopy cover of woody plants often 10-50% (Langdale-Brown *et al*. 1964). *Hyparrhenia rufa* and *Sporobolus pyramidalis* were the dominant grasses. In the area surveyed, these communities were mainly on the escarpment and beyond (Fig. 1.2), but very limited in the rift valley. In the areas beyond the escarpment, many had been modified owing to cultivation. The most abundant woody plant species in Wooded Grassland were: *Rhus natalensis*, *Combretum collinum*, *Acacia hockii* and *Annona senegalensis*, while *Hyparrhenia rufa* and *Sporobolus pyramidalis* were the most abundant non-woody species.

Fig. 1.2 Wooded Grassland communities in the surveyed area with frequent burning (top)

Woodland

These are vegetation communities where the tree crowns form a canopy which remains open (never interlocking) to allow growth of herbaceous vegetation, and lacks the multi-layered structure (Langdale-Brown *et al*. 1964). In the area surveyed, these were mainly riverine,

occurring along the main seasonal water courses (Fig. 1.3), hence of limited distribution. Most were *Acacia* dominated woodlands and some were mixed with *Crateva* sp. and *Acalypha* sp., occurring mainly along the pipeline route.   The most abundant plant species in Woodlands were *Tamarindus indica*, *Rhus natalensis* and *Acacia sieberiana,* with the understorey of *Grewia trichocarpa* and *Azima tetracantha. Hypoestes forskaolii*, *Panicum deustum* and *Sporobolus pyramidalis* were common herb layer species.

Fig. 1.3 Woodland with *Ficus* spp. and *Phoenix reclinata* along a water course (top left and right), *Combretum* woodland (middle left and right), and *Acacia* woodland (bottom)

Thicket-Grassland Mosaic

Thickets are communities with mainly armed, much branching species of woody plants, either forming dense clumps or continuous shrubby and tree tangles sometimes approaching 100% cover (Langdale-Brown *et al*. 1964). The drier deciduous ones in the project area, especially in the rift valley flats, are usually 2-4 m high. In the project area, they are commonly interspersed with grassland, forming a mosaic (Fig. 1.4). The most abundant plant species in Thicket-Grassland mosaics were *Acacia brevispica*, *Acalypha fruticosa*, *Azima tetracantha*, *Euphorbia candelabrum*, *Cadaba farinosa* and *Dichrostachys cinerea.* Succulent *Sansevieria* spp. are a common occurrence under the shade conditions of the tangle while *Sporobolus pyramidalis*, *Cynodon dactylon*, *Aloe* sp. and *Cissus oliveri* were common species in the herb layer. In the valley, there are vast areas of bare ground due to heavy grazing by livestock (Fig. 1.4). This kind of vegetation type is of limited distribution in the project area beyond the escarpment, occurring mainly in the flat valley (Fig. 1.4).

Fig. 1.4 Thicket communities interspersed with grassland in the valley flats with very short overgrazed grass and bare patches of ground

Open Grassland

These are vegetation communities with a high coverage of the grass layer by far dominating the woody layer. Woody plant cover in these communities is very low (often <5%, Langdale-Brown *et al*. 1964), with only sparse occurrence of trees and shrubs (Fig. 1.5). The most abundant non-woody plant species in the project area were *Sporobolus pyramidalis*, *Pennisetum purpureum*,

Imperata cylindrica, *Cynodon dactylon* and *Panicum maximum*. Grazing is by far the most evident factor affecting the structure of the community, keeping it at very low stature (Fig. 1.5). The woody species included *Acacia polyacantha* subsp. *campylacantha*, *Vernonia amygdalina*. Often, these grasslands supported some thicket communities. This vegetation type occurred mainly in the valley areas, being very limited beyond the escarpment.

Fig. 1.5 Open grassland communities heavily grazed in the valley flats

Bushed Grassland

These are vegetation communities of grassland with woody species (short shrubs) that do not form thicket but form scattered stands, thus allowing grass species to grow between them. The most abundant plant species in Bushed Grassland were *Combretum collinum*, *Sporobolus*

pyramidalis, *Imperata cylindrica*, *Albizia grandibracteata* and *Vernonia amygdalina* (Fig. 1.6). This kind of vegetation was mainly in the flat valley parts of the project area.

Fig. 1.6 Burnt bushed grassland beyond the escarpment (top left) and lightly Bushed Grassland (top right and bottom)

Bushland and *Shrubland*

Bushland communities are woody species dominated, with small trees and shrubs about 6 m high. These were mainly on the escarpment and beyond, but limited in the valley flats. The most abundant woody plant species were *Vernonia amygdalina*, *Acacia polyacantha* subsp. *campylacantha*, *Erythrina abyssinica*, *Acanthus polystachius* and *Albizia grandibracteata*. The herb layer was dominated by *Pennisetum purpureum*, *Imperata cylindrica*, *Cissampelos mucronata* and *Ipomoea cairica*. Shrublands are short with mainly shrubs and to about 4 m high. In the project area, Bushlands were mainly in ravines on the escarpment and some places beyond the escarpment. At the base of the escarpment were dense, near-pure *Acalypha fruticosa* shrubland forming dense tangles, difficult to penetrate in many places and with bare ground underneath (Fig. 1.7).

Fig. 1.7 *Acalypha fruticosa* common at the base of the escarpment and riverine Bushland in gorge on escarpment

Wetlands

These are vegetation communities of either permanent of seasonal water logging (Ramsar Convention Secretariat 2013, Government of Uganda 1995) with vegetation adapted to this water presence regime. In the project area, the most extensive wetland communities were in the valley flats, particularly along the shores of Lake Albert (Fig. 1.8). Occasionally, some ravines on the escarpment carried water even in the dry spell, feeding into wetlands of grassy nature dominated by *Cyperus articulatus* and sparse *Typha* sp.. One such semi-permanent wetland ecosystem runs from the base of the escarpment near 36 N 0250944 0138270 past the air strip before joining the permanent wetlands on the lake shore. The permanent ones were mainly composed of *Cyperus papyrus*, *Phragmites mauritianum* and *Typha capensis*. Other abundant species were *Leersia hexandra*, *Cyperus articulatus*, *Cayratia ibuensis*, *Cyperus dives*, and *Echinochloa pyramidalis*. *Cynodon dactylon* and *Sporobolus pyramidalis* were more common in the seasonally flooded grassland areas. The Buhuka flats are covered by extensive grasslands that get flooded during the wet seasons of the year. These are wetlands by the Ramsar Convention Secretariat definition (2013) and that of Uganda's wetland policy (Government of Uganda 1995).

Fig. 1.8 Wetland communities in the valley

Modified Habitats

Most areas along the pipleline have been modified from their original natural habitat mainly to cultivation. It is only localized and patchy parts that may be found with relics of natural

vegetation. These have been variably converted or modified from a range of vegetation types including Woodland, Bushland, Wooded Grassland, Wetland and others (Fig. 1.9).

Fig. 1.9 Modified environments within the project area

2.2 FLORA
3.2.1 Species abundance

Overall, the most abundant plant species, in terms of percentage cover, were *Sporobolus pyramidalis*, *Acalypha fruticosa*, *Cynodon dactylon Panicum maximum*, *Vernonia amygdalina* and *Rhus natalensis* in that order. The most frequent species were: *Sporobolus pyramidalis, Panicum maximum, Cynodon dactylon, , Flueggea virosa, Acalypha fruticosa*, and *Hoslundia opposita* in that order. The most common plant species in each of the main vegetation types are indicated in Table 1.2. *Sporobolus pyramidalis* and *Cynodon dactylon* are unpalatable to livestock, thus standing the grazing pressure to which many other graminoid and forb species are subjected. *Acalypha futicosa* (Fig. 1.7) and *Flueggea virosa* are also adaptable to browsing and other disturbances.

In the valley flats with floodplain, the most abundant species were *Cynodon dactylon, Sporobolus pyramidalis, Acalypha fruticosa, Phragmites kirkii, Capparis erythrocarpos, Senna* sp*., Asparagus africanus, Cissus oliveri, Typha capensis, Cyperus articulatus* and *Dichrostachys cinerea.* Here, there are a number of species that can stand seasonal flooding regimes, such as *Cynodon dactylon*, *Cyperus articulatus*, and *Sporobolus pyramidalis*.

On the escarpment, where the soil conditions are most marginal and fragile in the project area, the most abundant species were *Acalypha fruticosa, Rhus natalensis, Hypoestes forskaolii, Terminalia brownii, Acacia brevispica, Cissus oliveri, Sporobolus pyramidalis* and *Enteropogon macrostachyus.*

Beyond the escarpment, on the Plateau, soil conditions, including drainage, are better, with only localized areas of water logging. There is however a strong element of human influences attracted to the better arable farming soils. Here, *Pennisetum purpureum, Acacia polyacantha, Imperata cylindrica, Vernonia amygdalina, Panicum maximum, Combretum collinum, Acanthus polystachius* were the most abundant species.

3.2.2 Species richness

Overall, a total of 96 families and 635 species were registered in the surveyed project area. This includes 111 species that were recorded in areas disturbed with cultivation beyond the escarpment towards the refinery site along the pipeline. The cultivated areas were however excluded from any further analysis owing to their rapid change even within a given season of the year. The whole list of species is provided in Appendix II. The highest number of species was registered in Bushland, followed by Woodland and Wetland (Table 1.2). But these are vegetation types that were also accorded the highest sampling effort (Table 1.2). Naturally, they would be expected to yield more species. The species poorest vegetation type was Grassland with Thicket, and Bushed Grassland, both of which had the lowest number of sampling plots, 22 and 17 respectively, owing to their representation in the entire landscape. However, analysis of the mean number of species richness per plot provides a different picture. The highest species richness per plot was in sites with Bushed Grassland, followed by Wooded Grassland and Woodland in that order, while the lowest was Wetland. The general observation from these findings is that the more wooded vegetation types registered the highest species richness per sampling unit. Accordingly, the least wooded communities of Wetland and Grassland had the lowest species richness per sampling unit.

Table 1.2 Species richness, frequency and dominance by vegetation type

Vegetation Type	No. of plots surveyed	Species richness	Mean number of species per plot	Most frequent species	Most dominant species
Wetlands	73	316	4.33	i) *Cynodon dactylon* ii) *Sporobolus pyramidalis* iii) *Leersia hexandra* iv) *Cyperus articulatus* v) *Cyperus dives* vi) *Typha capensis* vii *Commelina beghalensis* viii) *Eclipta alba*	i) *Cynodon dactylon* ii) *Leersia hexandra* iii) *Sporobolus pyramidalis* iv) *Typha capensis* v) *Cyperus articulatus* vi) *Cyperus dives* vii) *Echinochloa pyramidalis* viii) *Phragmites mauritianum*
Bushed Grassland	17	229	13.47	i) *Sporobolus pyramidalis* ii) *Solanum incanum* iii) *Asparagus flagellaris* iv) *Panicum maximum* v) *Stereospermum kunthianum* vi) *Acalypha fruticosa* vii) *Lantana camara* viii) *Rhus natalensis*	i) *Sporobolus pyramidalis* ii) *Acalypha fruticosa* iii) *Panicum maximum* iv) *Euphorbia candelabrum* v) *Lantana camara* vi) *Acacia brevispica* vii) *Combretum collinum* viii) *Solanum incanum*
Bushland	74	463	6.26	i) *Panicum maximum* ii) *Acalypha*	i) *Acalypha fruticosa* ii) *Panicum maximum* iii) *Acacia brevispica*

Vegetation Type	No. of plots surveyed	Species richness	Mean number of species per plot	Most frequent species	Most dominant species
				fruticosa iii)*Sporobolus pyramidalis* iv)*Achyranthes aspera* v)*Vernonia amygdalina* vi) *Flueggea virosa* vii)*Albizia grandibracteata* viii)*Acalypha bipartita*	iv) *Albizia grandibracteata* v) *Sporobolus pyramidalis* vi) *Vernonia amygdalina* vii) *Flueggea virosa* viii) *Acalypha bipartita*
Grassland with Thicket	22	132	6.00	i)*Sporobolus pyramidalis* ii)*Acalypha fruticosa* iii) *Cadaba farinosa* iv)*Euphorbia candelabrum* v)*Azima tetracantha* vi) *Aloe* sp. vii)*Acacia brevispica* viii)*Cynodon dactylon*	i) *Sporobolus pyramidalis* ii) *Acalypha fruticosa* iii) *Euphorbia candelabrum* iv) *Azima tetracantha* v) *Acacia brevispica* vi) *Aloe* sp. vii) *Cynodon dactylon* viii) *Cadaba farinosa*
Open Grassland	45	273	6.07	i) *Sporobolus pyramidalis* ii) *Cynodon dactylon* iii) *Pennisetum purpureum* iv) *Acalypha fruticosa* v) *Chloris*	i) *Sporobolus pyramidalis* ii) *Cynodon dactylon* iii) *Pennisetum purpureum* iv) *Acalypha fruticosa* v) *Panicum maximum* vi) *Acacia polyacantha* vii) *Imperata cylindrica*

Vegetation Type	No. of plots surveyed	Species richness	Mean number of species per plot	Most frequent species	Most dominant species
				gayana vi) *Setaria sphacelata* vii) *Senna* sp. viii) *Panicum maximum*	viii) *Vernonia amygdalina*
Woodland	51	328	6.43	i) *Acalypha bipartita* ii) *Hoslundia opposita* iii) *Flueggea virosa* iv) *Cyphostemma adenocaule* v) *Grewia mollis* vi) *Rhus natalensis* vi) *Panicum maximum* viii) *Vernonia amygdalina*	i) *Albizia grandibracteata* ii) *Acalypha bipartita* iii) *Grewia mollis* iv) *Flueggea virosa* v) *Acacia polyacantha* vi) *Rhus natalensis* vii) *Combretum molle* viii) *Terminalia brownii* ix) *Panicum maximum*
Wooded Grassland	38	287	7.55	i) *Acacia hockii* ii) *Rhus natalensis* iii) *Hoslundia opposita* iv) *Combretum collinum* v) *Flueggea virosa* vi) *Panicum maximum* vii *Maytenus senegalensis*	i) *Rhus natalensis* ii) *Acacia hockii* iii) *Combretum collinum* iv) *Acacia polyacantha* v) *Panicum maximum* vi) *Maytenus senegalensis* vii) *Sporobolus pyramidalis* viii) *Terminalia brownii*

Vegetation Type	No. of plots surveyed	Species richness	Mean number of species per plot	Most frequent species	Most dominant species
				viii)*Solanum incanum*	

3.2.3 Life forms

Most species were herbs, trees, or shrubs (Fig. 1.10). Climbers were least frequent. The woody species altogether contributed 38.6% by species richness as compared to 61.4% of the non-woody species. In the valley flats with floodplains, the commonest were herbs and shrubs (Fig. 1.11). In the escarpment, the commonest were shrubs (Fig. 1.12) while in areas beyond the escarpment the herbs and trees were the commonest (Fig. 1.13). Woody climbers were the least common in all parts of the project area.
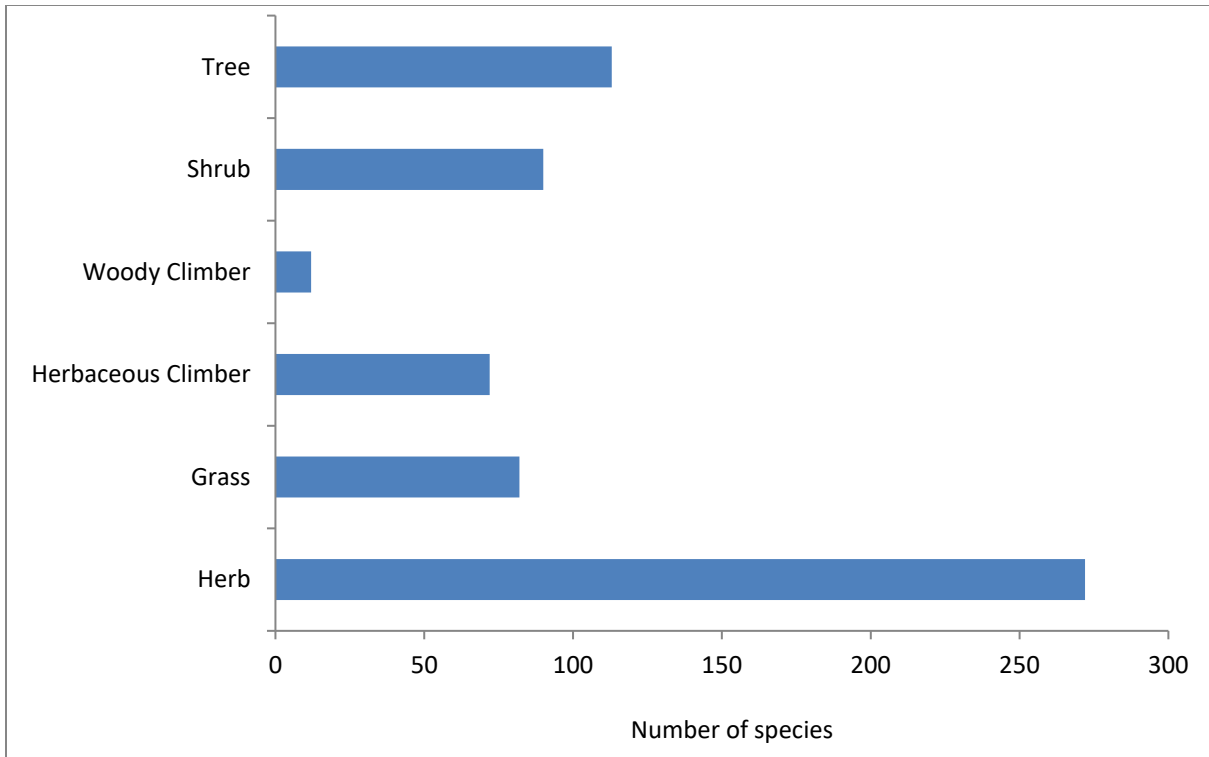
Fig. 1.10 Overall distribution of life forms in all the survey areas
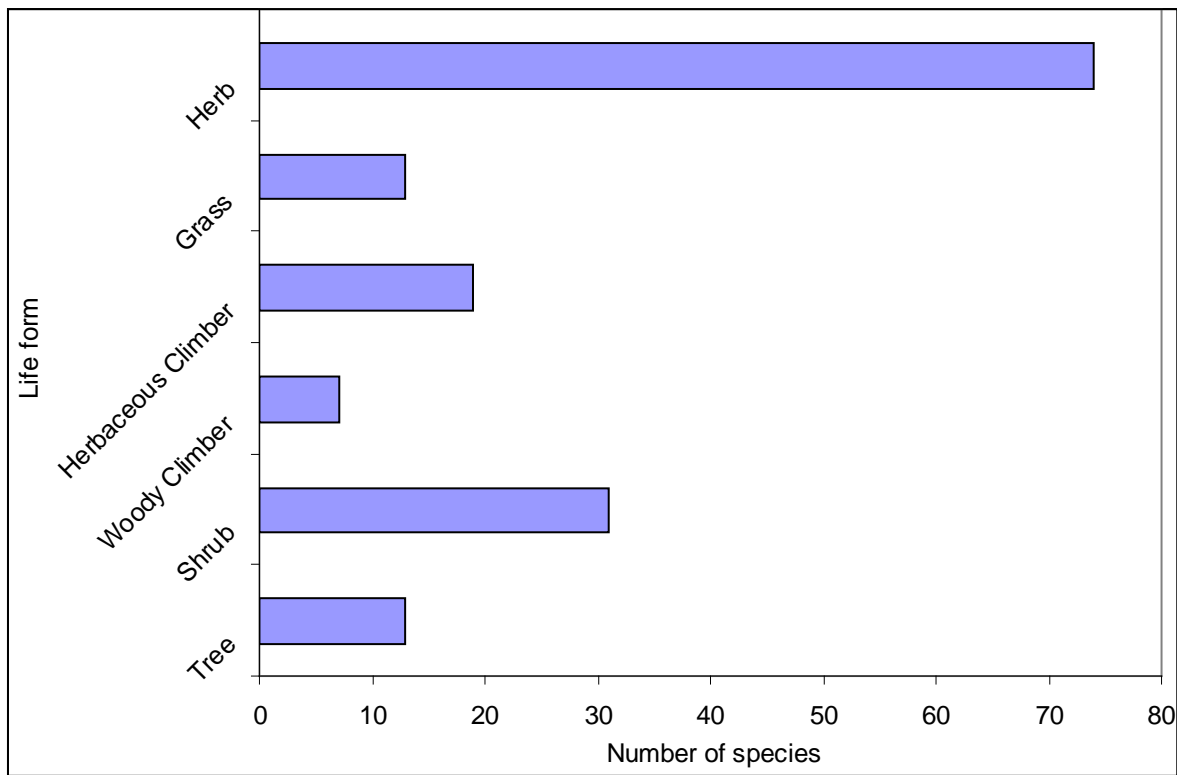
Fig. 1.11 Distribution of life forms in the valley flats
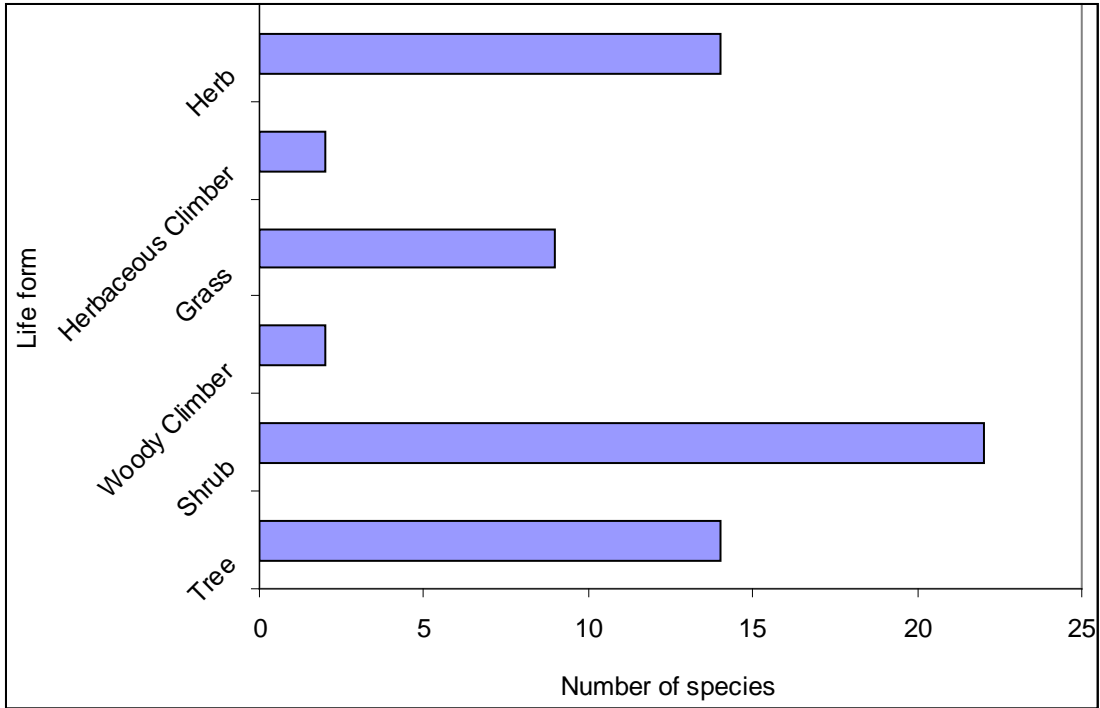
Fig. 1.12 Distribution of life forms on the escarpment

Fig. 1.13 Distribution of life forms beyond escarpment

3.2.4 Relative abundance and frequency

The DAFOR scale used was transformed to estimate the relative abundance of the species as explained in the methods in *Section 2.2.3*. This method gives a general picture about the relative abundance of the species. Accordingly, *Sporobolus pyramidalis* registered the highest relative abundance across all survey areas and all communities together followed by *Cynodon dactylon* and *Pennisetum purpureum*. A total of 94 species were quite uncommon in the survey sites, recorded from only one site and in each of the sites rated Rare (R) on the DAFOR scale. These include *Cordia africana*, *Cordia millennii*, *Cynometra alexandrii*, *Pterygota mildbraedii*, *Markhamia lutea*, all of which are good timber tree species, hence are under pressure from logging. None of these species is Red listed under IUCN. They are known from a number of localities in Bunyoro, Masaka, Mengo, Toro and Madi, and are widespread in Africa (Kalema & Beentje 2012). However, *Cordia millenii* is listed under Uganda's National Forestry Authority Reserved Species. It is therefore flagged for protection in Uganda owing to excessive felling for its high grade timber.

3.2.5 Species of conservation concern

Only very few species of conservation concern in terms of threat, endemism or rarity were registered in this study. These were mapped as shown in Appendix III.

Milicia excelsa is globally threatened, assessed as Lower Risk/near threatened ver 2.3 (IUCN 2013). It was recorded at 36N 282935 158810 in fallows; 36N 284458 158695 and 36N 284101 158935 in Bushland; and 36N 274062 151960 in Wooded Grassland. It is on Uganda's list of 'Reserved Tree Species' because it continues to be felled for its high quality timber, reducing its area of occupancy and its habitat quality. In Uganda, it is known to occur in the regons of Bunyoro, Mengo, Masaka, Mubende, Toro, West Nile, Madi, Acholi, Lango, Teso, Mbale and Busoga, and is widespread in Africa (Kalema & Beentje 2012). It is logged commercially throughout its range, and used for firewood, charcoal, timber, used especially for quality indoor and outdoor furniture. It is on Uganda's list of 'Reserved Tree Species'.

Cordia millenii at 36N 264541 140176 in cultivated land, is also globally threatened and assessed as Lower Risk/least concern ver 2.3 (IUCN 2013). Kalema & Beentje (2012) report that this and *Milicia excelsa* (Mvule Tree) are some of the tree species specifically targeted for exploitation especially for the supply of timber in Uganda although both are widespread in Africa.

Euphorbia candelabrum, a succulent species, is CITES listed under Appendix II. It was recorded from Thicket habitats in the Rift Valley at 36N 248648 135896, 36N248720 136012, 36N 248788 136204, 36N 248808 136402, 36N 248874 136601 and 36N 248999 136989.

Aloe sp. All *Aloe* species are listed under Appendix II of CITES (http://www.cites.org/eng/app/appendices.php accessed April 2014). It was growing in nearly all Thicket-Grassland mosaic vegetation communities.

Tamarindus indica is not threatened in the IUCN sense, but of conservation concern in Uganda and is on the Uganda Reserved Tree Species List of NFA owing to its heavy exploitation. It was fairly common on the Escarpment in Woodland and Wooded Grassland e.g. at 36N 250537 138345 and 36N 250501 137322. It is commercially use for food in many parts of northern Uganda and Teso (Katende *et al*. 1995).

3.2.6 Invasive species

The following five plant species were recorded in the first part of the survey. They are invasive aliens in Uganda, with a potential to spread further in the project area with disturbance (Cronk & Fuller 1995) even though they are still generally uncommon in the survey area. They are mainly concentrated in the valley on the Buhuka Flats (Table 1.3) and have been mapped as shown in Appendix IV. *Mimosa pigra* and *Lantana camara* are the commonest invasive alien species in the project area this far. They have been so far recorded from the highest number of plots and habitat type (Table 1.3). These two species are also some of the most notorious invasive alien species in the world (Lowe *et al*. 2000). *Eichhornia crassipes* (Water Hyacinth) is also one of the leading notorious 100 invasive alien species but this is still restricted in the project area to the shore environments around the Lake Albert.

i)   *Mimosa pigra* - recorded from Bushland, Wetland and Woodland habitats in varying
ii) *Pistia stratiotes* – in Wetland near Lake Albert at 36N 247864 137632 where it was locally Abundant
iii) *Eichhornia crassipes* - recorded from Wetland
iv) *Ricinus communis* – recorded from wetland and Woodland
v)   *Lantana camara* – recorded from Bushland, Wooded Grassland, Bushed Grassland and Moist Bushland

Mimosa pigra L. (Fabaceae) - (Bashful plant) - is an erect, much branched prickly shrub reaching a height of 3 to 6 m (Fig. 1.13). It reproduces via buoyant seed pods that can be spread long distances in flood waters. It can spread through natural grassland floodplain ecosystems and pastures, converting them into unproductive scrubland, reducing biodiversity. It grows in open, moist sites such as floodplains and river banks. In the project area, it is at worrisome levels as it has the potential to increase its abundance rapidly.

The management issues associated with the species include:
- The weed suppresses abundance of birds, reptiles, and plants
- It can reduce the area of grazing land and the carrying capacity of the land. Furthermore, if livestock are reliant on natural water sources for drinking, their access to water may be blocked.

It may reduce water flow and increase silt levels, as it commonly colonizes watercourse edges. This may threaten the sustainability of reservoirs and canals and any livelihoods reliant on them.

Recommended control:
The best recommended control measure is physical uprooting of the shrubs, especially before flowering and/or fruiting stage.

Pistia stratiotes L. (Araceae) - Water Lettuce - is evident in the project area. It is observable on the fringes of the *Phragmites-Typha* swamps along the Lake Albert (Fig. 1.14). It is a common floating perennial weed of waterways also known as Nile cabbage, Water cabbage or Water lettuce. It inhibits slow moving water such as ponds, lakes, swamps, or irrigation canals. Its origin is disputable, between North America and Africa, but has spread to many parts of the world, especially tropical regions. It can propagate both vegetatively and sexually (Ramey 2001) and can hence grow and cover large areas pretty fast.

Some of the impacts it may cause include:
i. Dense mats of the species can block gas exchange at the air-water interface, reducing the dissolved oxygen content in the water and killing aquatic life
ii. They also block light, killing native submerged plants, thus altering immersed plant communities (Ramey 2001)
iii. Massive coverage of water can block navigation
iv. Mosquitoes lay their eggs under the leaves, thus it can promote malaria incidence

Recommended control:
i. Mechanical harvesting e.g. raking - removing the water lettuce from the water - and transporting it to disposal areas on shore
ii. Sensitization of workers and communities to minimize its inadvertent or deliberate spread

Eichhornia crassipes (Water Hyacinth) (Fig. 1.15) was recorded at only low levels of abundance. It is an aquatic invasive species, capable of forming mats on the shoreline. *Ricinus communis* L. (Euphorbiaceae) (Castor Oil Plant) is a small tree or shrub indigenous to the southeastern Mediterranean Basin, Eastern Africa, and India (Rana *et al*. 2012). It is widespread throughout tropical regions (and widely grown elsewhere as an ornamental plant. The seed contains ricin, a toxin, which is also present in lower concentrations throughout the plant. In the project area, this species is still in low abundance (Fig. 1.16). This is easier to control by physical removal before flowering and fruiting stage.

Lantana camara L. (Verbenaceae) (Fig. 1.17) is a native shrub of tropical America, now introduced in many parts of the world, where it is invasive (Cronk & Fuller 1995, Binggeli 1998, Weber 2003, Walton 2006). The main dispersers are birds that eat the berries (Aravind *et al*. 2010). Some varieties of the species are cultivated as ornamentals (Floridata 2007). The leaves contain toxins that affect grazing animals such as goats and cattle (Barceloux 2008). Extracts of the fresh leaves have been found to have antibacterial properties and are traditionally used in Brazil in the treatment of respiratory system infections (Barreto *et al*. 2010). Places within which the shrub has so far been recorded are indicated in Table 1.3.

The main concerns about this species include:
- It can become a dominant understorey shrub by suppressing native shrubs; the dense thickets can even transform woodland into shrubland
- Its allelopathic (poisoning of the soil in its vicinity) qualities can affect the growth of nearby plants. It can therefore stall natural regeneration and poses a serious threat to native threatened plant species
- It can invade a wide range of environments. Its prolific all-year flowering and seed production allows rapid dispersal, and the seeds are spread fairly long distances by birds
- It can replace native pastures, threatening the habitat of local grazing fauna
- Its toxic leaves can cause many cases of cattle and sheep poisoning particularly young animals. Unripe berries are poisonous to humans and can cause death
- The dense thorny thickets can deter human access
- The capacity of the soil absorb water in dense stands of the shrub is reduced, increasing run-off and therefore soil erosion
- Thickets can be a breeding ground for malaria mosquitoes and tsetse flies

Recommended control:

> Physical removal or burning can be effective, provided that desirable trees are introduced to shade out re-growing *L. camara* plants. This may be difficult when the plant covers extensive areas (Kalema 2012).

Of much lower abundance was *Parkinsonia aculeata* L. (Fabaceae) (Fig. 1.19). This was only recorded from the Open Grassland areas near the lake shore in the floodplain in the Buhuka valley.

Table 1.3 Invasive alien plant species' location and abundance in the project area

Family	Species	Life form	Habitat	Location	Coordinates	Abundance (DAFOR)
Fabaceae	*Mimosa pigra*	Shrub	Bushland	Floodplain	36N 248660 135696	Occasional
			Wetland	Floodplain	36N 247816 135306 and 36N 248166 135504	Occasional
				Floodplain	36N 248350 135582 and 36N 248697 135789	Dominant
				Floodplain	36N 248531 135673	Frequent
			Woodland	Floodplain	36N 249463 135944	Occasional
Araceae	*Pistia stratiotes*	Herb	Wetland	Floodplain	36N 247864 137632	Abundant
Pontederiaceae	*Eichhornia crassipes*	Herb	Wetland	Floodplain	36N 247456 136122	Rare
					36N 247897 137420 and 36N 246645 135057	Occasional
					36N 247864 137632	Frequent

Family	Species	Life form	Habitat	Location	Coordinates	Abundance (DAFOR)
Euphorbiaceae	*Ricinus communis*	Shrub	Wetland	Floodplain	36N 247864 137632	Frequent
			Woodland	Escarpment	36N 250425 137187	Occasional
Verbenaceae	*Lantana camara*	Shrub	Bushland	Beyond Escarpment	36N 274099 151564	Occasional
					36N 255066 137991	Rare
			Wooded Grassland		36N 274096 151763, 36N 273894 153547 and 36N 274062 151960	Frequent
					36N 274020 152155 and 36N 273918 152540	Occasional
			Bushed Grassland		36N 273993 152352	Frequent

Fig. 1.13 Invasive *Mimosa pigra* forming dense tangles

Fig. 1.14 *Pisitia stratiotes* in *Phragmites-Typha* wetland on the shores of Lake Albert

Fig. 1.15. *Eichhornia crassipes* in *Phragmites-Typha* wetland on the shores of Lake Albert

Fig. 1.16. Invasive *Ricinus communis* recorded from escarpment and near some wetlands

Fig. 1.17 *Lantana camara* forming dense tangle

Fig. 1.18 *Parkinsonia aculeata* in the floodplain near the lake shore

3.2.7 Ecologically sensitive sites

The most ecologically critical habitats identified to-date are:

i) Wetlands, both permanent and seasonal, whose hydrology may be adversely affected, consequently affecting the flora that is habitat-specific, e.g. species of *Typha*, *Cyperus articulatus, Phragmites mauritianum* and in turn the fauna dependent of them. Construction of the central processing facility and the pipeline are likely to affect the groundwater flow on which the wetlands are dependent, thus affecting their ecological integrity or even causing their loss.

ii) Bushland and Wooded Grassland at the escarpment, the former mainly along ravines. The topography here is quite steep, making these habitats susceptible to soil erosion, or even landslides arising from any activity that may cause vegetation removal, destabilizing the fragile soils.

iii) Cultivation-modified habitats along the proposed pipeline route. These have relics of wetland in valley bottoms, Wooded Grassland, Bushland and Woodland in places. The area beyond the escarpment towards Hoima is much settled and cultivated, already suffering heavy degradation. The relics of natural or less disturbed patches of vegetation in places are instrumental as they are the last bits of refugium for biodiversity in these totally unprotected areas. A number of them are fragmented from one another, but there is some connectivity across some through rivers and seasonal streams. The forests are the most fragmented, having been cut down for cultivation (Fig. 1.19)

Fig. 1.19 Destroyed forest near Bugoma Central Forest Reserve

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APPENDIX I: Vegetation map of the project area

APPENDIX II: Checklist of plant species in the project area

APPENDIX III: Map of plant species of conservation concern

APPENDIX IV: Map of invasive plant species in the project area

APPENDIX C
Aquatic Ecology Baseline Study

Contents

Wet season aquatic biodiversity surveys of the Kingfisher Discovery Area, Lake Albert

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1. Introduction

The Kingfisher oil discovery field to be developed by CNOOC encompasses the Buhuka Flats of Buhuka parish at the eastern shores of Lake Albert in Kyangwali sub County, Hoima District. CNOOC would establish a Central Processing Facility (CPF) at the Buhuka Flats to develop the Kingfisher oil field. Crude oil and gas would then be transferred via pipeline to the oil refinery to be built at Kabale in Hoima District. As part of the mandatory Environmental and Social Impact Assessment (ESIA) required by the National Environment Management Authority (NEMA), CNOOC commissioned seasonal aquatic biodiversity surveys of surface waters targeting the main dry and rainy seasons, and the shorter dry season of 2014. It is expected that the baseline data assembled would be used to identify potentially vulnerable nearshore and other surface water habitats/resources likely to be critical to enhancing aquatic biodiversity conservation and fishery biology processes (breeding, nursery, feeding, sheltering) and hence to artisanal fisheries; at the Kingfisher Flats in particular and Lake Albert in general.

1.1 Desktop literature review

A compilation of baseline ecological studies and environmental and social impact assessment studies provided by the Client were reviewed plus other relevant literature. The studies were mainly those undertaken at Kingfisher Flats prior to various works including seismic survey, construction of jetty, road and airport; and experimental drilling for oil and gas (see Dry season Report). The literature review noted insuffient focus on specific ecological details on aquatic biodiversity of surface waters of the Kingfisher Flats. For example the ESIA for Kingfisher well No 3 fisheries assessment is generalized for the entire Lake Albert giving a list of commercially important fish species. The ESIA for Kingfisher well No 2 provides clear pictorial illustration of the surface waters of the Kingfisher

Flats including stream beds running down the escarpment, wetland storm channels, the Lagoon and the fringing waters of Lake Albert but experimental acquisition and analysis of sufficient aquatic biodiversity data was difficult to discern from the literature provided. In view of the above, identification of priority aquatic biodiversity components and acquisition and analysis of relevant aquatic data at the Kingfisher Flats was an essential component of this ESIA.

1.1 Study area, general objectives and survey methodology

The wet season aquatic biodiversity surveys were made between 23rd to 28th May 2014. The overall objective of the surveys was to assemble wet season aquatic baseline biodiversity and fishery biology data at target locations. The surveys covered water quality, algae, aquatic micro and macro invertebrates; plus the fishes. Sampling sites were located by GPS at the same sites used for the dry season survey of February/March 2014. The sites were originally selected as locations likely be the main potential entry points of oil pollution into surface waters. The locations included the near-shore zone of Buhuka Flats opposite proposed Kingfisher Discovery Area oil development wells at Pad 1, Pad 2, Pad 3, Pad 4-2 and Pad 5 (Figure 1). The Pad 5 transect, not surveyed during the dry season, was added to extend the southwestern reach of the survey for more complete monitoring. The Lagoon being a unique surface water resource located close to Pad 1 was also surveyed. The Lagoon is also close to the main Jetty for Kingfisher servicing activities relevant to oil development at Kingfisher Flats. Surface waters comprised by the wetland resources that traverse Kingfisher Flats were also surveyed, focusing the wet season extent of the water resources, their water quality and the diversity of macro-invertebrate fauna. Results for wetland habitats studies were presented as a separate section at the end of the survey Report.
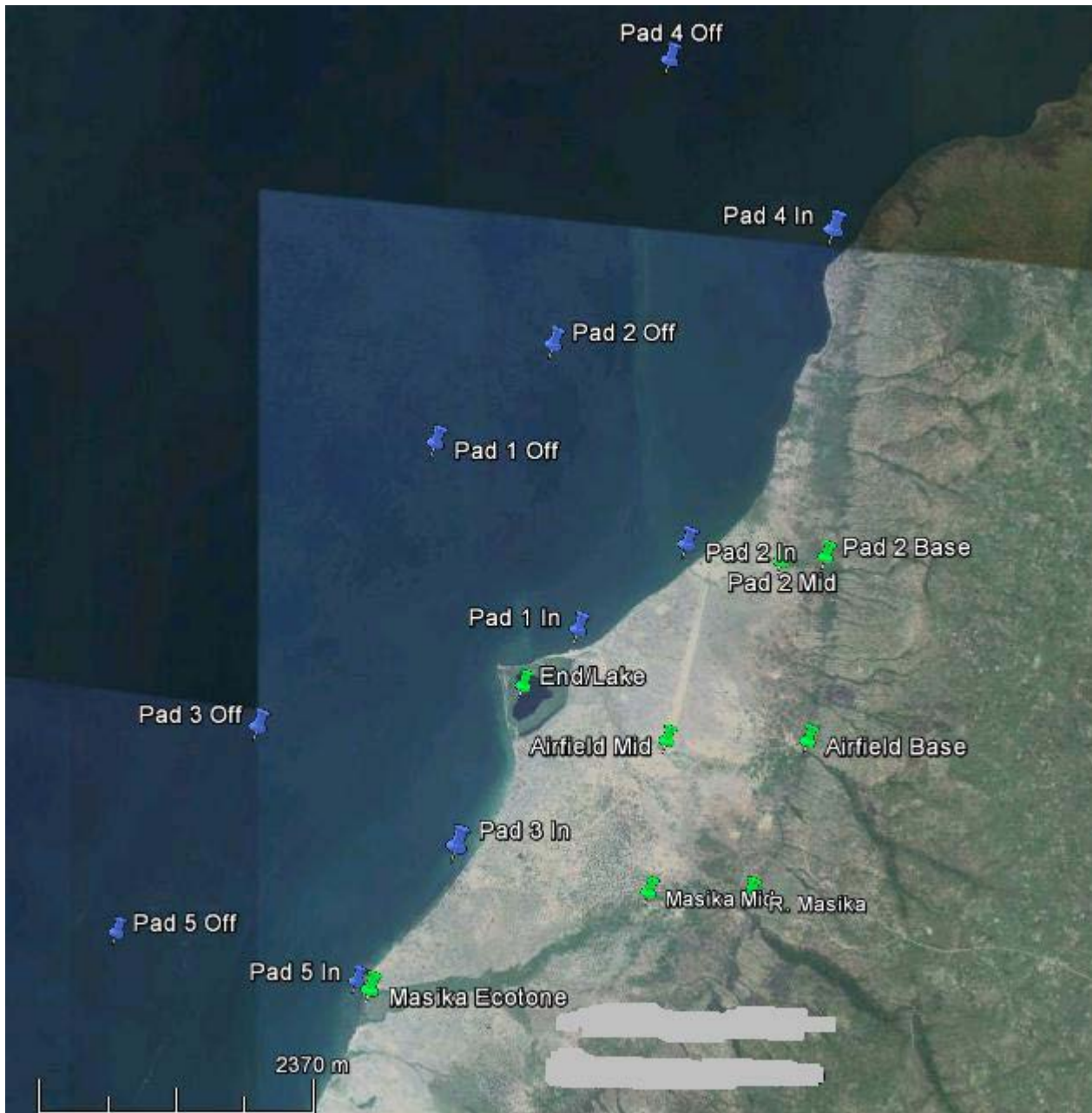
Figure 1. Map of Kingfisher flat sampling site (blue pins are the lake sites while green are the riverine sites)

Data for studies on water quality, macro invertebrates and the fishes were collected from the same locations along four transects two kilometers long (from the shore lake-ward) opposite each of the five selected oil well development pads. Samples from each transect were collected at two sites - about 10 m from shoreline (inshore) and at the end of the transect 2 kilometers from shore (offshore). In the Lagoon the samples were picked about 10 m from the shore and at about midway across the Lagoon. For each transect and sampled site shoreline topography, soil type and vegetation cover characteristics; water depth, nature of bottom sediments and GPS location were recorded. Table 1.1 below lists the environmental features at each sampling site plus the GPS locations.

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Table 1.1: Environmental features at sampled sites in nearshore waters of Lake Albert along Kingfisher flats (March 2014)

Parameter	Name of Transect				
	Pad 1	Pad 2	Pad 3	Pad 4-2	Pad 5
Shoreline features	High eroded banks; just to north of Lagoon; soils - sandy; Hinterland: seasonal wetland with eroded *Miscathedium* and patches of *Typha* plus *Phragmites*	Close to seasonal stream; high eroded banks of sandy clay; hinterland – heavily grazed grassland; big community at a distance	Fairly high eroded banks, soils -sandy clay; immediate shore lined with low thickets. Shoreline waters lined with clumps of *Cyperus laevigatus*	Pad 4-2 just north of village settlement in short scattered woodland; Shoreline few meters from escarpment,	
GPS Location: Inshore (10 m)	36N 0248441 UTM 0138118	36N 0249381 UTM 0138848	36N 0247377 UTM 0136236	36N 0250649 UTM 0141538	36N 0246523 UTM 0135109
Water depth & bottom type (Dry season)	1.1 m; sandy bottom with plant debris	2.6 m; clay mixed with shells	1.8 m; Sandy with live plant material	4.9 m; Soft mud	
Water depth & bottom type (Wet season)	1.5 m; sandy bottom with plant debris	4.4 m; clay mixed with shells	2.5 m; Sandy with live plant material	3.3 m; Soft mud	1.8m
GPS Location: Offshore (2 km)	36N 0247205 UTM 0139724	36N 0248228 UTM 0140570	36N 0245666 UTM 0137286	36N 0249238 UTM 0143016	36N 0244445 UTM 0135530
Water depth & bottom type (Dry season)	24.6 m; fine clay mixed with shells	14.0 m; Rocky with crushed shells	27.3 m; Very fine dark, smooth sand	28.6 m; Not determined	
Water depth & bottom type (Wet season)	26.9 m; fine clay mixed with shells	13.5 m; Rocky with crushed shells	27.3 m; Very fine dark, smooth sand	28.1 m; Not determined	26.8; fine dark sand

2   Water quality

2.1   Sampling and analysis methodology

Water samples assessed for baseline quality were collected at fifty centimetres under surface using a 5Lvan dorn sampler. Dissolved oxygen (mg L^{-1}), temperature (^{o}C), pH and water conductivity (µS cm^{-1}) were measured *in situ* at 0.5 m below water surface using Multiprobe (Hach HQ40d). Sample for determining water quality in the laboratory was transported in a cool-box on ice. Ammonia-nitrogen and nitrate-nitrogen were determined using Jenway 6505 UV/Vis Spectrophotometer. Ortho-phosphate, total phosphorus (TP), total nitrogen (TN) and soluble reactive silica were determined using various standard methods as set out in APHA (1995). Chlorophyll a was determined spectrophotometrically using the hot ethanol extraction method (ISO, 1992).

2.2   Results and discussion

2.2.1   Physical and chemical parameters (Lake)

Measurements of the physical and chemical parameters assessed fell within the accepted limits of national drinking water standards as per National Water and Sewerage Cooperation (Table 2.1). All the parameters were below the upper limits. Dissolved oxygen was more uniformly distributed at all sites sampled ranging from 7.03 - 7.95 mgL^{-1} highly suitable for both drinking water and water for a balanced biodiversity that supports high fish production (Romaire, 1985). The oxygen concentrations were higher than in the dry season sampling. pH on the other hand had a narrow range of 9.45 - 9.66 which were above the standards as compared with the water courses coming off the escarpment ranging from 8.8 - 9.2 (Table 7.2). An elevated pH above 9.5 can lead to ammonia toxicity while low pH of 4.4 - 5.2 is considered lethal to fisheries (Beveridge, 1996) yet the upper limit was almost reached. This however had no effect on the biodiversity due to the catchment composition and the buffering effects of the lake in addition with the photosynthetic activity that raises the bicarbonates that eventually increases the alkalinity. Conductivity continued also to have a narrow range of 632 - 634 µScm^{-1} only. The findings did not vary from the similar activities carried out in Lake Albert 40 years ago when pH ranged from 8.9 to 9.1 while conductivity was slightly higher at a range of 720 - 780 µScm^{-1} (Talling, 1963). The water qualities generally at all the sites were still suitable for fisheries productivity and maintenance of other aquatic biodiversity.

2.2.2 Phosphorus compound

The overall total phosphorus concentration ranged from 26.2 - 43.9 µgL^{-1} supplying soluble reactive phosphorus (SRP) in the range of 0.0 - 3.4 µgL^{-1} a typical condition that qualifies the sites as Oligotrophic had it not been other nutrient forms like Soluble reactive silica (SRSi). SRSi leads to additional biomass of chlorophyll a through the increase of diatoms which readily uptake them while SRP are readily absorbed by the green and blue-green algae. In an oligotrophic condition, less but very healthy fish including rare and endangered species are expected more so in if the area conserved. It can be said as of now; there is no phosphorus loading due to the on-going exploration activities hence no threat to fish productivity. If suitable mitigation measures are strictly applied including gazetting some of these sites as restricted breeding/nursery grounds during the time of oil production and pumping to Kabaale.

2.2.3 Silica compound

As mentioned above, the soluble reactive silica (SRSi) ranged from 410 - 1096µgL^{-1} in all the ten sites sampled (Table 2.1). This is the form which is readily absorbed by the diatoms hence contributing to their higher biovolume in the lake system. The presence of SRSi relays good energy source through the diatom *Cyclostephanodiscus* and *Nitzschia* species to fish. Since there was no water connectivity between the lake and the catchment area that was predicted to occur in the rainy season, the concentration of SRSi remained the same as the riverine wetlands discharge from the escarpment flats too was minimal.

2.2.4 Nitrogen compound

Total Nitrogen concentration decreased in the wet season ranging from 149 - 319 µgL^{-1} (Table 2.1) was good enough to sustain the aquatic ecosystem especially phytoplankton the major carbon producer (in fisheries productivity) in fisheries production. With the addition of Pad 5 sites, the inshore Total Nitrogen concentration was higher at 872 µgL^{-1}. This area is the one influenced by River Masika Ecotone hence its high nitrogen content. During the dry season, the site was not sampled so we can not conclude whether there was an increase or decrease. Other nitrogen products that includes ammonia had concentrations within the water column at a range of 3.1 - 28.7 µgL^{-1}. The higher concentration of 22.3 and 28.7µgL^{-1} was recorded from Pad 2 Inshore and Offshore sites. The reason as to why the concentration within Pad 2 became high during the dry season is not yet clear as there was no connectivity with the riverine wetland. Most probably, the run-off that came from the stream and settled at the bottom sediment was being released into the water column during

the mixing due to storm action the previous night in addition to the excretion product from aquatic animals, zooplankton, phytoplankton, macro benthos and bacteria. However a strong connectivity could be seen between River Masika Ecotone and Pad 5 Inshore that all measured Ammonia concentration of 23.6 μgL^{-1}. Ammonia becomes detrimental to fish health at a level greater than $20\mu gL^{-1}$ hence the ecosystem has to buffer it off to a lower concentration and this was the case in the wet season where the concentration at Pad 5 Offshore site decreased to 4.4 μgL^{-1}. In a healthy aquatic ecosystem, it is converted immediately into nitrate via the intermediate product nitrite in the presence of oxygen. Nitrite the intermediate product ranged from 0.0 - $10.4\mu gL^{-1}$ while nitrate the final product of nitrification ranged from 15.3 - $95.3\mu gL^{-1}$ an indication of efficient conversion in the presence of dissolved oxygen which was greater than 7.0 mgL^{-1} at all sites. A fall in oxygen concentration below 2.0 mgL^{-1} would result into cessation of nitrification process (Delince, 1992) hence the Kingfisher aquatic system during the wet season study remained healthy to sustain these biogeochemical processes that aid in sustaining all the aquatic biodiversity lives.

Table 2.1: Wet season water quality parameters at various sites in nearshore waters along Kingfisher Flats, Lake Albert - 26th May 2014.

Parameters		Pad 1 Inshore	Pad 1 Offshore	Pad 2 Inshore	Pad 2 Offshore	Pad 3 Inshore	Pad 3 Offshore	Pad 4-2 Inshore	Pad 4-2 Offshore	Pad 5 Inshore	Pad 5 Offshore	National Standard for portable water
Total Depth	m	1.5	24.3	2.6	13.5	1.8	27.3	3.3	28.1	1.8	26.8	
Secchi Depth	m	0.7	0.93	0.81	0.92	0.71	0.95	1.01	0.96	0.69	0.98	
Dissolved Oxygen	mgL^{-1}	7.53	7.80	7.03	7.94	7.56	7.72	7.50	7.95	7.58	7.95	**NS**
Temperature	°C	28.4	28.1	27.8	28.1	28.5	28.1	27.8	27.8	28.4	27.9	**20-35***
Conductivity	µScm^{-1}	634	633	633	633	632	634	633	633	632	634	**2500**
pH	--	9.60	9.62	9.61	9.61	9.45	9.63	9.66	9.66	9.66	9.66	**6.5-8.5**
Alkalinity	mgL^{-1}	316	332	316	360	324	320	240	320	240	300	**500**
Colour	Pt/Co	13	12	0	109	11	0	2	3	1	2	**15**
Hardness	mgL^{-1}	180	200	160	240	180	200	180	160	170	160	**500**
TDS	mgL^{-1}	304	313	317	312	310	312	304	313	310	312	**1200**
TS S	mgL^{-1}	3	2	1	1	2	1	1	1	1	1	**0**
Turbidity	NTU	2	2	2	3	4	2	2	2	3	5	**10**
Calcium: Ca^{2+}	mgL^{-1}	20.8	10	24	40	24	24	24	24	14.4	20.8	**75.0**
Magnesium: Mg^{2+}	mgL^{-1}	30.7	38.4	24	33.6	28.8	33.6	28.8	24	32.2	25.9	**50.0**
Fluoride: F$^-$	mgL^{-1}	1.2	1.3	1.2	1.2	1.1	1.3	1.1	1.3	1.1	1.2	**1.5**
Iron	mgL^{-1}	0.01	0.01	0.02	1.01	0.04	0.01	0.00	0.06	0.01	0.02	**5.0**
Sulphate	mgL^{-1}	11	11	10	10	11	11	10	10	10	10	**200.0**
Chloride: Cl$^-$	mgL^{-1}	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	**500.0**
BOD$_5$ at 20ºC	mgL^{-1}	0.0	0.6	0.9	0.4	0.5	0.2	0.3	0.6	0.5	0.1	**30***
COD	mgL^{-1}	11	10	11	15	7	15	14	12	12	11	**100***
SR P	µgL^{-1}	3.3	0.0	1.3	2.0	2.0	2.0	3.3	3.4	2.0	0.7	**5000***
TP	µgL^{-1}	26.2	33.8	28.7	31.3	43.9	36.3	33.8	26.2	33.8	38.9	**10000***
Nitrate	µgL^{-1}	23.1	24.2	95.3	30.9	55.3	32.0	35.3	23.1	26.4	15.3	**45000**
Nitrite	µgL^{-1}	8.3	6.9	10.4	9.7	2.1	0.7	1.4	2.1	1.4	0.0	**3000**
Ammonia	µgL^{-1}	8.2	19.8	22.3	28.7	14.6	9.5	12.1	3.1	23.6	4.4	**1000**
Total Nitrogen	µgL^{-1}	319	122	185	372	122	140	122	149	872	95	**10000***
SRSi	µgL^{-1}	576	512	1096	410	654	491	544	649	662	271	**NS**
Chlorophyll a	µgL^{-1}	2.1	2.1	2.1	1.0	1.0	2.1	3.1	3.1	2.1	2.1	**NS**
Faecal coliform	CFU/ 100mL	50	25	2	2	10	5	7	3	100	40	**0**

TDS = Total Dissolved Solids; TSS = Total Suspended Solids; TP = Total Phosphorus; SRP = Soluble Reactive Phosphorus; SRSi = Soluble Reactive Silica; NS = Not specified; * = Effluent discharge standard

2.2.5 Chlorophyll a

Chlorophyll a, an indirect determinant of algal biovolume, ranged from 1.0 - 3.1 µgL^{-1} (Table 2.1), a range that qualifies the study area as oligotrophic (0 - 8.5µgL^{-1} according to OECD, 1982). This range of Chlorophyll a maintains good food supply for the fish without visible algal blooms that could lead to reduced levels of dissolved oxygen by algal shading and eventual decay. Although the nutrient availability did not changed that much due to the low rainfall, the wet season still influenced algal community and changed from the dominant species (diatoms) into blue green algae.

2.2.6 Faecal coliform

Although Pad 2 both inshore and offshore retained the minute presences (2 colony forming units per 100ml) of faecal coliform, the rest of the sites had higher number ranging from 7 - 100 CFU/100ml). At all these sites, inshore sites had higher colonies than the offshore sites. This is attributed to the wet season influence during which run-off effect from the catchment is initially greater close to shore. National Water and Sewerage Cooperation qualified the standard of zero colony forming units per 100 mL (Table 2.1) as the recommended water for drinking that goes together with the same quality supporting healthy biodiversity in a given area.

3 Phytoplankton

3.1 Sampling and analysis methodology

At each sampling site, 20 ml of water for assessment of baseline status of phytoplankton was drawn at 0.5m depth, fixed with Lugol´s solution (Utermöhl, 1958), and stored away from light (Wetzel and Likens, 2000). The sedimentation method of Utermöhl (1958) was used to count the phytoplankton under an inverted microscope (Leica DM IL). Taxonomic identification was made with the help of standard literature (John et al., 2002; Komarek and Anagnostidis 1999). Species counts were made at a 400-times magnification. For each sample, two transects in the sedimentation chamber were counted and the average recorded. *Nitzschia* and *Planktolyngbya* were counted as filaments, and their total length and width measured using the micrometer scale inserted into the eyepiece (1 unit in the scale equal to 2.5 μm). Other species such as *Anabaena*, *Chroococcus*, *Merismopedia* and *Oocystis* were counted as single cells. Cell lengths and widths were determined for biovolume calculation. Twenty (20) randomly selected specimens from the dominant species were measured and their volumes calculated by assuming a geometric shape, that is, for *Microcystis*. The formula '$\pi d3/6$' was used where 'd' denotes cell diameter (Hillebrand et al 1999; Wetzel and Likens 2000). The biovolume was then calculated by multiplying the mean cell volume with cell density.

3.2 Results and discussion

At almost all study sites, more than fifty percent of the biovolume was dominated by blue-green algae that ranged from 0.84 to 3.53 mm^3L^{-1} (Table 3.1) lower than those recorded during the dry season. The low biovolume measurement during the wet season is due to first, disappearance of the *Anabaena circinalis* that was more pronounced in the dry season. The diatoms were second in importance towards the biomass contribution with a biovolume ranging from 0.91 to 3.09 mm^3L^{-1} showing also a decrease in biovolume from the dry season. This observation could be attributed to the increase in grazing pressure from the bigger zooplankton population that increased during the wet season sampling. Green algae biovolume ranged from 0.05 to 8.46 mm^3L^{-1} and Cryptomonads appeared in marginal biomass of 0.09 and 0.14 mm^3L^{-1} in two sites only. Dinoflagellate was of less importance appearing in only two sites (Pad 3 Inshore and Pad 5 Inshore) all recording a biovolume of 0.12 mm^3L^{-1}.

Table 3.1: Wet season distribution and abundance of phytoplankton expressed as biovolume (mm³ L⁻¹), in nearshore waters along Kingfisher Flats, Lake Albert, - 26th May 2014.

	Pad 1		Pad 2		Pad 3		Pad 4		Pad 5	
	In	**Off**	**In**	**Off**	**In**	**Off**	**In**	**Off**	**In**	**Off**
Blue-green	1.90	3.53	1.92	3.99	2.84	1.65	7.29	0.84	2.82	5.35
Cryptomonads	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14
Diatoms	1.88	1.54	0.94	1.58	2.07	3.09	2.19	1.29	0.91	2.37
Dinoflagellates	0.00	0.12	0.00	0.00	0.12	0.00	0.00	0.00	0.00	0.00
Euglenoids	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Green algae	0.10	0.08	0.05	0.16	0.30	0.73	8.46	4.60	1.52	4.09
Total	**3.88**	**5.36**	**2.91**	**5.73**	**5.33**	**5.47**	**17.94**	**6.73**	**5.25**	**11.95**

A total of 35 genera of phytoplankton belonging to six families comprised by Blue-green algae; Cryptomonads; Diatoms; Dinoflagellates, Euglenoids and Green algae (Table 3.2) were identified and contributed to the overall biovolume above indicating an increase from the dry season in both the genera and family that were 26 and five respectively. Blue-green algae comprised eight genera making a total of 20 species. Cryptomonads, Dinoflagellates and Euglenoids each had two species also an increase from the dry season with the new entry of Euglenoids. Diatoms had six genera with a total of eight species also an increase form the dry season. Green algae had the highest number of 12 genera comprising of 20 species. Generally all the genera increased during the wet season sampling despite loss of Anabaena.

Among the blue-green algae six species i.e.: *Anabaenopsis tanganikae, Aphanocapsa incerta, Aphanocapsa nubilium, Chroococcus limneticus, Planktolyngbya circumcreta and Planktolyngbya limnetica* were present at all sampled sites. *Cylindrospermopsis* and *Merismopedia* were rare and only site specific with the complete disappearance of *Coelosphaerium*. Notably, *Microcystis*, more especially *Microcystis aeruginosa* recently identified as the only toxin producing blue-green algae in Ugandan freshwater habitats (Okello et al, 2010), continued to be conspicuously absent at all sites sampled due to the site pristine environmental conditions being portrayed. This finding agrees with a one year round survey done 40 years ago in Lake Albert where none of the Microcystis species were recorded (Talling, 1963). Unlike in Lake Victoria with anthropogenic eutrophication *Microcystis*

aeruginosa are constantly proliferating (Okello et al, 2011. *Cryptomonads* and *Dinoflagellates* were of less importance as they were only recorded from one site each (Pad 1 and Pad 3 and Pad 4-2 inshore).

Of the five genera of Diatoms identified, *Cyclostephanodiscus species; Nitzschia acicularis* and *Nitzschia fonticola* were represented at all sites sampled while the third *Navicula* continued to contribute in lesser sites. *Aulacoseira* that was conspicuously absent in the dry season samples reappeared in Pad 3 Offshore. The reappearance could be also an indication that *Aulacoseira* are present but its being highly selected and feed on by the zooplankton and fish. It is believed that this genus has almost disappeared from Lake Victoria too leading to virtually total decline of some native fish species which fed almost exclusively on it (Ogutu-Ohwayo et al, 2002). The disappearance in Lake Victoria was linked to the declining level of soluble reactive silica with increasing eutrophication (Hecky, 1993). The majority of the 18 green algae species were recovered at all sampling sites but the genera *Closterium, Dictyosphaerium, Didymocystis, Gonatozygon, Kirchneriella, Oocystis and Pediastrum* were still rare during the wet season season

In general, there was an increase in the species composition per site ranging from 18 to 26 higher than that recorded during the dry season (15 to 23). The species increases however were mainly those with small cells hence contributing to lesser biovolume unlike in the dry season where there were big cells from Anabaena that resulted into higher biovolume. Secondly, the increase in bigger zooplankton population and the recovery/increase of other fish species increased the grazing pressure on the bigger algal community highly selected for feeding.

Table 3.2: Dry season taxonomic checklist, species composition and distribution of Phytoplankton in nearshore waters along Kingfisher Flats, Lake Albert (February 2014).

Family	Species	Pad 1		Pad 2		Pad 3		Pad 4-2	
		In	Off	In	Off	In	Off	In	Off
Blue-green	*Anabaena circinalis*	√	√	√	√	√	√	√	√
	Anabaenopsis tanganikae		√		√		√	√	
	Aphanocapsa delicatissima				√				√
	Aphanocapsa elachista				√			√	√
	Aphanocapsa holistica		√	√	√		√		
	Aphanocapsa incerta			√					
	Aphanocapsa nubilium	√	√	√	√	√	√	√	√
	Chroococcus aphanocapsiodes								√
	Chroococcus dispersus			√			√		
	Chroococcus limneticus	√	√	√	√	√	√	√	√
	Coelosphaerium kuetzinganianum							√	√
	Cylindrospermopsis africana	√	√	√					
	Merismopedia tenuissima			√					
	Planktolyngbya circumcreta	√	√	√	√	√	√	√	√
	Planktolyngbya limnetica	√	√	√	√	√	√	√	√
	Planktolyngbya tallingii	√	√		√		√	√	√
Cryptomonads	*Cryptomonads caudata*		√						
Diatoms	*Cyclostephanodiscus species*	√	√	√	√	√	√	√	√
	Navicula gastrum			√					
	Nitzschia acicularis	√	√	√	√	√	√	√	√
	Nitzschia fonticola	√	√	√	√	√	√	√	√
	Nitzschia nyassensis			√	√	√	√		
Dinoflagellates	*Glenodinum species*					√	√	√	
Green algae	*Actinastrum species*		√		√	√	√	√	√
	Closterium acerosum	√							
	Cosmarium species		√		√	√	√	√	√
	Dictyosphaerium species						√		
	Didymocystis tuberculata						√		√
	Kirchneriella obesa	√							
	Monoraphidium contortum	√	√	√	√	√	√	√	√
	Oocystis gigas							√	
	Pediastrum tetras					√			
	Scenedesmus acuminatus		√		√		√		√
	Scenedesmus bicuadatus					√	√		
	Scenedesmus costato	√	√						
	Scenedesmus perfolatus	√	√	√	√	√	√	√	√
	Tetraedron trigonum		√		√		√	√	√
Total species		15	20	15	22	15	23	20	20

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4 Zooplankton diversity

4.1 Sampling and analysis methodology

Field samples were taken in near shore-waters along five transects at PAD 1, PAD 2, PAD 3, PAD 4, and PAD 5; each with two sampling sites. The Lagoon was also sampled at two sites along a transect from the shore to the middle. Vertical zooplankton hauls were taken from 0.5m above the bottom sediments to the surface using a conical net of 0.25m mouth opening and 60μm nitex mesh. Three hauls were taken to make a composite sample, which was preserved with 4% sugar-formalin solution. In the laboratory, samples were examined at appropriate magnification under an inverted microscope (X40 for counting and X100 for taxonomic identification). Species identification was done using published keys (Rutner-Kolisko, 1974, Brooks, 1957, Pennak, 1953, Sars, 1895) enumerated and density data compiled.

4.2 Results

4.2.1 Species composition, relative abundance and distribution

Species richness, abundance, distribution and frequency of occurrence of Zooplankton at near-shore waters of Kingfisher discovery area, Lake Albert, in May 2014 (Wet Season) are detailed in Table 4.1. Wet season and dry season (February/March 2014) species distribution (frequency of occurrence - % age) was also computed and compared in the able. The Lagoon transect with the highest number of rotifer species exhibited highest decline in species richness at both sampling sites in the wet compared to the dry season (Figure 4.2). Species richness at the rest of the transects varied marginally (Figure 4.1). The dominant species among copepods was *Thermocyclops neglectus* ranging from 17,111 - 148,545 individuals per m^2 with 100% frequency of occurrence, *Diaphnosoma excisum* (0 - 44,799 Individuals per m^2; 92%) among Cladocera and Rotifera represented by *Keratella tropica* (28,968 - 161,277 Individuals per m^2, 100%) in the main lake. Similar species were recorded in the Lagoon but with very low abundances; *T. neglectus* (3,032 - 8,219 Individuals per m^2), *D. excisum* (606 - 943 Individuals per m^2) and *K. tropica* (9,162 - 19,200 Individuals per m^2) - (Table 4.1).
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Table 4.1: Species richness, distribution, abundance and frequency of occurrence (wet and dry season compared) of zooplankton taxa from study cites in near-shore waters of Kingfisher Flats, Lake Albert.

Habitats	Lagoon		PAD 1		PAD2		PAD 3		PAD 4		PAD 5		Frequency Of occurrence (% age)	
	Inshore	Offshore	Inshore	Offshore	Inshore	Offshore	Inshore	Offshore	Inshore	Offshore	Inshore	Offshore	May (Wet)	Feb. (Dry)
Copepoda:														
Mesocyclops sp.			7,949		1,617		943	707	1,671	7,747	2,425	4,850	**67**	**70**
Thermocyclops emini				29,305									**8**	**0**
Thermocyclopsneglectus	3,032	8,219	41,363	102,735	66,020	80,335	17,111	48,808	43,647	148,545	56,791	74,104	**100**	**100**
Tropocyclops confinnis			1,347	1,684	1,347	4,999	404	11,553	4,177	2,358	606	5,389	**83**	**20**
Tropocyclopstenellus								1,650	2,088	1,011			**25**	**0**
Cyclopoid copepodite	16,168	17,920	154,675	320,668	84,883	362,402	71,679	240,972	219,280	622,473	174,009	201,832	**100**	**100**
Nauplius larvae	158,448	116,949	126,381	575,316	175,424	734,801	87,240	356,507	450,255	980,866	86,297	435,731	**100**	**100**
Copepoda species	**1**	**1**	**3**	**3**	**3**	**2**	**3**	**4**	**4**	**4**	**3**	**3**		
Cladocera:														
Ceriodaphniacornuta					808		539	3,537	9,815	5,726	1,011	12,126	**58**	**60**
Ceriodaphniadubia			3,099						1,253	2,358		1,347	**33**	**50**
Chydorussp													**0**	**10**
Daphnia lumholtzi													**0**	**30**
Daphnia lumholtzi (helmeted)													**0**	**10**
Diaphanosomaexcisum	606	943	2,560	19,873	539	7,855		44,799	25,687	25,263	404	36,378	**92**	**90**
Moinamicrura			1,752	10,442	674	1,071	674	9,431	1,880	3,368	1,011	6,198	**83**	**90**
Cladoceraspcies	**1**	**1**	**3**	**2**	**3**	**2**	**2**	**3**	**4**	**4**	**3**	**4**		
Rotifera:														
Ascomorpha sp.	3,436	943			135	714					404		**42**	**10**
*Asplanchna*sp.													**0**	**10**
Brachionusangularis	9,196	674				714							**25**	**40**
Brachionuscalyciflorus				337	135		404			337	202		**42**	**30**
Brachionusfalcatus		472											**8**	**20**
Brachionuspatulus													**0**	**10**
Keratellatropica	19,200	9,162	34,627	79,156	28,968	117,468	61,304	50,222	86,250	139,113	161,277	71,948	**100**	**80**

Species	1	2	3	4	5	6	7	8	9	10	11	12		
Lecane bulla	404					357							**17**	**0**
Polyarthra vulgaris.	21,625	21,423	269	1,347									**33**	**30**
Synchaeta spp.			808			6,784	943	12,497	13,574	21,894		25,869	**58**	**40**
Trichocercacylindrica							404					539	**17**	**0**
Rotifera species	5	5	3	3	3	5	4	2	2	3	3	3		
Total species	7	7	9	8	9	9	9	9	10	11	9	10		
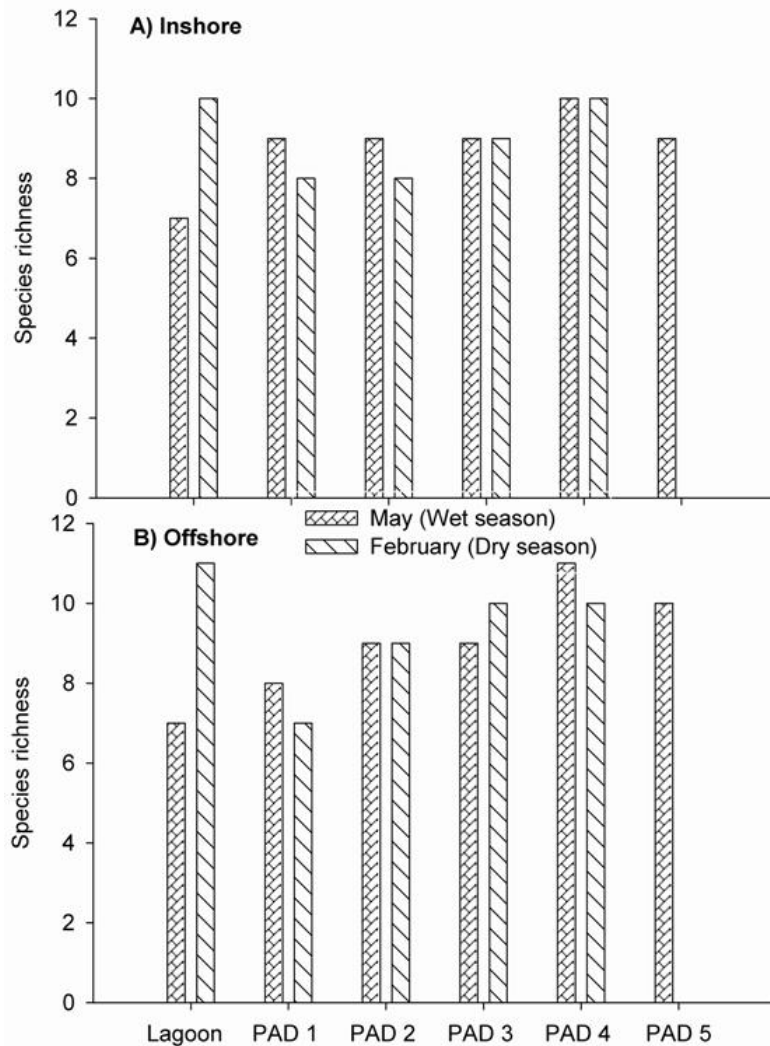
Figure 4.1. Comparison of species richness (wet and dry seasons, 2014) inshore (A) and offshore (B) within the near-shore waters of Kingfisher Flats, Lake Albert.

The Lagoon exhibited lowest total abundances ranging from 176,704 (inshore) and 232,114 Indiv.m^{-2} (offshore) in the current (wet season) data sets compared to February sampling (dry season) where it contributed the highest abundance 912,135 (Inshore) and 1,095,794 (offshore) Indiv.m^{-2} (Fig. 4.2). The major decrease in the Lagoon was in rotifer abundance while the other taxa (copepods and cladocerans) increased (Fig. 4.2). A drastic increase in abundance was also observed in PAD 4 ranging from 859,578 (inshore) - 1,961,058 (offshore) Indiv.m^{-2} in the current sampling compared to February sampling which was 304,230 (inshore) - 369,442 (offshore) Indiv.m^{-2} (Fig. 4.2). In general, there was tremendous increase in abundance for all taxa in the wet season compared to dry season results (Fig. 4.2).

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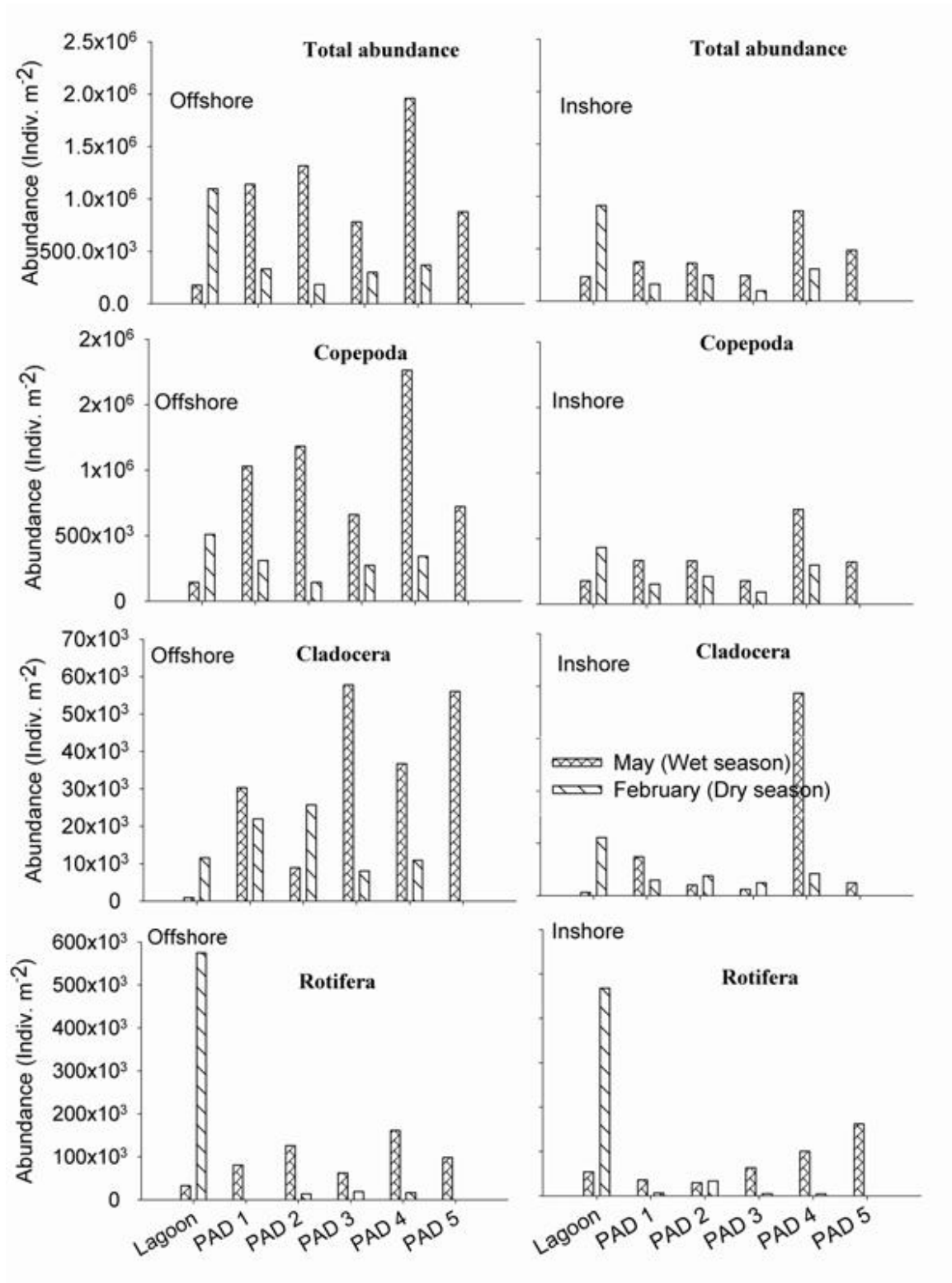
Figure 4.2 Seasonal variation and comparison of abundance for zooplankton taxa across study sites at Kingfisher discovery area, Lake Albert in May (wet season) and February (dry season) 2014. Note the different scales at Y-axis

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Total abundance in the lagoon decreased from 1,095,794 Indiv.m^{-2} in dry season to 176,706 Indiv.m^{-2} in the wet season (range of 919,088 Indiv. m^{-2}) offshore and from 912135 (dry season) to 232113 Indiv.m^{-2} (wet season) inshore (range of 680,022 Indiv. m^{-2}) inshore (Fig. 4.2). The notable observations were; copeponds which shot up from previous sampling compared to cladocerans and rotifers (Fig. 4.2). Among copepods the young stages (Nauplius larvae and cyclopoid copepods) and *T. neglectus* were the main contributors to the increment, while *Diaphnosoma excisum,Ceriodaphnia cornuta* and *C. dubia* contributed to the Cladocera (Table 4.1). A drastic drop in rotifers was caused by *Brachionus anguralis* (previously reported dominating in the Lagoon)*, B. falcatus and B. calyciflorus,* while *Keratella tropic* strongly increased (Table 4.1).

Copepods were strongly recorded in terms of relative abundance (offshore 80.9% - 90.2%, Inshore 66% - 91.3%;) relative to Cladocera (offshore 0.5% - 7.3%, Inshore 0.3% - 2.0%) and Rotifera (offshore 7.0% - 18.4%, Inshore 8.1% - 33.4%;) (Fig. 4.3). A major change was among rotifers in the current data which was recorded 18.5% and 23.2% (relative abundance) in the Lagoon for offshore and inshore respectively compared to the previous sampling 52.5% and 51.3% (Fig. 4.3). The calanoid copepods were still not recorded in all samples analysed, indicating absence or reality (Lehman et al., 1998) of this particular taxon in Lake Albert.
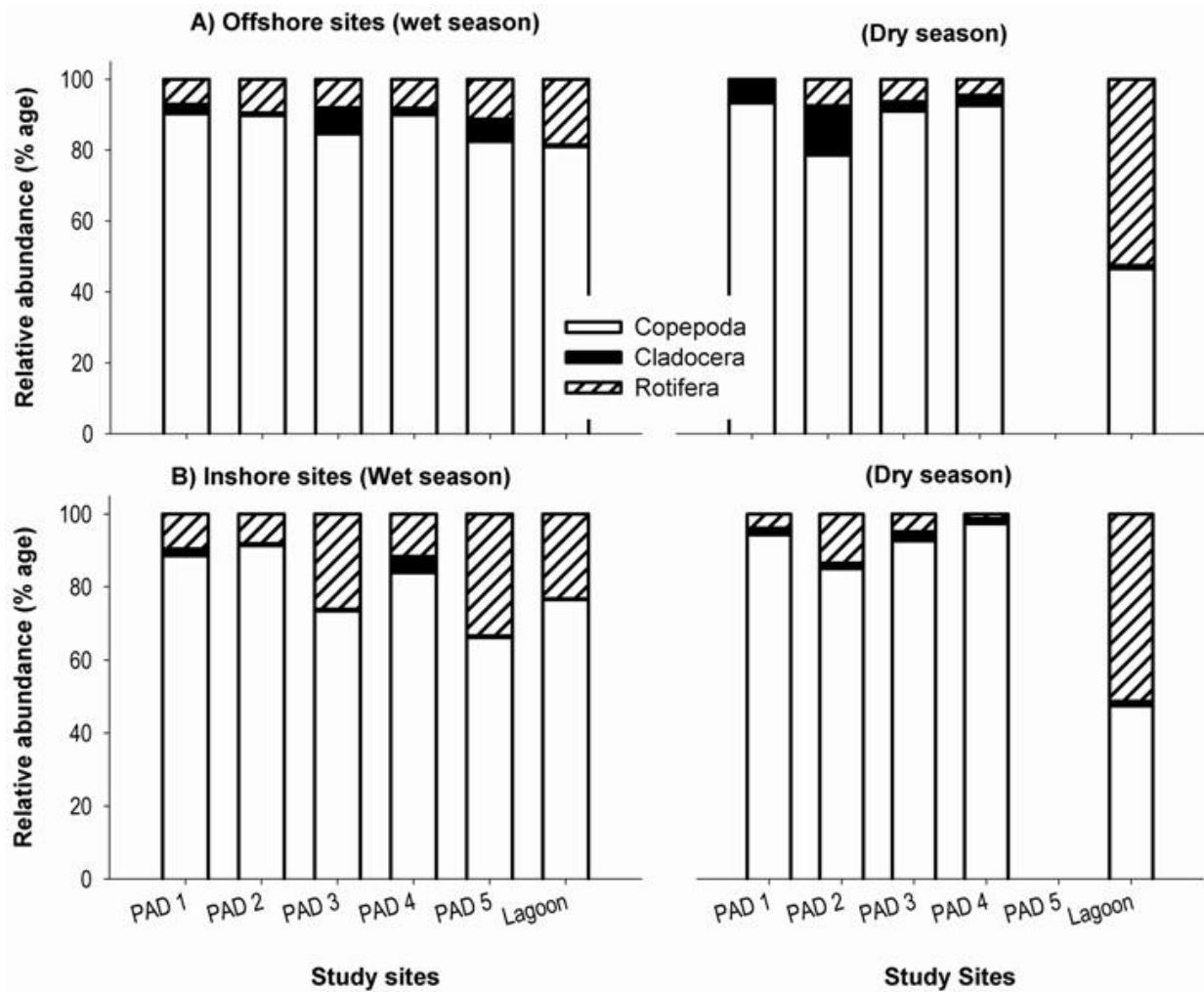
Figure 2.3. Comparing relative abundance (Dry and Wet seasons) of zooplankton from offshore (A) and Inshore (B) study areas around the Kingfisher discovery area May 2014.

4.3 Discussion

The current (wet season) results compared to February (dry season), generally reflected a stable and healthy lake dominated by the cyclopoid copepods with less rotifers as the latter are more responsive to alterations in water quality, an attribute which make them potential indicators of pollution and trophic conditions (Sladecek, 1983, Tasevska et al., 2010, Vincent et al., 2012). A reflection of earlier studies (Lehman et al., 1998) reveals similar composition of copepod dominancy in relative abundance, though the number of cladoceran diversity reported (Green, 1971, Campbell et al., 2005) continued to decreased. An explanation could be due to discrepancy in sampling methods as well as inadequacy in taxonomic resolution, increased human activities around the lake (such as bad fishing methods, overexploitation, habitat degradation and oil & gas exploitation and development) that have led to some changes in the water quality (NaFFIRI Report, 2007, Wandera and Balirwa, 2010)

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and increase in zooplanktivorous species mainly *Brycinus nurse* (Ragoge) and *Neobola bredoi* *(*Muziri) (Linda et al., 2005, Wandera and Balirwa, 2010). A Catch Assessment Survey (CAS) around this lake by National Fisheries Resources Research Institute (NaFIRRI) has revealed an upcoming zooplanktivorous fishes *Neobola bredoi* with an estimated annual catch of 78,000 tons followed by *Brycinus nurse* (51,000 tons) constituting 51% and 34% of commercial catches respectively (NaFFIRI, 2012), the change in fish composition can have potential to cause changes in community structure of zooplankton due to their predatory effects of these micro-organisms "top-down" effect (Michael et al., 1997).

The drastic changes in the Lagoon and adjacent sites in copepod and rotifer abundance could also be due to factors like; water age, variation in nutrient loads from hinterland and connectivity to the lake as a result of precipitation (Baranyi et al., 2002, Lehman et al., 1998, Bledzki and Ellison, 2000). However, the increment in copepods (Cyclops) is a positive change as copepods are highly considered key in sustaining the fishery in most water bodies (Mwebaza-Ndawula et al., 2001, Mwebaza-Ndawula et al., 2003, Mwebaza-Ndawula et al., 2005). The Lagoons, river mouth and large bays harboring marginal vegetation are habitats singled out as areas where prey species, especially haplochromines, hide and breed (Wandera and Balirwa, 2010) and it might explain the variation in zooplankton abundance in the Lagoon.

Though, the influx of nutrients to the lake influences productivity of phytoplankton and then zooplankton dynamics (Lehman et al., 1998), the abundance and spatial distribution of zooplankton is also highly dependent on other factors such as; fecundity, seasonality in predator (fish) production, tolerances to temperature (causing fluctuation in Egg Development Time (EDT)), length of time spent in the water column, hydrodynamic processes, natural mortality and the amount of exposure to the influence of anthropogenic activities.

In general, the zooplankton community increased tremendously during the wet season with copepods and cladocerans contributing to the abundance increment while rotifers generally decreased. Calanoid copepods were absent from all samples collected while rotifer species *Keratella tropic* increased and *Brachionus angularis* dropped especially in the Lagoon. The planned second dry season studies would confirm the trends in taxonomic composition, distribution and abundance patterns.

5 Taxonomic composition, distribution and abundance of macro-invertebrates and their status as indicators of environmental quality

5.1 Specific objective

i. Describe site specific characteristics of bottom substrates sampled for macro-invertebrates at the selected transect in near-shore waters of Kingfisher Flats and at the riverine wetland sites.

ii. Determine taxonomic composition distribution and relative abundance of the macro-invertebrates.

iii. Characterise and compare the seasonal (dry and wet) composition, abundance and distribution of macro-invertebrate taxa across sampled transects.

iv. Basing on literature characterise the significance of macro-invertebrates as indicators of environmental quality at sampled transects of Kingfisher Flats.

v. Deduce the current environmental conditions at the sampled transects/sites of Kingfisher Flats based on distribution and abundance of various macro –invertebrate taxa

5.2 Sampling and analysis methodology

Water depth (m) at each sampling site was measured using an eco-sounder of 400Hz and triplicate bottom sediment samples containing benthic macro-invertebrates collected using Ponar grab of approximate jaw area and inner depth of 238.0 cm^2 and 8.0 cm, respectively (APHA, 1992). The sediment samples were emptied into plastic basin, their physical characteristics (e.g. soft mud, sandy, stony, etc) noted. The samples were subjected to further processing procedures (APHA, 1992; Ferraro and Cole, 1992 Ochieng, 2006 and Ochieng *et al*., 2008) in order to sort, identified and quantified the macro-invertebrates. Taxonomic identification was done using guides of Mandal-Barth, 1954; Merrit and Cummins, 1984 and De Moor *et al*., 2003

The data was processed using MS excel program. With the known jaw area of the sampling gear (ponar grab), mean numbers of macro-invertebrate taxa were calculated from the counts got from the combined three sediment samples (n=3) at each site. The mean values were rounded off to the nearest whole numbers to determine the macro-invertebrate taxa numbers (richness) and also used to calculate their abundance (mean numbers per square meter). Three indices namely; (i) EPT (Ephemeroptera, Plecoptera and Trichoptera) taxa richness, (ii) Total taxa richness and (iii) Abundance of macro-invertebrate individuals (Wenn, 2008; Oghenekaro, 2011) were determined and used for description of macro-invertebrate status as indicators of environmental quality. Mean

numbers of macro-invertebrate individuals recovered during the dry (February/March 2014) and wet (May 2014) seasons were compared using Paired samples T test ($p = 0.05$) in SPSS 11.5 for Windows. The information is presented in form of graphs for EPT and Total taxa richness, and tables giving the details of all taxa abundances and distribution at each site.

5.3   Results

5.3.1   Macro-invertebrate composition, abundance and distribution within the near-shore zone of Kingfisher Discovery area.

Ephemeroptera, Plecoptera and Trichoptera (EPT) taxa richness

Ephemeroptera, Plecoptera and Trichoptera (EPT) richness at sampled sites in the near-shore of the lake, ranged from 0 to 2, during both dry and wet seasons. The highest number (2) was found at inshore sites of Pad 1 and Pad 4 during dry season; and only at sites of Pad 4 during wet season. The rest of the sites including those of Pad 5 sampled only during wet season, had ETP richness of 1 or none in the two seasons (Fig. 5.1). The ephemeroptera taxa which were part of this richness during dry season were only C*aenis* sp and *Povilla adusta,* the former occurring at Pad 1 inshore and Lagoon offshore and the later occurring at Pad 1 inshore, Pad 2 offshore and Pad 4 inshore. The ephemeroptera taxa which were part of this richness during wet season were only *Povilla adusta,* occurring at Pad 2 inshore, Pad 3 inshore, Pad 4 inshore, Lagoon inshore and Pad 5 inshore. The order Plecoptera was not recovered during both dry and wet seasons (Table 5.1). Among the trichoptera, only members of the family Psychomidae were found at Pad 3 offshore and Pad 4 inshore and offshore during dry season. Trichoptera species *Dipseudopsis* of the family Dipseudopsidae was the only one found during wet season, at Pad 4 inshore (Table 5.1).
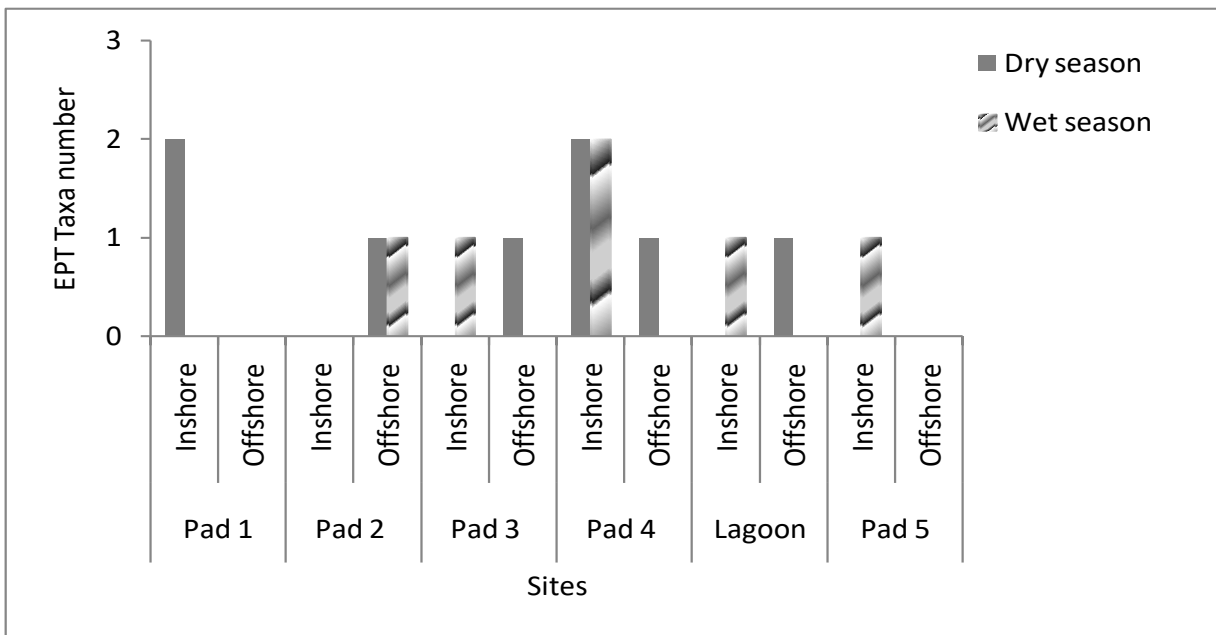
Figure 3.1. Ephemeroptera, Plecoptera and Trichoptera (EPT) taxa richness at the near-shore sites of Kingfisher Flats during dry (February/March) and wet (May) seasons, 2014

Total taxa richness

As indicated (Fig. 5.2, Table 5.1), total ETP taxa richness during dry season, ranged from 3 to 15, with the highest value of 15 occurring at offshore site of Pad 2 transect. This site (Pad 2 offshore) was where the highest number of Ephemeroptera species of *Povilla adusta*, were recovered. During wet season, total taxa number ranged from 2 at Lagoon offshore to 15 at Pad 2 offshore. Pad 2 offshore, was again the site where the highest number of Ephemeroptera species of *Povilla adusta*, were recovered during wet season (Table 5.1).
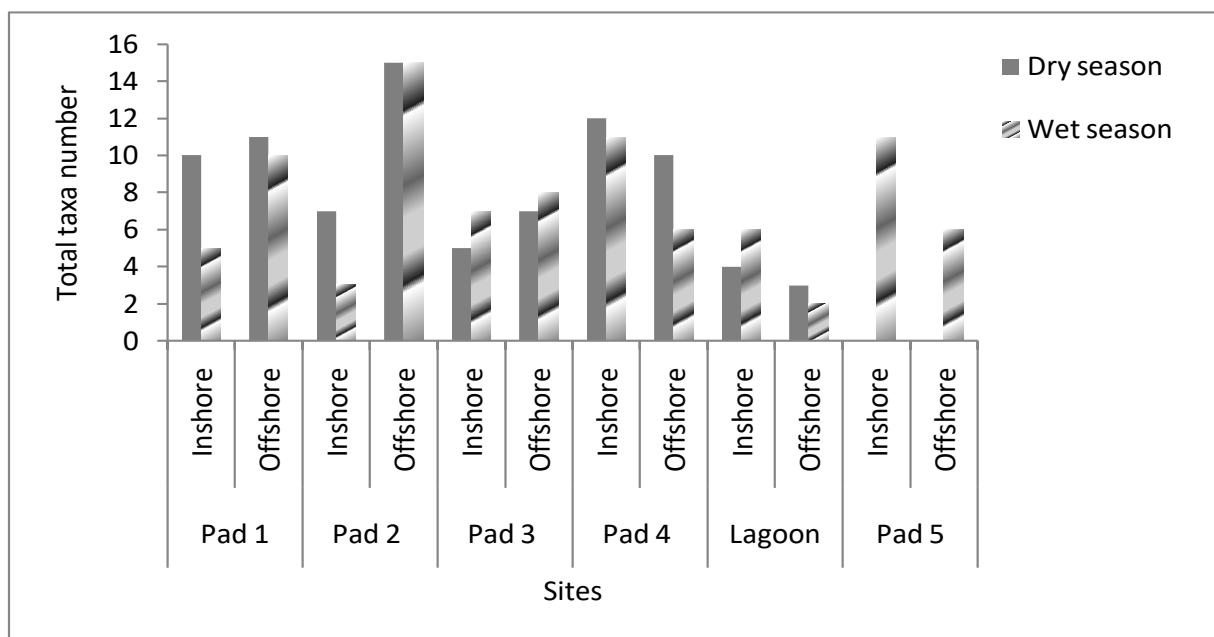
Figure 5.2. Total taxa richness at the near-shore sites of Kingfisher Flats during dry (February/March) and wet (May) seasons, 2014

Macro-invertebrate abundance and distribution

The gastropods (snails), bivalves (clams), Chaoboridae (phantom miges), ephemeroptera (Mayflies) and oligochaetes (aquatic worms) were the most common and abundant macro-invertebrates recovered from bottom substrates during the two surveys of dry and wet seasons (Table 5.2). During dry season, the species of gastropods such as *Melanoides tuberculata*, *Cleopatra sp,Gabbia humerosa*, *Gabbia walleri* and *Bellamya unicolor*, were the most abundant and distributed taxa at the sites. Their densities (mean numbers per square meter) ranged from 0 to 1064 at the various sites were they occurred. These were followed by the bivalves such as *Byssanodonta parasitica* and *Corbicula africana*, whose densities at the sites, ranged from 0 to 294. The oligochaetes, though with low densities, were also common in most sites during dry season and their densities ranged from 0 to 84; the highest being at the Lagoon transect.

During wet season (Table 5.1), the gastropod species namely; *M. Tuberculata* and *B. unicolor*, were the most abundant and widely distributed taxa at the sites. Their densities (mean numbers per square meter) ranged from 0 to 896 at the various sites were they occurred. These were followed by the bivalves such as *Byssanodonta parasitica* and *Corbicula africana*, whose densities at the sites, ranged from 0 to 672. Other macro-invertebrate taxa which were common at the sites during wet season were *Povilla adusta*, *Chaoborus* and oligochaetes. Their density ranges were 0 to 1707, 0 to

294 and 0 to 168, respectively. Among the sites, Pad 2 offshore had greater taxa numbers and densities of macro-invertebrates relative to other sites. Specifically, the greatest densities 1036 and 1708 of *Povilla adusta* (pollution sensitive) found during dry and wet seasons, respectively, were at Pad 2 offshore. The gastropod genus *Biomphalaria,* was found mainly during the wet season at Pad 2 offshore, Pad 4 inshore and Pad 5 inshore, each with density of approximately 14.

Table 5.1: Macro-invertebrate taxa abundance and distribution within the near-shore of the lake

Lake near-shore taxa mean no. per square meter

Family	Genus	Species	Pad 1 inshore D	Pad 1 inshore W	Pad 1 offshore D	Pad 1 offshore W	Pad 2 inshore D	Pad 2 inshore W	Pad 2 offshore D	Pad 2 offshore W	Pad 3 inshore D	Pad 3 inshore W	Pad 3 offshore D	Pad 3 offshore W	Pad 4 inshore D	Pad 4 inshore W	Pad 4 offshore D	Pad 4 offshore W	Lagoon inshore D	Lagoon inshore W	Lagoon offshore D	Lagoon offshore W	Pad 5 inshore D*	Pad 5 inshore W	Pad 5 offshore D*	Pad 5 offshore W
*Chironomidae			28	28	28	84	0	0	0	0	0	0	0	56	98	14	42	0	14	0	14	28		14		0
Ceratopogonidae	*Palpomyia*		0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	56	0	0	0		0		0
Chaoboridae	*Chaoborus*		0	0	14	280	0	70	0	0	0	0	0	168	0	14	0	0	0	0	42	0		0		294
Libellulidae			0	0	14	0	0	0	0	0	0	0	0	0	14	42	0	0	0	0	0	0		28		0
Coenagronidae			0	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0		0		0
Gomphidae	*Progomphus*		14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0		0
Polymitarcyidae	*Povilla*	*adusta*	42	0	0	0	0	0	1036	1,708	0	14	0	0	14	140	0	0	0	14	0	0		364		0
Caenidae	*Caenis*		14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	0		0		0
Dipseudopsidae	*Dipseudopsis*		0	0	0	0	0	0	0	0	0	0	0	28	0	0	0	0	0	0	0	0		0		0
Psychomidae			0	0	0	0	0	0	0	0	0	0	28	0	28	0	28	0	0	0	0	0		0		0
Thiaridae	*Melanoides*	*tuberculata*	0	0	168	28	14	0	462	896	14	28	42	0	322	98	518	168	0	0	0	84		0		42
Thiaridae	*Cleopatra*		14	0	28	0	14	0	392	0	28	0	280	0	238	0	56	0	0	0	0	0		0		0
Thiaridae	*Cleopatra*	*pirothi*	0	0	0	28	0	0	0	406	0	0	0	280	0	28	0	56	0	0	0	0		0		0
Bithyniidae	*Gabbia*	*humerosa*	882	14	0	0	0	0	28	84	1064	0	0	0	14	0	0	0	0	0	0	0		0		14
Bithyniidae	*Gabbia*	*tilhoi*	0	0	0	0	0	0	70	210	0	0	0	0	0	0	0	0	0	0	0	0		0		0
Bithyniidae	*Gabbia*	*walleri*	0	0	84	0	0	0	490	574	0	0	28	70	28	0	42	0	0	0	0	0		14		322
Viviparidae	*Bellamya*	*unicolor*	14	0	168	70	238	0	238	154	0	14	182	112	994	154	252	14	0	84	0	0		56		56
Planorbidae	*Biomphalaria*		0	0	0	0	0	0	14	14	0	0	0	0	0	14	0	0	0	0	0	0		14		0
Planorbidae	*Bulinus*		14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0		0
Sphaeriidae	*Sphaerium*		28	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0		0		0
Sphaeriidae	*Sphaerium*	*victoriae*	0	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		70		0
Sphaeriidae	*Byssanodonta*	*parasitica*	0	0	182	84	14	0	182	294	0	0	0	14	56	0	98	14	0	0	0	0		28		0
Unionidae	*Caelatura*	*bakeri*	0	0	28	42	28	0	14	42	14	28	0	0	0	0	0	56	0	56	0	0		42		0
Unionidae	*Caelatura*	*acuminata*	0	0	14	14	0	0	14	42	0	0	0	0	0	0	14	0	0	0	0	0		0		0
Corbiculidae	*Corbicula*	*africana*	0	0	28	28	98	0	112	672	0	0	0	14	294	140	238	112	0	42	0	0		56		0
Mutelidae	*Mutela*		0	14	0	0	0	0	0	0	0	0	0	0	28	0	0	0	0	0	0	0		0		0
*Leeches			0	0	0	0	0	0	196	294	0	0	0	0	0	28	0	0	0	0	0	0		42		0
*Oligochaetes			0	70	28	28	70	168	0	14	28	140	56	98	0	70	0	0	56	28	84	14		42		28
Atyidae	*Caridina*	*nilotica*	14	0	0	0	0	0	56	14	0	0	0	0	0	0	42	0	0	0	0	0		14		0

* = Organisms not identified further, D = Dry season, W = Wet season, D* = Not sampled during dry season

5.4   Discussion

The diverse types of bottom substrates notably clay/snail shells, sand/plant materials, soft mud, and rock/shells was recorded by this study at various sites during the dry and wet seasons - a demonstration of presence of a rich diversity of benthic macro-habitats in the near-shore waters of Kingfisher Flats. Results from the study illustrate also the suitability of these micro-habitats for a diverse range of macro-invertebrates. Another study by Wetzel (2001) identified the suitability of similar macro-habitats for a wider range of benthic organisms. These results identify the near-shore waters of the Kingfisher Flats as unique environments for aquatic biodiversity assessment in relation to likely impacts of oil and gas exploration and development.

In this study, bio-assessment of environmental quality of the near-shore waters and the riverine wetlands of Kingfisher Flats was based on ephemeroptera, plecoptera and trichoptera (EPT) richness index, in combination with other indices such as macro-invertebrate total taxa richness and individual taxa abundance, successfully applied in the United Kingdom (Wenn, 2008), South Africa (Oghenekaro, 2011) and North Africa (Beauchrad *et al*., 2003), among others. EPT refers to the number of taxa (e.g. genera) of ephemeroptera (Mayflies), Plecoptera (Stoneflies) and Trichoptera (Caddis flies) in a sample. EPT are considered least tolerant to pollution e.g. organic pollution and therefore aquatic environments with presence of EPT and especially with high richness are regarded to be of good quality. Total taxa richness also refers to the total number of all macro-invertebrate taxa (e.g. genera) in a sample and the higher its richness, the better the environmental quality.

Based on EPT and total taxa richness results from both dry and wet season surveys, the sampling sites of the near-shore waters and riverine wetlands of Kingfisher Flats were grouped under three categories of environmental quality. Those with EPT score of 2 to 3 and total taxa mostly from 10 to 12 were of moderate to good environmental conditions, those with EPT score of 1 and total taxa mostly from 5 to 10, were of fair environmental conditions, and those with EPT score of 0 and varying total taxa of 1 to 7, were of poor environmental conditions. Accordingly, Pad 1 inshore and Pad 4 inshore were of moderate to good environmental conditions; Pad 2 offshore, Pad 3 inshore, Pad 3 offshore, Pad 4 offshore, Pad 5 inshore, Lagoon inshore and Lagoon offshore, were of fair environmental conditions; and the rest of the sites namely Pad 1 offshore, Pad 2 inshore and Pad 5 inshore, were of poor conditions.

Although literature indicates that densities of benthic macro-invertebrates especially the insect group, tend to increase from dry to wet season (Wetzel, 2001), this has not been the case for the present two surveys. Results from the two surveys indicate that Ephemeroptera, Plecoptera and Trichoptera (EPT) and total taxa richness computed for the near-shore of the lake during the dry season, were similar to those of the wet season. Secondly, macro-invertebrate individual taxa mean numbers for the dry and wet seasons were not significantly different ($p > 0.05$). This was probably because of the short period the rain had actually occurred before the second survey (May 2014) was conducted. On the average water depths recorded from near-shore sampling sites during the wet (May 2014) season increased by only about 0.3m (see Table), over that recorded during the dry season (February/March 2014). The small increase was deemed to be due to the apparent rise in lake level contributed by the rains. Given the short time between onset of substantial rainfall and the start of the wet season, data collection on May 23; plus complexities involved in macro-invertebrate life cycles (Wetzel, 2001), the observed lack of significant difference in the two data sets may thus be explainable. The planned third round of sampling to collect the final batch of data towards this seasonal aquatic biodiversity study should add further depth to the overall picture of the taxonomic composition, distribution and abundance of macro-invertebrates and their status as indicators of environmental quality in the near-shore and riverine wetlands of Kingfisher Flats.

6 Fishes

6.1 Materials and methods

Data were obtained from experimental fishing using multifilament gillnets ranging from 1-6" increasing by ½"; set perpendicular to the shore. Gillnets were set in the evening and hauled at dawn. On retrieval, fish species were identified using Greenwood (1966) and the total length (TL) and standard length (SL) were measured to the nearest 1 mm. The individual weights of fish were determined to the nearest 0.1g using a digital scale (model CS-10KWP-IP65). Fish were then dissected and sexed. Sexes were determined for only those fish whose gonads were identifiable as male and female and maturity stages of fish were assigned from stage I to VI according to a method described by Witte & Van Densen (1995). Fish in stages I, II and III were regarded immature whereas those in stages IV, V, VI and VII were mature. Fish guts were fixed in 4% formalin and later preserved in 70% ethanol in labeled sample bottles for food content identification in the laboratory. To determine food of a fish samples, guts were split open, contents emptied onto a petri dish and examined under compound microscope (Model XSZ-H). The food items were identified and points allotted to different degrees of stomach fullness according Hynes (1950) to give stomach fullness index. The contribution of food items relative to all food items in the gut was determined through visual judgment.

6.2 Data processing and analysis

Species composition and relative abundance were calculated from the catch statistics. Population structure was determined by grouping fish in size classes and mean total length determined. Size at first maturity was determined as the average length at which 50% of the population had advanced to stage IV of gonad development. Relative condition factor (Kn) was calculated as the ratio of observed individual fish weight to expected weight of an individual of a given length calculated using regression constants a and b obtained from running a length-weight relationship according to LeCren (1951). The relative importance of food items was estimated from multiplying the stomach fullness index by percentage contribution of food items.

6.3 Results and discussion

6.3.1 Fish taxa composition, abundance and distribution

Taxa composition and numerical relative abundance of fishes sampled at the experimental transects in near-shore waters of Kingfisher Flats during the wet season (May 2014) are summarized in Table

6.1. A total of 19 fish species belonging to 16 genera and 8 families were recorded compared to13 species from 11 genera and 5 families sampled during the dry season in March. Six species: *Alestes macrolepidotus* (Characidae); *Neobola bredoi, Barilus niloticus, Barbus bynii* (Cyprinidae); and *Thoracochromis avium, Alestes macrolepidotus (*Cichlidae*)* – not caught during the dry season sampling – were registered during the wet season. On the other hand *Synodontis schall, Barbus perience* and *Sarotherodon galilaeus* present in the catches during the dry season were not recovered during the wet season. The difference in species richness could be due to migratory response to inflow of run-off into the lake. It is general knowledge that migratory fish run upstream.

Table 6.1: Wet season taxa composition and relative abundance (% numbers) of fish species caught at near-shore transects along Kingfisher Flats (May, 2014)

Family	Species	Lagoon	PAD 1	PAD 2	PAD 3	PAD 4	PAD 5	Total
Polypteridae	*Polypterus senegalis*	3.85						0.17
Characidae	*Hydrocynus forskahlii*		0.48	5.11	1.19	5.13	5.95	2.76
	Alestes baremose	11.54	0.48	0.73	2.38		2.38	1.55
	Alestes macrolepidotus	23.08			9.52		4.76	3.11
	Brycinus nurse		68.42	52.55	54.76	64.10	8.33	50.60
Cyprinidae	*Barilus niloticus*		0.48					0.17
	Barbus bynii		0.48	0.73				0.35
	Neobola bredoi		8.13					2.94
Bagridae	*Bagrus bayad*	3.85			3.57		1.19	0.86
	Auchenoglanis occidentalis		1.44					0.52
Schilbeidae	*Schilbe intermedius*			12.41		2.56		3.11
Clariidae	*Clarias gariepinus*		0.48					0.17
Centropomidae	*Lates niloticus*			28.47	26.19	28.21	23.81	15.89
Cichlidae	*Oreochromis niloticus*	30.77						1.38
	Oreochromis leucostictus	15.38						0.69
	Thoracochromis wingati						48.81	7.08
	Neochromis nigricans		0.96					0.35
	Thoracochromis avium		0.48					0.17
	Thoracochromis loati	11.54	18.18		2.38		4.76	8.12
	Total	**4.5**	**36.1**	**23.7**	**14.5**	**6.7**	**14.5**	**100.0**
8		19	7	11	6	7	4	8	19

The highest percentage catch by numbers across the experimental transects was recorded at PAD-1(36.1%) followed by PAD-2 (29.3%), while PAD-3 and PAD-5 – a new transect added in May - contributed 14.5% each and PAD-4 registared6.7%. The transect in the Lagoon contributed the least relative count of fish (4.5%) possibly because some of the fishing gears set there were interfered with by the large monitor lizard reported present by local fishermen.

The number of fish species recorded at each of the experimental transects during the wet and dry seasons are compared in Figure 6.1. The transect at PAD-1 contributed the highest number of

species during both the dry (12 species) and wet season (11 species). The least number (4 species) were recovered from PAD-4 during the wet season and from PAD-2 (4) during dry season. Note that dry season fishing experiments in the Lagoon were not successful. The general seasonal species distribution trends across the sampling transects are basically similar but the comparison is weakened by the fact that it was not practical to gathered data for all the transects on any single night.
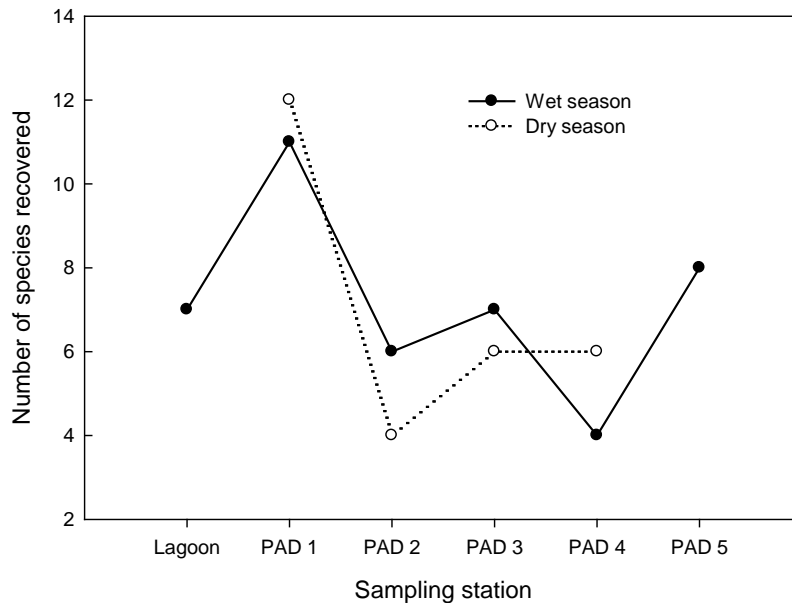
Figure 6.1: Seasonal variation in the number of fish species recovered from near-shore transects at Kingfisher Flats in March and May 2014.

Brief fishing experiments in the near-shore waters of Kingfisher Flats during the dry (March) and wet (May) seasons of 2014, using only gillnets of graded mesh sizes revealed a taxonomic diversity of 19 fish species belonging to 11 genera and 5 families. The species richness – 35.8% of the 53 fish species reported to occur in Lake Albert (Greenwood, 1966; 1981; Worthington, 1929) – is remarkable. It is expected that more fish species will be found when more types of fishing gears are used during the final planned fishing experiment of this survey later in the year.

Relative abundance (% weight) of fishes caught in near-shore waters across sampling transects during the wet season of May 2014 are detailed in Table 6.2. PAD-2 contributed the highest biomass (31.3%), followed by PAD-5 (22.7%) and PAD-1 (15.8%) while the Lagoon close to PAD 1 yielded

the least biomass (3.4%). *Lates niloticus, B. nurse, Hydrocynus forskahlii* and *Alestes baremose* yielded the highest individual species biomass contributing 41.98, 16.66, 11.58 and 3.29 percent of the total catch, respectively. In comparison with corresponding dry season (March 2014) percent biomass catches, PAD-4.2 contributed the highest biomass (29.1%), followed by PAD-3 (25.4%) and PAD-1 (25.3%) while PAD-2 yielded the least biomass (20.2%). *L.niloticus*, *H.forskahlii*, *A.baremose*, *Synodontis schall* and *Bagrus bayad* yielded highest biomass contributing 40.4, 17.6, 9.2, 8.5, and 8.4 percent of the total catch, respectively.

Table 6.2: Relative abundance (% weight) of fish species caught in near-shore waters across the sampling transects during the wet season of May 2014

Family	Species	Lagoon	PAD 1	PAD 2	PAD 3	PAD 4	PAD 5	Total
Polypteridae	*Polypterus senegalis*	15.89						0.53
Characidae	*Hydrocynus forskahlii*		1.66	11.54	2.08	10.81	26.91	11.58
	Alestes baremose	8.21	3.15	1.21	4.70		10.53	4.25
	Alestes macrolepidotus	17.62			3.96		1.21	1.46
	Brycinus nurse		50.60	14.54	16.64	10.44	1.70	16.66
Cyprinidae	*Barilus niloticus*		1.24					0.20
	Barbus bynii		3.40	1.34				0.96
	Neobola bredoi		0.17					0.03
Bagridae	*Bagrus bayad*	1.59			16.43		3.34	3.26
	Auchenoglanis occidentalis		16.94					2.68
Schilbeidae	*Schilbe intermedius*			17.85		4.25		6.09
Clariidae	*Clarias gariepinus*		2.04					0.32
Centropomidae	*Lates niloticus*			53.54	55.21	74.50	35.74	41.98
Cichlidae	*Oreochromis niloticus*	35.63						1.19
	Oreochromis leucostictus	18.28						0.61
	Thoracochromis wingati						19.97	4.54
	Neochromis nigricans		1.29					0.20
	Thoracochromis avium		1.12					0.18
	Thoracochromis loati	2.78	18.40		0.98		0.61	3.29
	Total	3.4	15.8	31.3	14.9	11.9	22.7	100.0

6.3.2 Species abundance (Catch rates)

Catch rates (number/weight of fish per net per night) were calculated based on the total number of gillnets used at that particular habitat. Fish species were grouped into different categories depending on the numbers of nets deemed capable of capturing them were used. The species are categorized into two capture categories namely; Category A: fishes that grow to small adult size – caught in nets up to 2" and Category B: fishes growing to medium and large sized adults – Caught in nets up to 5". Catch rates as numbers and weights per net night are plotted in Figure 6.2 and Figure 6. 3,

respectively; compared with the respective catch rates recorded during the dry season. During the wet season the highest number of fish per net was recorded at PAD-1 (9.5) and the lowest at the Lagoon (1.18); while the corresponding values during the dry season were obtained at PAD- 3 (3.91) and PAD-4.2 (2.0). Wet season wt/net/night catcheswere highest at PAD-2 (326.1g) and lowest at PAD-1 (180.2g); while dry season catch rates were highest at PAD-4.2 (326.1g) and lowest at PAD-3 (180.0g). The above numerical and biomass relative abundance data across experimental transect; and catch rates (number and biomass/net/night) represent a strong multispecies fishery in the near-shore waters of Kingfisher Flats.
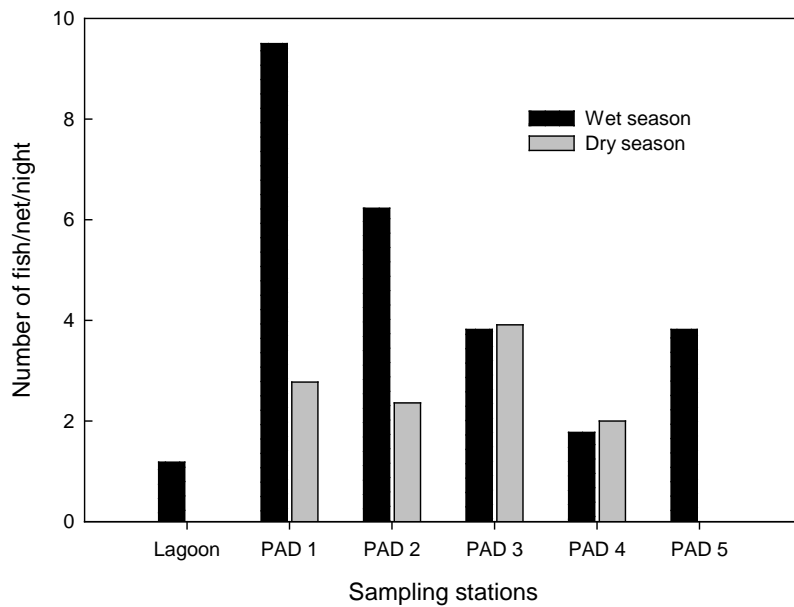
Figure 6.2: Seasonal variation in the number of fish caught/net/night from sampled transects in the near shore waters of kingfisher flats
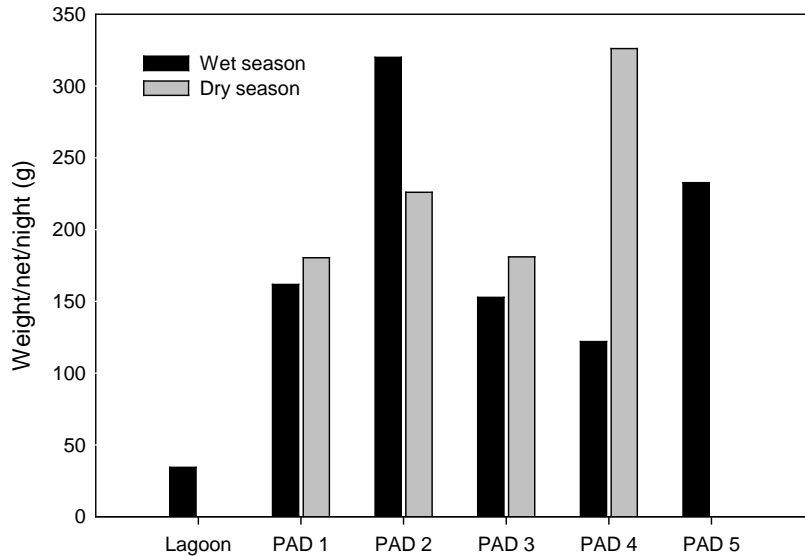
Figure 6.3. Seasonal variation in the weight of fish caught/net/night from the sampled stations in the near shore waters of kingfisher flats

During the wet season the highest number of fish per net per night was recorded at PAD-1 (9.5) and the lowest at the Lagoon (1.18); while the corresponding values during the dry season were obtained at PAD- 3 (3.91) and PAD-4.2 (2.0). Wet season wt/net/night catches were highest at PAD-2 (326.1g) and lowest at PAD-1 (180.2g); while dry season catch rates were highest at PAD-4.2 (326.1g) and lowest at PAD-3 (180.0g). The above numerical and biomass relative abundance data across experimental transects; and catch rates (number and biomass/net/night) represent a strong multispecies fishery in the near-shore waters of Kingfisher Flats. These statistics are testimony to the vibrant artisanal fishery in the near-shore waters of Kingfisher Flats based primarily on.

6.3.3 Biology of dominant fish species

Selected biological parameters of dominant fish species namely *Alestes baremose, Brycinus nurse, Bagrus bayad, Hydrocynus forskahlii, Lates niloticus* caught in experimental gillnets in near-shore waters along Kingfisher Flats are tabulated in Table 6.3 Most of these dominant fish during the wet season comprised mature and immature populations, good relative condition factor with maximum sizes slightly smaller than those in the dry season. Clearly much more data over several seasonal rounds would be required to visualize clear trends. Tentatively, available data points to likely

similarity and differences in biological parameters like food habits and percentage maturity of various fish species in Table 6.3.

Table 6.3: Selected biological parameters of dominant fish species caught in experimental gillnets in nearshore waters of Kingfisher Flats during the dry season (March 2014) and wet season (May, 2014)

Date of sampling		Mar-2014	May, 2014
Species/Season			
Alestes baremose	Size range (cm)	14.8 – 25.4	23.2 – 30.6
	Mean length (cm TL)	20.1	26.4
	Maturity (%)	21%	33.4%
	Main food type (Increasing importance)	Povilla, Odonata, Detritus	Povilla, Odonata
	Mean condition factor	1.014±0.03	0.85±0.03
	Sample size (No.)	19	9
Brycinus nurse	Size range (cm)	7.8 – 12.1	8.6 – 9.4
	Mean length (cm TL)	9.06	9.0
	Maturity (%)	59%	50%
	Main food type (Increasing importance)	Povilla, Odonata, *Caridina nilotica*	Insect remains
	Mean condition factor	1.014±0.02	0.90±0.006
	Sample size (No.)	61	85
Bagrus bayad	Size range (cm)	21.5 – 39.4	10.5 – 33.0
	Mean length (cm TL)	30.1	23.3
	Maturity (%)	25%	Nil
	Main food type (Increasing importance)	Povilla, Odonata, Fish	Fish
	Mean condition factor	1.001±0.03	1.00±0.02
	Sample size (No.)	4	6
Hydrocynus forskahlii	Size range (cm)	11.5 – 35.5	14.5 – 45.3
	Mean length (cm TL)	25.1	22.8
	Maturity (%)	61.5%	27.8%
	Main food type (Increasing importance)	Fish, C. nilotica, Povilla	Fish, , Povilla
	Mean condition factor	1.00±0.02	1.01±0.03
	Sample size (No)	13	18
Lates niloticus	Size range (cm)	10.5 - 35	8.4 – 38.4
	Mean length (cm TL)	24.8	19.4
	Maturity (%)	12.5%	9.3%
	Main food type (Increasing importance)	Fish, C. nilotica	Fish, C. nilotica
	Mean condition factor	1.00±0.01	1.00±0.001
	Sample size (No.)	32	75
Oreochromis niloticus	Size range (cm)		6.8 – 18.8
	Mean length (cm TL)		10.2
	Maturity (%)		0
	Main food type (Increasing importance)		Algae
	Mean condition factor		1.00±0.06
	Sample size (No.)		7
Schilbe intermedius	Size range (cm)		15.4 – 22.6
	Mean length (cm TL)		19.1
	Maturity (%)		27.8%
	Main food type (Increasing importance)		Fish, Povilla, Odonata, C. nilotica
	Mean condition factor		1.02±0.01
	Sample size (No.)	-	18

In general the fish community in the near-shore zone of Kingfisher Flats is comprised by a fairly uniform rich multispecies mix of various ages in good condition- a reflection of adequate food. Invertebrates notably *Povilla adusta* and other invertebrates likely constitute the main food for juveniles while most adults feed mainly on fish. The native near-shore commercial fishery by gillnets is mostly based on *Lates niloticus, Brycinus nurse, Hydrocynus forskahlii and Alestes baremose;* while *Neobola bredoi* features strongly in the seine net commercial fishery.

7 Aquatic biodiversity survey of the riverine Wetlands of Buhuka Flats

7.1 Introduction

River Masika and two other riverine wetlands (local names yet to be found) traverse the Buhuka Flats from the escarpment to Lake Albert. A quick aquatic biodiversity survey of these wetlands was made during the dry season February 2014 to collect baseline data on their dry season extent, major vegetation formations, extent of surface water flows, key water quality parameters and major macro-invertebrate fauna. For this survey the nameless wetlands were loaned the names of "Airfield Stream" and "Pad 2 Stream". The "Airfield wetland" runs closest to the airstrip and is believed to overflow into the Lagoon during the rainy season. "Pad 2 Stream" is the third wetland system and it drains into Lake Albert close to oil development Pad 2.

7.2 Extent of the wetlands on Buhuka Flats

Masika River drains a large catchment in the hinterland beyond the escarpment. The river cascades down the escarpment through a deep gorge covered in scattered woodland and bush. At the base of the escarpment the river emerges with a brisk flow over rocks covered in thickets of short acacia shrubs and a scattering of *Euphorbia candelabra* (see pictures below). Midway the course of River Masika, patches of permanent wetland vegetation interspersed with woodland and bush were noted largely confined to the relatively narrow river valley. The riverine wetland widens considerably at the lower floodplain and delta sections. *Cyperus papyrus*, *Phragmites* and *Miscanthidium* were the dominant wetland vegetation. The popular wetland smell of hydrogen sulphide was strong in the delta section which the population is using for laundry and watering of cattle.

The riverine wetland system "Airfield Stream" also flows over rocks and goes through a disturbed section mainly due to overgrazing around the airfield and road construction (see pictures below).

During the wet season survey the river was a shallow steady stream. The lower floodplain section of "Airfield" tends to merge with the lagoon wetland. Stands of *Miscathidium* and *Phragmites* severely degraded by grazing were noted here.

"Pad 2 Stream" wetland system also flows over rocks through open savannah grassland vegetation and then dries up before the newly constructed bridge close to the shores of the lake. The GPS locations and other features of the wetland streams are summarised in Table 7.1.

Table 7.1: Environmental features at sampled sites, Riverine wetlands along Kingfisher flats (February 2014)

Parameter	Name of River/Stream		
	River Masika	Airfield Stream	Pad 2 Stream
Features	Flowing over rock through a large thicket of short shrubs of acacia patched with euphorbia. Towards the lake it is fringed with Papyrus, *Phragmites* and *Miscanthidium.*	Flowing over the rock. According to the local community, the stream has been in existence for the last three years. It flows through a disturbed wetland section around the airfield before entering into the lagoon	Pad 4-2 just north of village settlement in short scattered woodland; Shoreline few meters from escarpment,
GPS Location: Base at escarpment	36N 0249921 UTM 0135851	36N 0250426 UTM 0137188	36N 0250584 UTM 0138756
Water depth & bottom type	0.3m; rocky bottom	0.2 m; rocky bottom	0.2 m; rocky bottom
GPS Location: Middle	36N 0249057 UTM 0135880	36N 0249212 UTM 0137181	36N 0250203 UTM 0138716
Water depth & bottom type	0.5 m; fine sand. Community cross from this point; wash clothes; water animals	0.1 m; fine dark mud with water spreading to about 8 meters wide.	0.1 m; fine dark mud with water flowing in a small stretch about 3 meters wide.
GPS Location: End/Lake interface	36N 024662 UTM 0134964	36N 0247968 UTM 0137651	No coordinates taken
Water depth & bottom type	0.4 m; fine clay mixed with sand and smell of hydrogen sulphide	This is the lagoon shoreline. Depth not determined	Not determined as the interface was dry

7.3 Water quality

Measurements of the physical and chemical parameters assessed varied within the accepted limits of national drinking water/effluent discharge standards as per National Water and Sewerage Cooperation (Table 7.2). Because of differences in the nature of each habitat, dissolved oxygen varied at all sites sampled ranging from 1.3mgL^{-1} at River Masika Ecotone to 9.2mgL^{-1} in Pad 2 mid stream suitable for a balance biodiversity. pH also varied ranging from 7.1 at River Masika Ecotone to 9.6 at Pad 2 mid stream. Conductivity ranged 278 µScm^{-1} at the R. Masika Base to 966µScm^{-1} in the middle of the Lagoon. To a greater extent, the lake buffering capacity seems to be more influenced by Airfield/Lagoon and Pad 2 riverine wetland systems.

7.3.1 Phosphorus compound

The overall total phosphorus concentration ranged from 79.4 - 350.3µgL^{-1} supplying soluble reactive phosphorus (SRP) in the range of 0.2 in Lagoon middle to 34.5µgL^{-1} at the base of River Masika. The high concentration could have been due to the human interference as some rocks were found

smeared with the white soap remains most likely from laundry in addition to the rock geological composition.

7.3.2 Silica compound

Soluble reactive silica (SRSi) ranged from 456.7 - 929.7µgL^{-1} in all the nine sites sampled (Table 7.2). With more run-off joining in during the wet season, the concentrations are expected to increase and influence even that in the adjoining shoreline.

7.3.3 Nitrogen compound

Total Nitrogen concentration ranged from 104.2 - 863.1µgL^{-1} (Table 7.2) leading into the ammonia concentration of 4.4 - 33.9 µgL^{-1}. Nitrite the intermediate product ranged from 0.0 - 4.8µgL^{-1} similar to the lake condition while nitrate the final product of nitrification ranged from 18.6 - 179.7µgL^{-1} an indication of efficient conversion in the presence of dissolved oxygen which was greater than 6.3mgL^{-1} at all sites except R. Masika Ecotone (Wetzel, 2001).

7.3.4 Chlorophyll a

Chlorophyll a, ranged from 0.0 - 18.3µgL^{-1} (Table 7.2), this at some sites might decrease during the wet season as the algae do proliferate in the presence of sunlight which will be shaded off with the grown wetland plants.

7.3.5 Faecal coliform

All sites within the riverine wetland had faecal coliform ranging from 4 - 504 colony forming units per 100 mL well above the National Water and Sewerage Cooperation standard of zero colony forming units per 100 mL recommended for drinking water that goes together with the same quality supporting healthy biodiversity in a given area. The minute presences of coliform at these sites were possibly related to the community lacked proper of proper sanitation. There was a marked observation clearly seen while sampling R. Masika Ecotone that indeed showed the highest count of 540 CFU.

Table 7.2: Water quality parameters of samples from various wetland habitats on of Kingfisher Flats, Lake Albert (February 2014)

Parameters	Unit	River Masika Base	River Masika Middle	River Masika Ecotone	Airfield Base	Airfield Middle	Lagoon Inshore	Lagoon middle	Pad 2 Base	Pad 2 Middle	National Standard for portable water
Total Depth	m	<0.05	<0.05	<0.05	<0.05	<0.02	NM	NM	<0.05	<0.02	
Dissolved Oxygen	mgL^{-1}	7.9	7.4	1.3	7.8	8.2	6.4	6.3	7.4	9.6	**NS**
Temperature	°C	25.8	26.7	18.2	25.2	28.9	26.4	26.7	26.7	33.9	**20-35***
Conductivity	µScm^{-1}	278	290	407	507	960	978	966	656	626	**2500**
pH	--	8.8	8.6	7.1	9.2	8.9	8.4	8.2	9.2	9.6	**6.5-8.5**
Alkalinity	mgL^{-1}	144	140	188	292	540	412	432	332	364	**500**
Colour	Pt/Co	95	57	247	43	156	113	126	40	104	**15**
Hardness	mgL^{-1}	180	180	204	272	404	340	344	272	240	**500**
TDS	mgL^{-1}	131	157	188	254	614	615	614	293	312	**1200**
TS S	mgL^{-1}	12	5	18	4	17	11	9	4.0	10	**0**
Turbidity	NTU	6	9	10	5	10	8	8	5.0	7.5	**10**
Calcium: Ca^{2+}	mgL^{-1}	28.8	32	67.2	59.2	137.6	102	88	35.2	49.6	**75.0**
Magnesium: Mg^{2+}	mgL^{-1}	25.9	24	11.5	29.8	14.4	20.2	29.5	44.6	27.8	**50.0**
Fluoride: F$^-$	mgL^{-1}	1.0	0.8	0.8	1.1	0.9	0.9	0.9	1.1	1.0	**1.5**
Iron	mgL^{-1}	0.2	0.2	0.6	0.1	0.1	0.1	0.1	0.0	0.2	**5.0**
Sulphate	mgL^{-1}	2.0	2.0	4	1.0	19.0	3.0	2.0	11.0	8.0	**200.0**
Chloride: Cl$^-$	mgL^{-1}	0.1	0.1	0.04	0.04	0.1	0.1	0.1	0.04	0.5	**500.0**
BOD$_5$ at 20°C	mgL^{-1}	1.1	0.8	4.5	1.8	2.8	2.2	2.3	1.3	4.2	**30***
COD	mgL^{-1}	5.0	9.0	14.0	3.0	0.0	29.0	37.0	0.0	0.0	**100***
SR P	µgL^{-1}	34.5	3.3	12.4	15.8	3.3	0.7	0.2	10.2	9.9	**5000***
TP	µgL^{-1}		79.4			350.3	124.9	117.3			**10000***
Nitrate	µgL^{-1}	179.7	70.9	60.9	164.2	127.5	18.6	20.9	77.5	47.5	**45000**
Nitrite	µgL^{-1}	4.8	2.1	0.0	0.0	0.0	0.7	2.1	0.0	0.0	**3000**
Ammonia	µgL^{-1}	6.9	23.6	23.6	14.6	4.4	6.9	17.2	4.4	33.9	**1000**
Total Nitrogen	µgL^{-1}		175.6			595.3	648.8	863.1			**10000***
SRSi	µgL^{-1}	635.7	522.1	610.6	629.4	534.7	456.7	929.7	604.3	522.5	**NS**
Chlorophyll a	µgL^{-1}	2.6	2.6	5.2	2.6	3.5	18.3	23.5	0.0	2.6	**NS**
Faecal coliform	CFU/100mL	260	126	540	140	20	4	12	28	8	**0**

TDS = Total Dissolved Solids; TSS = Total Suspended Solids; TP = Total Phosphorus; SRP = Soluble Reactive Phosphorus; SRSi = Soluble Reactive Silica; NS = Not specified; * = Effluent discharge standard

7.4   Phytoplankton

In the riverine wetland, phytoplankton samples were identified and quantified from selected sites with clearance to receive sunlight. The Lagoon area had the highest total phytoplankton biovolume of 189.78 mm^3 L^{-1} at the inshore sites. Of this biovolume, more than 50% was contributed by the blue-green algae while Diatoms and Green algae shared similar proportions. Cryptomonads and Euglenoids appeared in minor biomass. The major biomass contributors were *Anabaena circinalis* (Blue-green) and *Scenedesmus acuminatus* (Green). All samples from the River base that was sipping through the rock at the foot of the escarpment sheltered with shrubs and wetland plants were not analysed due to the habitat characteristics unfavourable for the phytoplankton proliferation.

Table 7.4.1: Dry season distribution and abundance of phytoplankton in various wetland habitats on Kingfisher Flats at the shores of Lake Albert, expressed as biovolume (mm^3 L^{-1}) - February 2014.

Study sites	Lagoon		Airfield		River Masika	
	Inshore	**Middle**	**Base**	**Middle**	**Base**	**Ecotone**
Blue-green algae	109.90	18.20	ND	69.06	ND	2.07
Cryptomonads	7.49	10.29	ND	0.00	ND	0.00
Diatoms	33.89	18.61	ND	0.00	ND	7.42
Dinoflagellates	0.00	0.00	ND	0.00	ND	0.00
Euglenoids	0.27	0.14	ND	0.00	ND	0.00
Green algae	38.23	18.53	ND	1.90	ND	0.01
Total	**189.78**	**65.77**		**70.96**		**9.50**

ND = No analysed

A total of 31 genera belonging to five families of phytoplankton comprised by Blue-green algae; Cryptomonads; Diatoms; Euglenoids and Green algae (Table 7.4.1) were identified and contributed to the overall biovolume above. Blue-green algae comprised nine genera making a total of 10 species while Cryptomonads had only one genus and species. Diatoms had eight genera that comprised of eight species also. Green algae had the highest number of genera (11) comprising of 12 species.

Among the blue-green algae five species i.e.: *Anabaena circinalis, Aphanocapsa nubilium, Chroococcus limneticus, Merismopedia tenuissima* and *Planktolyngbya limnetica* were present at all sampled sites. *Coelomoron; Cylindrospermopsis* and *Merismopedia* were rare and only site specific. Notably, *Microcystis* more especially *Microcystis aeruginosa* recently identified as the only toxin

producing blue-green algae in Ugandan freshwater habitats (Okello et al, 2009) was conspicuously absent at all sites sampled due to the site pristine environmental conditions. Unlike in Lake Victoria and its catchment areas with anthropogenic eutrophication *Microcystis aeruginosa* are constantly proliferating (Okello et al, 2011). *Cryptomonads* was only importance for the two sites at the Lagoon.

Ten of the identified Diatoms genera were represented in the two riverine wetland systems (Lagoon and River Masika) while the Airfield stream showed only four species (*Navicula gastrum; Nitzschia acicularis; Nitzschia fonticola* and *Surirella species)*. The rare *Aulacoseira* that has almost disappeared from Lake Victoria leading to the disappearance of some native fish species from Lake Victoria as well as it forms their best feeds (Ogutu-Ohwayo et al, 2002).were present at the two sites in the lagoon. The green algae that comprised of 13 different species were present mainly in the Lagoon sites and absent in the Airfield samples. Only *Actinastrum species* was recorded from River Masika Ecotone.

Table 7.4.2: Dry season phytoplankton taxonomic checklist, species composition and distribution in various wetland habitats on Kingfisher Flats, shores of Lake Albert - February 2014

Family	Species	Lagoon		Airfield	R. Masika
		Inshore	Middle	Middle	Ecotone
Blue-green	*Anabaena circinalis*	√	√	√	√
	Anabaenopsis tanganikae	√	√		
	Aphanocapsa delicatissima		√		
	Aphanocapsa nubilium	√	√	√	√
	Chroococcus limnetica	√		√	√
	Chroococcus species		√		
	Coelomoron species		√		
	Cylindrospermopsis africana			√	
	Merismopedia glaca	√			
	Merismopedia tenuissima	√	√		√
	Planktolyngbya circumcreta		√		
	Planktolyngbya limnetica	√	√	√	√
	Psuedoanabaena species	√			
Cryptomonads	*Cryptomonads species*	√	√		
Diatoms	*Aulacoseira granulata*	√	√		
	Cyclostephanodiscus species	√	√		√
	Epithemia argus				√
	Raphidium species		√		
	Navicula gastrum			√	√
	Nitzschia acicularis	√	√	√	√
	Nitzschia fonticola			√	
	Raphidium species		√		
	Surirella species			√	
	Synedra cunnigton				√
Green algae	*Actinastrum species*	√			√
	Ankistrodesmusfalactus		√		
	Closterium acerosum	√			
	Crucigenia fenestrata	√	√		
	Kirchneriella obesa	√			
	Monoraphidium contortum	√	√		
	Oocystis gigas	√			
	Pediastrum simplex	√	√		
	Scenedesmus acuminatus	√	√		
	Scenedesmus bijugatus		√		
	Scenedesmus perfolatus	√	√		
	Selenestrum	√			
	Tetraedron trigonum		√		
Total species		**22**	**23**	**09**	**11**

7.5   Macro-invertebrate composition and abundance within the riverine wetlands

The most common taxa at riverine wetland sites were the genus *Macrocoris* (Hemiptera) with mean density of 0 to 28 individuals/m^2, Chironomidae (Diptera) with 0 to 28 individuals/m^2, and oligochaetes with 0 to 196 individuals/m^2. Others such as the *Simulium* (Diptera) with density ranging from 0 to 210 individuals/m^2, were rare and recovered only from Pad 2 base. The *Biomphalaria* (Gastropod) were also rare and only found at Air field and Pad 2 base (Table 7.5.1).

Table 7.5.1: Macro-invertebrate taxa composition and abundance within the riverine area

	Taxa details		River taxa mean no. per square meter						
Family	Genus	Species	Air field stream	Air field base	Airfield	Pad 2 Base	Mid 2	R. Masika base of escapment	R. Masika ecotone shores
Chironomidae			28	28	0	14	0	0	0
Simulidae	*Simulium*		0	210	0	28	0	0	0
Libellulidae			0	0	14	42	0	0	0
Naucoridae	*Macrocoris*		0	84	98	14	0	14	0
Baetidae			0	28	0	0	0	0	0
Ephemerellidae	*Ephemerella*		0	14	0	0	0	0	0
Hyrophilidae	*Hydrobius*		0	0	0	0	14	0	14
Gyrinidae	*Dineutus*		0	14	0	14	0	0	0
Psephinidae	*Ectopria*		0	14	0	0	0	0	0
Hypropsychidae	*Parapsyche*		0	28	0	0	0	0	0
Planorbidae	*Biomphalaria*		0	0	196	14	0	0	0
Lymnaeidae	*Lymnaea*	*exserta*	0	14	0	0	0	0	0
*Oligochaetes			0	196	0	0	0	14	14
* = Not identified further									

In the riverine wetland sites, EPT indicated favorable environment at Air field base as compared to the rest. Total taxa results showed that Air field Base and Pad 2 Base were the ones with moderate good conditions as compared to others (Figure 7.5.1). If the rivers in the sampled riverine area are seasonal, then low counts of macro-invertebrates in some of these sites could be attributed to such factor, especially during this present dry season. The lagoon appears to be isolated from the lake and may be facing a number of environmental setbacks. During dry season like the present one, the lagoon seem to be disconnected from the lake, suffers inadequate mixing and probably low dissolved oxygen in the bottom sediments due to organic decomposition. These suspected harsh conditions in the lagoon concur with the present findings that indicate absence of intolerant species of ephemroptera, plecoptera and trichoptera (Figure 7.5.2) but presence of some tolerant organisms such as chironomidae and oligochaetes (Kellog, 1994) in the place. As similarly reported in the

previous study (NaFIRRI 2008), a lagoon such as the present one, can be a unique habitat for fish and other organisms including macro-invertebrates

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Figure 7.5.1: Total taxa richness index within the riverine area

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Figure 7.5.2: Ephemeroptera, Plecoptera and Trichoptera (EPT) taxa richness index within the riverine area

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Second wet season aquatic biodiversity surveys of the Kingfisher Discovery Area, Lake Albert

By

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1   Introduction

The Kingfisher oil discovery field to be developed by CNOOC encompasses the Buhuka Flats of Buhuka parish at the eastern shores of Lake Albert in Kyangwali sub County, Hoima District. CNOOC would establish a Central Processing Facility (CPF) at the Buhuka Flats to develop the Kingfisher oil field. Crude oil and gas would then be transferred via pipeline to the oil refinery to be built at Kabale in Hoima District. As part of the mandatory Environmental and Social Impact Assessment (ESIA) required by the National Environment Management Authority (NEMA), CNOOC commissioned seasonal aquatic biodiversity surveys of surface waters targeting the main dry and rainy seasons, and the shorter dry season of 2014. The dry season, first wet season and second wet season biodiversity surveys were made between 23rd February to 8th March 2014, 23rd to 28th May 2014 and 15th -20th November 2014, respectively. The design of the biodiversity surveys was preceded by a review of previous relevant baseline ecological studies, environmental and social impact assessment reports, plus other relevant literature provided by the Client. The literature review noted insufficient focus on aquatic biodiversity of surface waters of the Kingfisher Flats. The seasonal aquatic biodiversity surveys were accordingly designed to fill this gap. The wealth of baseline data assembled would constitute vital input into rational environmental decision making to guide establishment of the Central Processing facility for the development of the oil and gas reserves at the Buhuka Flats.

1.1   General objectives and survey methodology

The overall objective of wet season 2 surveys was to assemble baseline aquatic biodiversity data focusing on aquatic macro-invertebrates, the fishes and the extent of wetland habitats as well as their dominant flora and macro-invertebrate fauna at target locations of King Fisher Flats. Survey locations were originally selected as those likely to be the main potential entry

routes for oil pollution into surface waters of Kingfisher Flats. The locations included the near-shore zone of Buhuka Flats opposite Kingfisher Discovery Area oil development wells at Pad 1, Pad 2, Pad 3, Pad 4-2 and Pad 5 (Figure 1). The Lagoon being a unique surface water resource located close to Pad 1 was also surveyed. The Lagoon is also close to the main Jetty for servicing activities relevant to oil development at Kingfisher Flats.
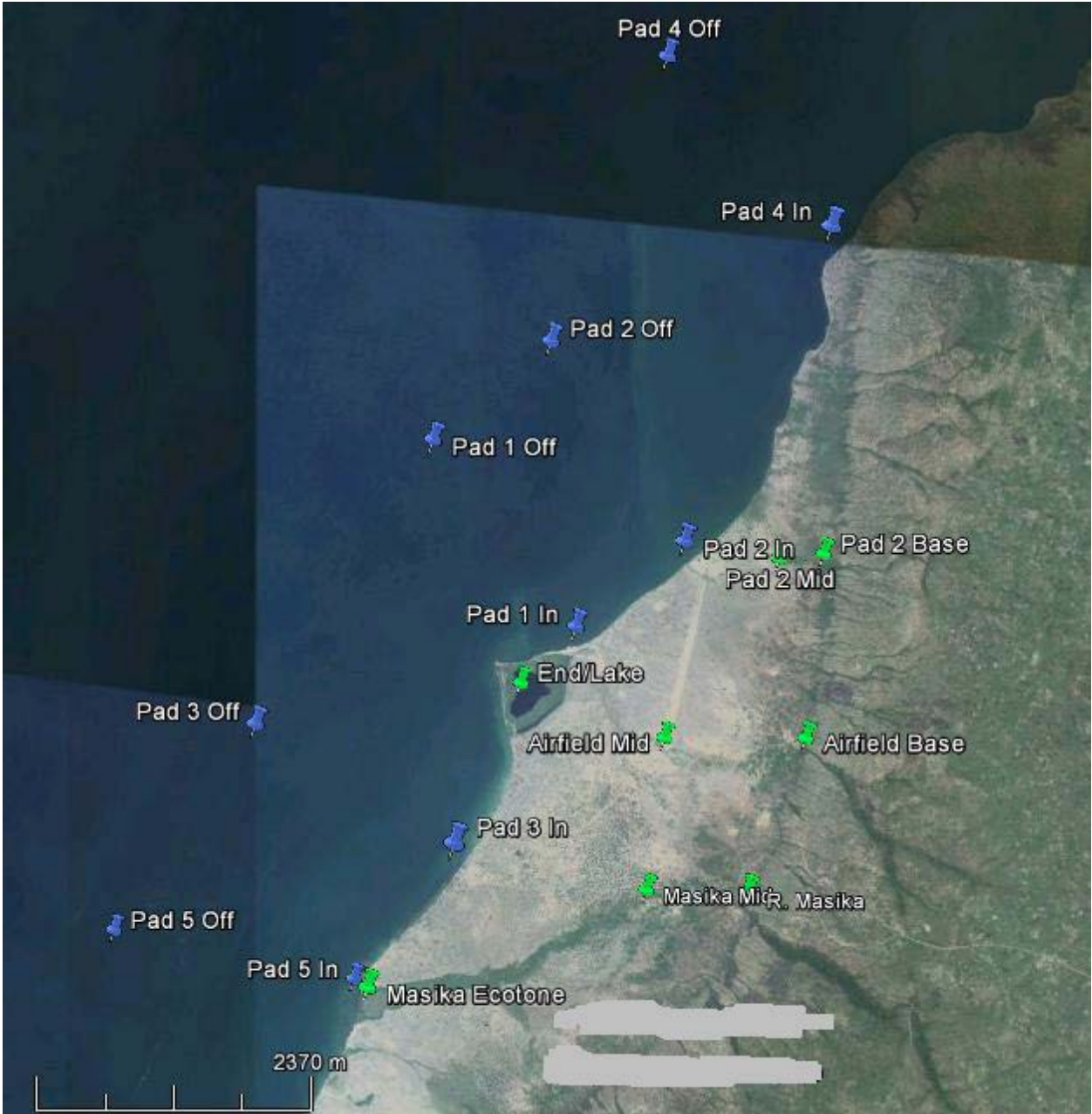
Figure 1. Map of Kingfisher flat sampling site (blue pins are the lake sites while green are the riverine sites)

1.2. Sampling site

Sampling sites for wet season 2 2014 survey were located by GPS and they were the same sites sampled during the dry season survey of February/March and wet season 1 in May 2014. Data for macro invertebrates and the fishes were collected from the same locations along five transects two kilometers long (from the shore lake-ward) opposite each of the five selected oil well development pads. Samples from each transect were collected at two sites - about 10 m from shoreline (inshore) and at the end of the transect 2 kilometers from shore (offshore). In the Lagoon the samples were picked about 10 m from the shore and at about midway across the Lagoon. For each transect and sampled site, shoreline topography, soil type and vegetation cover characteristics; water depth, nature of bottom sediments and GPS location were recorded. Table 1.1 below lists the environmental features at each sampling site plus the GPS locations.

Table 1.1: Environmental features at sampled sites in nearshore waters of Lake Albert along Kingfisher flats (March 2014)

Parameter	Name of Transect				
	Pad 1	Pad 2	Pad 3	Pad 4-2	Pad 5
Shoreline features	High eroded banks; just to north of Lagoon; soils - sandy; Hinterland: seasonal wetland with eroded *Miscathedium* and patches of *Typha* plus *Phragmites*	Close to seasonal stream; high eroded banks of sandy clay; hinterland – heavily grazed grassland; big community at a distance	Fairly high eroded banks, soils -sandy clay; immediate shore lined with low thickets. Shoreline waters lined with clumps of *Cyperus laevigatus*	Pad 4-2 just north of village settlement in short scattered woodland; Shoreline few meters from escarpment,	Pad 5 low lying shoreline with seasonal wetland with both emergent and submerged fringing macrophytes
GPS Location: Inshore (10 m)	36N 0248441 UTM 0138118	36N 0249381 UTM 0138848	36N 0247377 UTM 0136236	36N 0250649 UTM 0141538	36N 0246523 UTM 0135109
Water depth & bottom type (Dry season)	1.1 m; sandy bottom with plant debris	2.6 m; clay mixed with shells	1.8 m; Sandy with live plant material	4.9 m; Soft mud	1.8m; sandy clay
Water depth & bottom type (Wet	1.5 m; sandy bottom with plant debris	4.4 m; clay mixed with shells	2.5 m; Sandy with live plant material	3.3 m; Soft mud	1.8m

season)					
GPS Location: Offshore (2 km)	36N 0247205 UTM 0139724	36N 0248228 UTM 0140570	36N 0245666 UTM 0137286	36N 0249238 UTM 0143016	36N 0244445 UTM 0135530
Water depth & bottom type (Dry season)	24.6 m; fine clay mixed with shells	14.0 m; Rocky with crushed shells	27.3 m; Very fine dark, smooth sand	28.6 m; Not determined	
Water depth & bottom type (Wet season)	26.9 m; fine clay mixed with shells	13.5 m; Rocky with crushed shells	27.3 m; Very fine dark, smooth sand	28.1 m; Not determined	26.8; fine dark sand

2 Taxonomic composition, distribution and abundance of macro-invertebrates

2.1 Specific objective

i. Describe site specific characteristics of bottom substrates sampled for macro-invertebrates at the selected transect in near-shore waters of Kingfisher Flats and at the riverine wetland sites.

ii. Determine taxonomic composition distribution and relative abundance of the macro-invertebrates.

iii. Characterise and compare the seasonal (dry and wet) composition, abundance and distribution of macro-invertebrate taxa across sampled transects.

iv. Basing on literature evaluate the significance of macro-invertebrates as indicators of environmental quality at sampled transects of Kingfisher Flats.

v. Deduce the current environmental conditions at the sampled transects/sites of Kingfisher Flats based on distribution and abundance of various macro –invertebrate taxa

2.1.1 Sampling and analysis methodology

Water depth (m) at each sampling site was measured using an eco-sounder of 400Hz and triplicate bottom sediment samples containing benthic macro-invertebrates collected using Ponar grab of approximate jaw area and inner depth of 238.0 cm^2 and 8.0 cm, respectively (APHA, 1992). The sediment samples were emptied into plastic basin, their physical characteristics (e.g. soft mud, sandy, stony, etc) noted. The samples were subjected to further processing procedures (APHA, 1992; Ferraro and Cole, 1992 Ochieng, 2006 and Ochieng *et al.*, 2008) in order to sort, identify and quantify the macro-invertebrates. Taxonomic identification was done using guides of Mandal-Barth, 1954; Merrit and Cummins, 1984 and De Moor *et al.*, 2003

The data was processed using MS excel program. With the known jaw area of the sampling gear (ponar grab), mean numbers of macro-invertebrate taxa were calculated from the counts got from the combined three sediment samples (n=3) at each site. The mean values were rounded off to the nearest whole numbers to determine the macro-invertebrate taxa numbers (richness) and also used to calculate their abundance (mean numbers per square

meter). Three indices namely; (i) EPT (Ephemeroptera, Plecoptera and Trichoptera) taxa richness, (ii) Total taxa richness and (iii) Abundance of macro-invertebrate individuals (Wenn, 2008; Oghenekaro, 2011) were determined and used for description of macro-invertebrate status as indicators of environmental quality. Mean numbers of macro-invertebrate individuals recovered during the dry season (March), wet season 1 (May) and wet season 2 (November) 2014 were compared using Paired samples T test ($p = 0.05$) in SPSS 11.5 for Windows. The information is presented in form of graphs for EPT and Total taxa richness, and tables giving the details of all taxa abundances and distribution at samples sites.

2.2   Results

2.2.1   Water depths and bottom substrates within the near-shore of the lake

The present total water depth (meters, m) at the inshore stations, ranged from 1.4 to 10.6 at Lagoon and Pad 4, respectively. At offshore sites, water depth ranged from 2.0 at lagoon to 29.0 at Pad 3. These were generally similar to the water depths recorded during the previous two surveys (Table 2.1). Bottom substrates varied from station to station as they were found in the previous surveys; consisting of substrates such as sand, plant material, clay, and snail shells (Table 2.1).

Table 2.1 Water depths and bottom substrates at sampled near-shore sites of the lake

		Pad 1		Pad 2		Pad 3		Pad 4		Lagoon		Pad 5	
Sites													
Staions		Inshore	Offshore	Inshore	Offshore	Inshore	Offshore	Inshore	Offshore	Inshore	Offshore	Inshore	Offshore
Water depth (m)	D	1.1	26.9	4.4	14	2.5	27.3	14.9	28.6	1.4	1.8	ND	ND
	W1	1	ND	3.3	13.5	2.8	27.7	15.6	28.1	1.6	ND	2.8	ND
	W2	1.5	25.3	2.5	13.7	3	29	10.6	28.7	1.4	2	1.9	28
Bottom substrates (In D & W1 seasons)		Sand and plant materials	Fine clay mixed with shells	Clay mixed with shells	Rocky with crushed shells	Sandy with plant growths	Very fine smooth & dark sand	Soft mud	ND	ND	ND	ND	ND
Bottom substrates (In W2 season)		Brown clear sand	Dark grey,sticky clay shells and fragments	Fine grey clay	Sandy clay bottom with shell/fragments	Bottom composed *Najas* sp and other submerged plants,no mud, bear bottom	Dark fine grey clay	Grey clay a lot of shells(fragments)t	Grey clay shell fragments	ND	ND	Bottom full of macrophytes(*Najas sp*)	Dark grey fine clay
		D = Dry season, W1 = Wet season 1, W2 = Wet season 2, ND = Not done											

2.2.2 Water depths and bottom substrates at the riverine area

The riverine sites were generally shallow; their water depths were within 0.5m, and most of their bottom substrates consisted of mainly sand.

2.2.3 Ephemeroptera, Plecoptera and Trichoptera (EPT) taxa richness

During wet season 2 Ephemeroptera, Plecoptera and Trichoptera (EPT) richness, at the stations of near-shore of the lake, ranged from 0 to 2, and compared well with those reported for dry season and wet season 1 (Figure 2.1). *Povilla adusta* (Ephemeroptera) was the most common species within the present EPT richness – similar to that found in the previous surveys. *Povilla adusta* was found at Pad 2 offshore, Pad 3 inshore, Pad 4 inshore and Pad 5 inshore - almost similar to the occurrences observed in the previous surveys (Table 2.2). Among the Trichoptera, *Dipseudopsis* sp of the family Dipseudopsidae was the only taxon recovered during wet season 2, at same station of Pad 4 inshore where it was found during wet season 1 (Table 3.2).
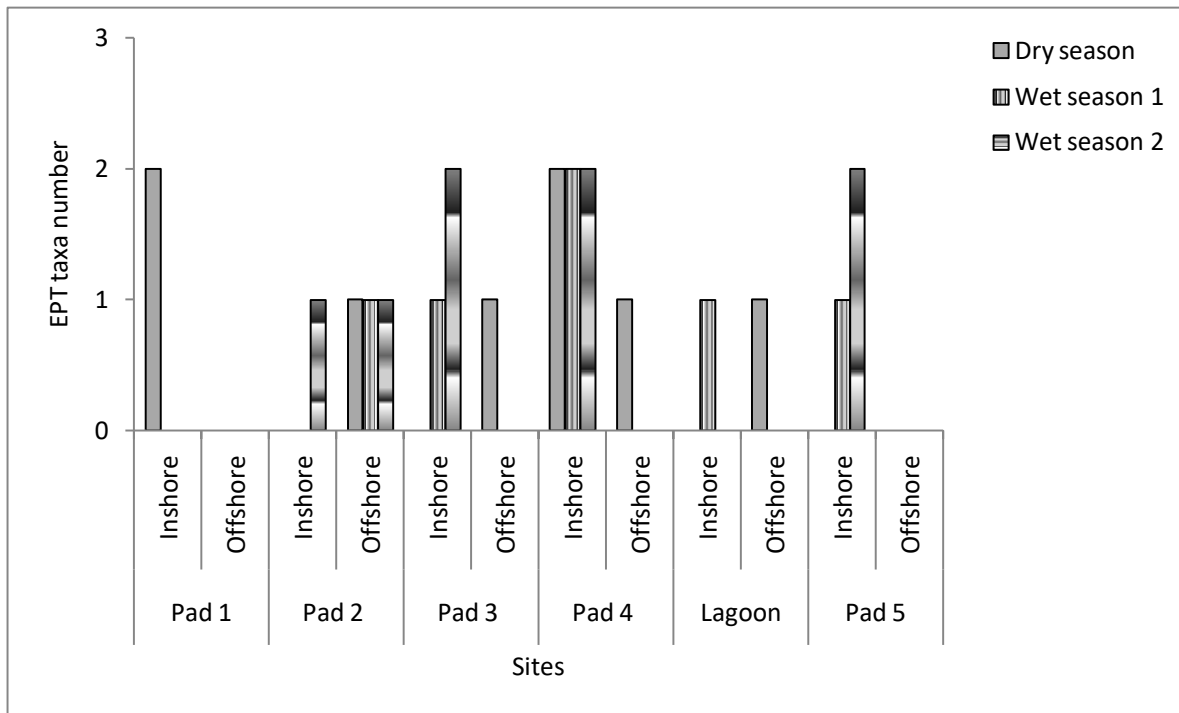
Figure 2.1 Ephemeroptera, Plecoptera and Trichoptera (EPT) taxa richness at the near-shore of the lake

2.2.4 Total taxa richness within near-shore of the lake

Total taxa richness during this survey, ranged from 2 at Pad 1 inshore to 15 at Pad 3 inshore. During wet season 1, total taxa number ranged from 2 at Lagoon offshore to 15 at Pad 2 offshore (Figure. 2.2).
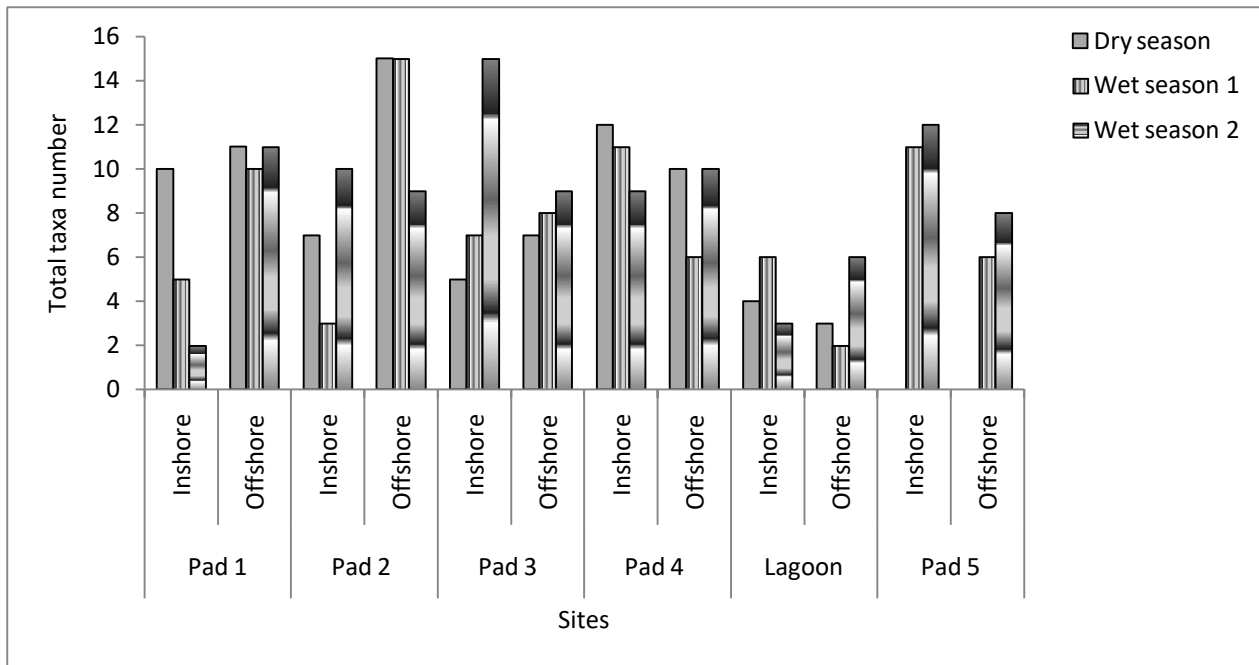
Figure 2.2 Total macro-invertebrate taxa richness at the near-shore of the lake

2.2.5 Macro-invertebrate abundance and distribution within near-shore of the lake

As found during the previous surveys, the gastropods, bivalves, Chaoboridae, ephemeroptera and oligochaetes (aquatic worms) were the most common and abundant macro-invertebrates within the bottom substrates during this survey. During this survey, species of gastropods such as *Melanoides tuberculata* and *Bellamya unicolor*, *Corbicular africana* (Bivalve) and *Povilla adusta* (Ephemeroptera), were the most abundant. The present situation is quite similar to the previous ones (Table 2.2).

NB **A dedicated search did not find *Bellamya rubicunda* or *Gabiella candida* at the inshore stations or the wetland streams of Kingfisher Flats of Lake Albert.**

Table 2.2 Macro-invertebrate taxa abundance and distribution within the near-shore of the lake

Lake near-shore taxa mean no. per square meter

Family	Genus	Species	Pad 1 inshore D	W1	W2	Pad 1 offshore D	W1	W2	Pad 2 inshore D	W1	W2	Pad 2 offshore D	W1	W2	Pad 3 inshore D	W1	W2	Pad 3 offshore D	W1	W2	Pad 4 inshore D	W1	W2	Pad 4 offshore D	W1	W2	Lagoon inshore D	W1	W2
*Chironomidae			28	28	8	28	84	36	0	0	3	0	0	0	0	56	25	98	14	14	42	0	0	14	0	6	14	28	28
Ceratopogonidae	*Palpomyia*		0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	56	0	0
Chaoboridae	*Chaoborus*		0	0	0	14	280	518	0	70	0	0	0	0	0	0	0	0	168	322	0	14	0	0	0	0	0	0	28
Libellulidae			0	0	0	14	0	0	0	0	28	0	0	0	0	0	28	0	0	0	14	42	28	0	0	0	0	0	0
Coenagronidae			0	0	0	0	0	0	0	0	0	0	0	0	0	14	14	0	0	0	0	0	0	0	0	0	0	0	0
Gomphidae	*Progomphus*		14	0	42	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0
Gomphidae	*Hagenius*		0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0	0
Polymitarcyidae	*Povilla*	*adusta*	42	0	0	0	0	0	0	0	0	1036	1,708	1,204	0	14	28	0	0	0	14	140	994	0	0	0	0	14	0
Caenidae	*Caenis*		14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baetidae	*Baetis*		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0
Dipseudopsidae	*Dipseudopsis*		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28	28	0	0	0	0	0	0
Psychomidae			0	0	0	0	0	0	0	0	28	0	0	0	0	0	0	28	0	0	28	0	0	28	0	0	0	0	0
Thiaridae	*Melanoides*	*tuberculata*	0	0	0	168	28	210	14	0	98	462	896	42	14	28	28	42	0	84	322	98	0	518	168	14	0	0	0
Thiaridae	*Cleopatra*		14	0	0	28	0	0	14	0	0	392	0	0	28	0	0	280	0	0	238	0	0	56	0	0	0	0	0
Thiaridae	*Cleopatra*	*pirothi*	0	0	0	0	28	28	0	0	0	0	406	42	0	0	0	0	280	14	0	28	0	0	56	0	0	0	0
Bithyniidae	*Gabbia*	*humerosa*	882	14	0	0	0	0	0	0	1,401	28	84	0	1064	0	1,078	0	0	0	14	0	0	0	0	0	0	0	0
Bithyniidae	*Gabbia*	*tilhoi*	0	0	0	0	0	0	0	0	0	70	210	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bithyniidae	*Gabbia*	*walleri*	0	0	0	84	0	210	0	0	0	490	574	14	0	0	0	28	70	14	28	0	0	42	0	0	0	0	0
Viviparidae	*Bellamya*	*unicolor*	14	0	0	168	70	70	238	0	14	238	154	56	0	14	84	182	112	42	994	154	126	252	14	56	0	84	0
Planorbidae	*Biomphalaria*		0	0	0	0	0	0	0	0	14	14	14	0	0	0	28	0	0	0	0	14	14	0	0	0	0	0	0
Planorbidae	*Bulinus*		14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sphaeriidae	*Sphaerium*		28	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sphaeriidae	*Sphaerium*	*victoriae*	0	28	0	0	0	42	0	0	70	0	0	0	0	0	28	0	0	0	0	0	0	0	0	14	0	0	0
Sphaeriidae	*Byssanodonta*	*parasitica*	0	0	0	182	84	518	14	0	0	182	294	14	0	0	0	0	14	0	56	0	14	98	14	28	0	0	0
Unionidae	*Caelatura*	*bakeri*	0	0	0	28	42	84	28	0	0	14	42	42	14	28	14	0	0	0	0	0	0	0	56	42	0	56	0
Unionidae	*Caelatura*	*acuminata*	0	0	0	14	14	0	0	0	0	14	42	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	0
Unionidae	*Caelatura*	*mocenti*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0	0
Corbiculidae	*Corbicula*	*africana*	0	0	0	28	28	140	98	0	0	112	672	42	0	0	84	0	14	14	294	140	112	238	112	56	0	42	14
Mutelidae	*Mutela*		0	14	0	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0	28	0	0	0	0	0	0	0	0
Mutelidae	*Aspatharia*		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*Leeches			0	0	0	0	0	0	0	0	0	196	294	14	0	0	0	0	0	0	0	28	0	0	0	0	0	0	0
*Oligochaetes			0	70	0	28	28	0	70	168	42	0	14	0	28	140	0	56	98	28	0	70	0	0	0	42	56	28	0
Atyidae	*Caridina*	*nilotica*	14	0	0	0	0	56	0	0	14	56	14	0	0	0	42	0	0	56	0	0	616	42	0	210	0	0	0

* = Family not identified further, D = Dry season, W1 = Wet season 1, W2 = Wet season 2, D* = Not sampled during dry season

3 Macro-invertebrate taxa composition, abundance and distribution at the riverine wetlands

3.1 Ephemeroptera, Plecoptera and Trichoptera (EPT) taxa richness

During the present survey, Ephemeroptera, Plecoptera and Trichoptera (EPT) taxa richness within the four sampled riverine sites ranged from 0 to 3. The highest number of 3 was found at Pad 2 base and River Masika Mid, with none (0) at River Masika ecotone and 2 at River Masika Base of escarpment (Figure. 3.1). EPT was relatively higher at Pad 2 Base and River Masika Mid in the present than in the previous surveys and were composed mainly of *Baetis* sp (Ephemeroptera) and *Cheumatopsyche* sp (Trichoptera), as indicated (Table 3.1).
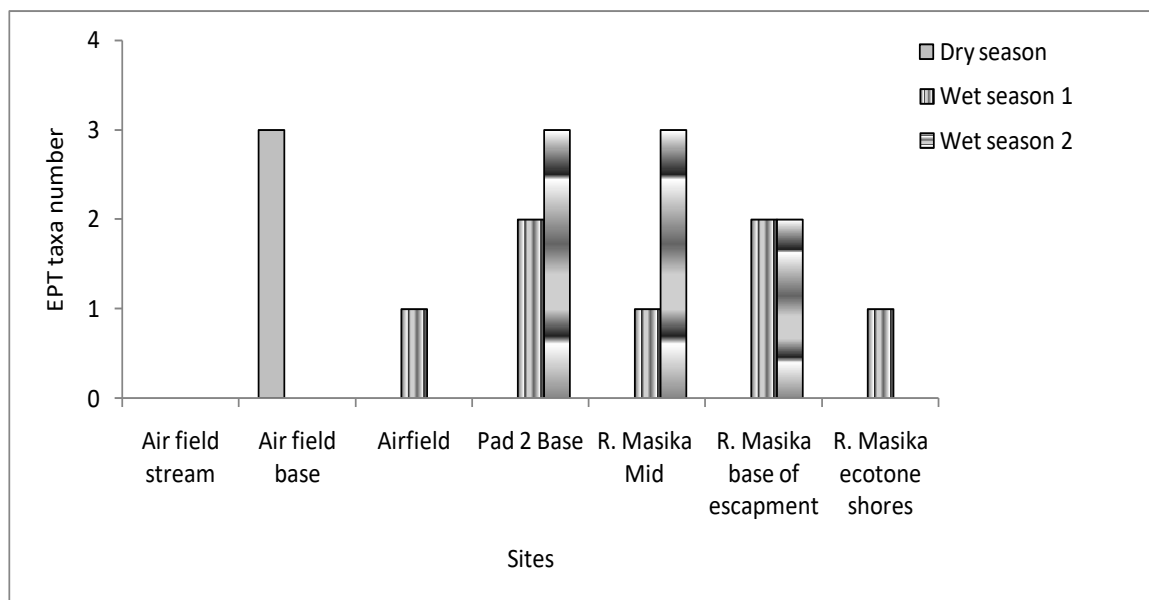
Figure 3.1 Ephemeroptera, Plecoptera and Trichoptera (EPT) taxa richness in riverine wetlands

3.2 Total taxa richness

In this sampling period (Figure. 3.2), total taxa richness at four sampled sites within the riverine area ranged from 0 at River Masika ecotone to 17 at Pad 2 Base. The values were generally higher than those of the previous surveys, except at the ecotone area.
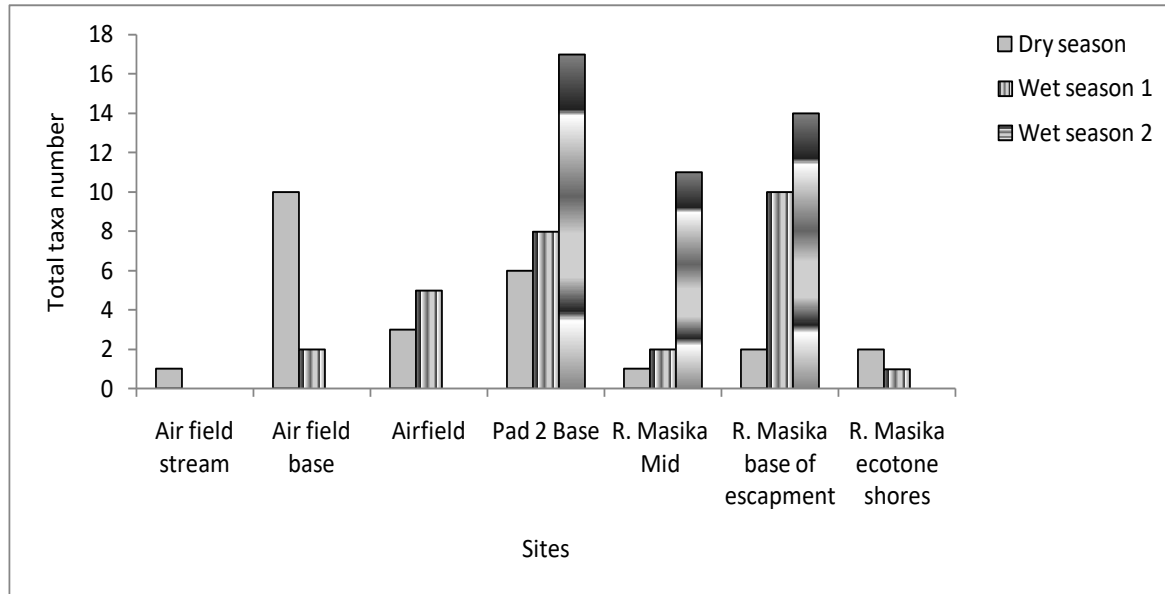
Figure 3.2 Total taxa richness at the riverine area

3.3   Macro-invertebrate abundance and distribution

The most abundant taxa during this season, though at particular sites such as Pad 2 Base and River Masika base of escarpment, were the Baetis sp (Ephemeroptera) and Cheumatopsyche sp (Trichoptera) with densities ranging from 0 to 6,723 individuals/m^2. Chironomidae (Diptera) with density of 0 to 98, and oligochaetes with density 0 to 385, were also generally common in the sites, as previously found. Others such as the *Simulium* (Diptera) with density ranging from 0 to 77, were recovered only from Pad 2 base (as previously) and also at River Masika base of escarpment (Table 3.1).

Table 3.1 Macro-invertebrate taxa composition and abundance in the riverine wetlands

	Taxa details		River taxa mean no. per square meter																				
Family	Genus	Species	Air field stream			Air field base			Airfield mid			Pad 2 Base			Masika Mid			R. Masika base of escapment			R. Masika ecotone shores		
			D	W1*	W2*	D	W1	W2*	D	W1	W2*	D	W1	W2	D	W1	W2	D	W1	W2	D	W1	W2
*Chironomidae			28			28	0		0	0		14	0	21	0	0	98	0	0	49	0	0	0
Chaoboridae	Chaoborus		0			0	14		0	0		0	0	0	0	0	0	0	0	0	0	0	0
Simulidae	Simulium		0			210	0		0	0		28	56	77	0	0	14	0	0	35	0	0	0
Tipulidae	Tipula		0			0	0		0	0		0	14	35	0	0	0	0	14	98	0	0	0
Tabanidae	Tabanus		0			0	0		0	0		0	0	0	0	0	0	0	14	0	0	0	0
Stratiomyiiddae	Euparyphus		0			0	0		0	0		0	0	14	0	0	0	0	0	7	0	0	0
Libellulidae			0			0	0		14	14		42	14	0	0	14	0	0	0	0	0	0	0
Gomphidae	Progomphus		0			0	0		0	0		0	0	0	0	0	7	0	14	7	0	0	0
Libellulidae	Symptrum		0			0	0		0	0		0	0	0	0	0	21	28	0	0	0	0	0
Libellulidae	Brachymesia		0			0	0		0	0		0	0	91	0	0	0	0	0	126	0	0	0
Libellulidae	libellula		0			0	0		0	0		0	0	7	0	0	0	0	0	7	0	0	0
Aeshnidae	Coryphaeschna		0			0	0		0	0		0	14	0	0	0	0	0	0	0	0	0	0
Aeshnidae	Aschna		0			0	0		0	0		0	0	0	0	0	0	14	0	0	0	0	0
Aeshnidae	Epiaeschna		0			0	0		0	0		0	0	0	0	0	0	0	0	7	0	0	0
Coenarionidae			0			0	0		0	0		0	0	14	0	0	28	0	0	0	0	0	0
Calopterygidae	Haaerina		0			0	0		0	0		0	0	14	0	0	0	0	0	0	0	0	0
Naucoridae	Macrocoris		0			84	0		98	0		14	0	0	0	0	0	14	0	0	0	0	0
Naucoridae	Pelocoris		0			0	0		14	0		0	0	126	0	0	0	0	0	0	0	0	0
Nepidae	Nepa		0			0	0		0	0		0	0	7	0	0	0	0	0	0	0	0	0
Gerridae	Rheumatobates		0			0	0		0	0		0	0	7	0	0	0	0	0	0	0	0	0
Baetidae			0			28	0		0	0		0	0	0	0	0	0	0	0	0	0	0	0
Ephemerellidae	Ephemerella		0			14	0		0	0		0	0	0	0	0	0	0	0	0	0	0	0
Caenidae	Caenis		0			0	0		0	0		14	0	7	0	0	0	0	0	0	0	0	0
Baetidae	Baetis		0			0	0		0	70		0	56	1,155	0	70	91	0	1008	6,723	0	0	0
Hyrophilidae	Hydrobius		0			0	0		0	14		0	0	0	14	0	0	0	0	0	14	0	0
Gyrinidae	Dineutus		0			14	0		0	0		14	0	56	0	0	0	0	0	0	0	0	0
Psephinidae	Ectopria		0			14	0		0	0		0	0	0	0	0	0	0	0	0	0	0	0
Elmidae	Neocylloepus		0			0	0		0	0		0	0	0	0	0	0	0	0	70	0	0	0
Elmidae	Ancyronyx		0			0	0		0	0		0	0	0	0	0	14	0	0	35	0	0	0
Elmidae	Limnius		0			0	0		0	0		0	0	0	0	0	7	0	0	0	0	0	0
Hypropsychidae	Parapsyche		0			28	0		0	0		0	0	0	0	0	0	0	0	0	0	0	0
Hydropsychidae	Cheumatopsyche		0			0	0		0	0		0	0	658	0	0	70	0	364	2,801	0	0	0
Hydropsychidae	Potamyia		0			0	0		0	0		0	0	0	0	0	0	0	0	0	0	14	0
Philopotomidae	Chimarra		0			0	0		0	0		0	0	49	0	0	0	0	0	0	0	0	0
Pyralidae	Petrophila		0			0	0		0	0		0	0	0	0	0	0	0	0	14	0	0	0
Planorbidae	Biomphalaria		0			0	0		196	0		14	42	49	0	0	0	0	14	0	0	0	0
Lymnaeidae	Lymnaea	exserta	0			14	0		0	0		0	0	0	0	0	0	0	0	0	0	0	0
*Leeches			0			0	0		0	0		0	0	0	0	0	0	0	14	0	0	0	0
*Oligochaetes			0			196	14		0	14		0	14	385	0	0	7	14	14	42	14	0	0

= Family not identified further, D = Dry season, W1 = Wet season, W2 Wet season 2, W1* = Not sampled during wet1 season, W2* = Not sampled during wet season 2

3.4 Statistical comparison of macro-invertebrate densies among seasonal samples

Outputs from the Paired samples T-Tests indicated few cases of significant ($p < 0.05$) differences between densities of macro-invertebrate taxa recovered from particular sites during present (November 2014) and previous dry (February/March 2014) and wet (May 2014) seasons. These were:

(i) In comparison with dry season (first sampling), macro-invertebrate densities at the Lake near-shore were significantly ($p < 0.05$) lower than the present (wet season-2) densities at Pad 3 inshore but higher at Pad 2 offshore.

(ii) In comparison with wet season 1 (second sampling), macro-invertebrate densities at the Lake near-shore were significantly ($p < 0.05$) lower than the present (wet season-2) densities at Pad 1 inshore and higher at Pad 2 offshore, respectively

(iii) In comparison with dry season (first sampling) and wet season 1 (second sampling), macro-invertebrate densities at the riverine area were significantly ($p < 0.05$) different (lower) than the densities of wet seasn-2 only at River Masika Mid .

3.5 Discussion

The presence of some most sensitive macro-invertebrate taxa (EPT) such as those of Ephemeroptera (May flies) and Trichoptera (Caddis flies) (Wenn, 2008) at stations of Pad 2 offshore, Pad 3 inshore, Pad 4 inshore and Pad 5 inshore of the lake and Pad 2 Base, River Masika Mid and River Masika Base of escarpment of the riverine area, indicate relatively favourable environmental conditions. *Povilla adusta* (May fly) that have been found to occur in most of the sites at the near-shore lake area during present and previous surveys, have been reported (De moor *et al*., 2003) to dwell in lentic waters where they burrow into clay and hard substrates such as wood and feed mainly on microscopic algae. The Ephemeroptera genus called *Baetis*, which was also found in most of the riverine sites, are known to prefer lotic riffle areas under small to medium sized stones and are collector-gatherer feeders, generally on detritus (De moor *et al*., 2003). These indicate that the near-shore lake sites and the riverine sites that were presently sampled were still close to their natural conditions.

However, it has been specifically observed that the taxa of May flies at the riverine sites have varied since the first sampling (dry season). The dry and first wet season had just rare occurrences of *ephemerella* and *Caenis*, respectively, to relatively more abundant occurrence of *Baetis*, in all the four riverine sites sampled during this second wet season. It should be noted that although *Baetis* are genus of May flies, which are among the most sensitive taxa to pollution e.g. organic pollution, they have been reported to be reasonably tolerant to nutrient enrichment as compared to other genera of Ephemeroptera. Therefore their current occurrence in high abundance in most of the riverine sites could probably be a sign of some nutrient enrichment in this lotic environment.

The relatively higher total taxa numbers and significant (p <0.05) greater macro-invertebrate densities presently found in specific sites of riverine area as compared to the previous dry and wet season 1 results, indicate that the riverine area had much more negative impact than the lake area during previous dry period, and at the moment, it has quite recovered following the just ending long rainy season. Duration of rains have been reported to bring in suitable habitats (Beauchard *et al*., 2003) and probably adequate food resources that support more macro-invertebrates and dry period would lead to reduction of taxa richness, in streams such as the present ones. As described in a related study (Buffagni *et al*., 2009), the riverine area (lotic) in a normal situation, is expected to have greater EPT and total taxa than the near-shore lake area (lentic) and these have been presently observed to have started taking shape at the riverine area relative to the lake area.

The presence of abundant species of gastropods such as *Melanoides tuberculata* and *Bellamya unicolor* and *Povilla adusta* (Ephemeroptera), and *Baetis* sp (Ephemeroptera) and *Cheumatopsyche* sp (Trichoptera), within the sites of lake and riverine areas, respectively, found during the present and previous surveys, were a sign of insignificant contamination in these areas, if any. This is because most of the mentioned species above are known to be pollution intolerant (Kellog, 1994) and therefore would not survive in such environments if they were contaminated. The present findings give a trend in changes regarding the macro-invertebrate composition, abundance and distribution, and their related indications of environmental conditions, since its inception early this year. It therefore, follows that this kind of periodic bio-

monitoring is meaningful and can help in tracing environmental changes and guide in subsequent formulation of mitigation measures where necessary.

The snail Gabiola is very common in Lake Albert. … has never been encountered during these present surveys and is not reported in the literatures available to us.

4 Fishes

4.1 Fish taxa composition, abundance and distribution

A total of 15 fish species belonging to 7 families and 13 genera were recorded during wet season 2 sampling of November, 2014 compared to 19 fish species belonging to 8 families and 16 genera recorded during wet season 1 of May, 2014; and 13 species, 5 families and 11 genera from the dry season sampling (**Table 4.1**). Two catfish species *Synodontis schall, and S. frontosus* were recovered for the first time since the survey begun and so was Cyprinidae *Labeo horrie*. On the other hand, *Polypterus senegalis, Alestes macrolepidotus,,Clarius gariepinus, Barilus niloticus, Neobola bredoli and* Haplochromines *Neochromis sp and Astatotilapia "scarlet anal"* that were recorded in wet season 1 samples were not recovered during wet season 2. This could be attributed to the unsuccessful gillnet fishing experiments in the lagoon and beach seining at PAD-1 inshore. PAD-5 sites contributed the highest number of fish species (10 species) during wet season 2, unlike PAD-1 sites that dominated both the dry season (12 species) and wet season 1 (11 species). The least number of species were recovered from the Lagoon (2 species) during wet season 2 unlike from PAD-4 in wet season 1 and PAD-2 in the dry season. PAD-1 sites contributed the highest number of species during each of the three seasonal fishing surveys (**Figure 4.1**).
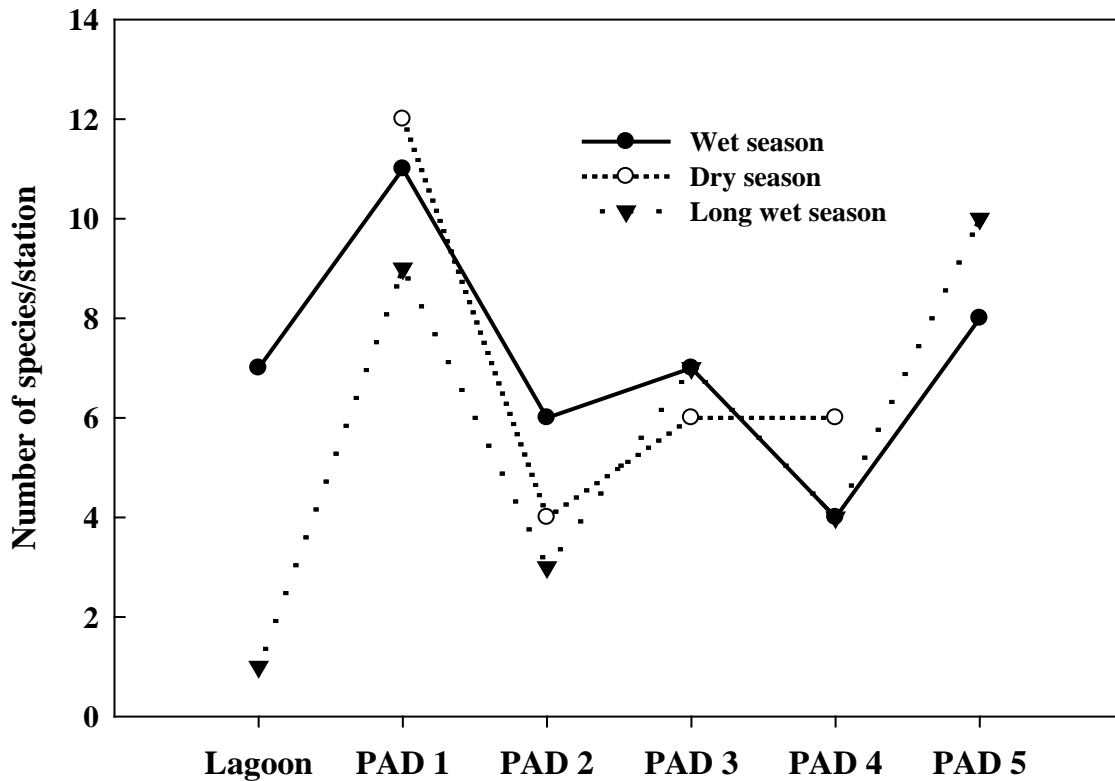
Figure 4.1 Total number of fish species recovered at nearshore sampling sites of Kingfisher flats during the dry season (March), wet season 1(May) and wet season 2 (November), 2014

Fish species distribution tended to differ by transect sampled, indicating habitat influence. The catfishes *Synodontis shall and S. frontosus* and *Auchenoglanis occidentalis* were only recovered from PAD-1 during wet season 2 while *Labeo horrie, Oreochromis leucostictus* and *Sarotherodon gallileaus* were only recovered from PAD-5, same season. Oreochromis niloticus was mainly recovered from the Lagoon in basket traps; while *Brycinus nurse* remained the most abundant fish species during wet season 2 as it was in the wet season 1 and the dry season. Other species of numerical importance during wet season 2 included *Lates niloticus, Oreochromis niloticus, Hydrocynus forskhalii* and haplochromines. In wet season 1 *Lates niloticus, Schilbe mystus* and haplochromines were the more numerically important and in the dry season mainly *Lates niloticus* and *Hydrocynus forskahlii dominated.* Key commercial species of Lake Albert recovered consistently though at varying numerical abundance include the Tiger

fish *Hydrocynus forskahlii,* the Nile perch *Lates niloticus, Alestes baremose, Bagrus bayad* and the Tilapias (**Table 4.1**).

Table 4.1: Seasonal taxa composition and relative abundance (% numbers) of fish species caught in near shore waters along Kingfisher Flats (March, May and November, 2014)

Sampling period			Mar. 2014	May. 2014	Nov, 2014
			Dry	Wet 1	Wet 2
Family	Species	Site	(% by Numbers)		
Polypteridae	*Polypterus senegalis*	Lagoon		3.85	
		PAD-1			
		PAD-2			
		PAD-3			
		PAD-4			
		PAD-5			
		All		**0.17**	
Characidae	*Hydrocynus forskahlii*	Lagoon			
		PAD-1		0.48	11.11
		PAD-2	24.24	5.11	2.44
		PAD-3	4.65	1.19	0.78
		PAD-4	7.14	5.13	11.76
		PAD-5		5.95	2.04
		All	**6.73**	**2.76**	**4.17**
	Alestes baremose	Lagoon		11.54	
		PAD-1	1.64	0.48	
		PAD-2	24.24	0.73	1.22
		PAD-3	8.14	2.38	3.10
		PAD-4	7.14		
		PAD-5		2.38	1.02
		All	**8.65**	**1.15**	**1.39**
	Alestes macrolepidotus	Lagoon		23.08	
		PAD-1			
		PAD-2			
		PAD-3		9.52	
		PAD-4			
		PAD-5		4.76	
		All		**3.11**	
	Brycinus nurse	Lagoon			
		PAD-1		68.42	60.49
		PAD-2		52.55	96.34
		PAD-3		54.76	77.52
		PAD-4		64.10	23.53
		PAD-5		8.33	83.67
		All		**50.60**	**73.61**
Cyprinidae	*Labeo horie*	Lagoon			
		PAD-1			
		PAD-2			
		PAD-3			
		PAD-4			
		PAD-5			2.04
		All			**0.46**
	Barilus niloticus	Lagoon			

		PAD-1		0.48	
		PAD-2			
		PAD-3			
		PAD-4			
		PAD-5			
		All		**0.17**	
	Barbus bynii	Lagoon			
		PAD-1		0.48	1.23
		PAD-2		0.73	
		PAD-3			
		PAD-4			
		PAD-5			2.04
		All		**0.35**	**0.69**
	Barbus perince	Lagoon			
		PAD-1	6.56		
		PAD-2			
		PAD-3			
		PAD-4			
		PAD-5			
		All	**1.92**		
	Neobola bredoi	Lagoon			
		PAD-1		8.13	
		PAD-2			
		PAD-3			
		PAD-4			
		PAD-5			
		All		**2.94**	
Bagridae	*Bagrus bayad*	Lagoon		3.85	
		PAD-1	3.28		3.70
		PAD-2			
		PAD-3	1.16	3.57	1.55
		PAD-4	3.57		
		PAD-5		1.19	
		All	**1.92**	**0.86**	**1.16**
	Auchenoglanis occidentalis	Lagoon			
		PAD-1		1.44	1.23
		PAD-2			
		PAD-3			
		PAD-4			
		PAD-5			
		All		**0.52**	**0.23**
Mochockidae	*Synodontis schall*	Lagoon			
		PAD-1	3.28		1.23
		PAD-2			
		PAD-3			
		PAD-4	17.86		
		PAD-5			
		All	**3.37**		**0.23**
	Synodontis frontosus	Lagoon			
		PAD-1			3.70
		PAD-2			
		PAD-3			
		PAD-4			

Family	Species	Location			
		PAD-5			
		All			**0.69**
Schilbeidae	*Schilbe mystus*	Lagoon			
		PAD-1			
		PAD-2		12.41	
		PAD-3			0.78
		PAD-4		2.56	
		PAD-5			
		All		**3.11**	**0.23**
Clariidae	*Clarias gariepinus*	Lagoon			
		PAD-1		0.48	
		PAD-2			
		PAD-3			
		PAD-4			
		PAD-5			
		All		**0.17**	
Centropomidae	*Lates niloticus*	Lagoon			
		PAD-1	16.39		3.70
		PAD-2	18.18	28.47	
		PAD-3	8.14	26.19	10.85
		PAD-4	32.14	28.21	58.82
		PAD-5		23.81	1.02
		All	**15.38**	**15.89**	**8.80**
Cichlidae	*Oreochromis niloticus*	Lagoon		30.77	100
		PAD-1	1.64		
		PAD-2			
		PAD-3			5.43
		PAD-4			5.88
		PAD-5			2.04
		All	**0.48**	**1.38**	**4.40**
	Oreochromis leucostictus	Lagoon		15.38	
		PAD-1	6.56		
		PAD-2			
		PAD-3			
		PAD-4			
		PAD-5			2.04
		All	**1.92**	**0.69**	**0.46**
	Sarotherodon galilaeus	Lagoon			
		PAD-1	1.64		
		PAD-2			
		PAD-3			
		PAD-4			
		PAD-5			1.02
		All	**0.48**		**0.23**
	Haplochromines	Lagoon		11.54	
		PAD-1	27.87	27.75	13.58
		PAD-2			
		PAD-3	4.65	2.38	
		PAD-4			
		PAD-5		53.57	3.06
		All	**10.1**	**18.66**	**3.24**

The trend in relative abundance both by numbers and weight was not clearly discernable but a general decline in fish abundance was indicated. The overall species abundance by numbers across sampled habitats did not show a clear pattern however, during wet season 2 PAD-3 yielded most fish (29.8%) but lower than that reported from PAD-1 (36.1%) during wet season 1 and PAD-3 (41.3%) in the dry season. There is a general decline in the numbers of fish recovered. The least number of fish for both wet season2 (1.85%) and wet season 1 (4.5%) were from the Lagoon and from PAD- 4 during the dry season (4.5%). However, by weight, PAD-3 contributed the highest biomass (27.2%) during wet season 2 and lower than the highest biomass reported in PAD-2 (31.3%) in wet season 1 and PAD-4 (29.1%) in the dry season. The least biomass of fish during wet season 2 was from PAD-2 (8.27%) unlike during wet season 1 where least biomass was from PAD-1 (3.4%) and from PAD-2 (20.2%) during the dry season (**Figure 4.2**).
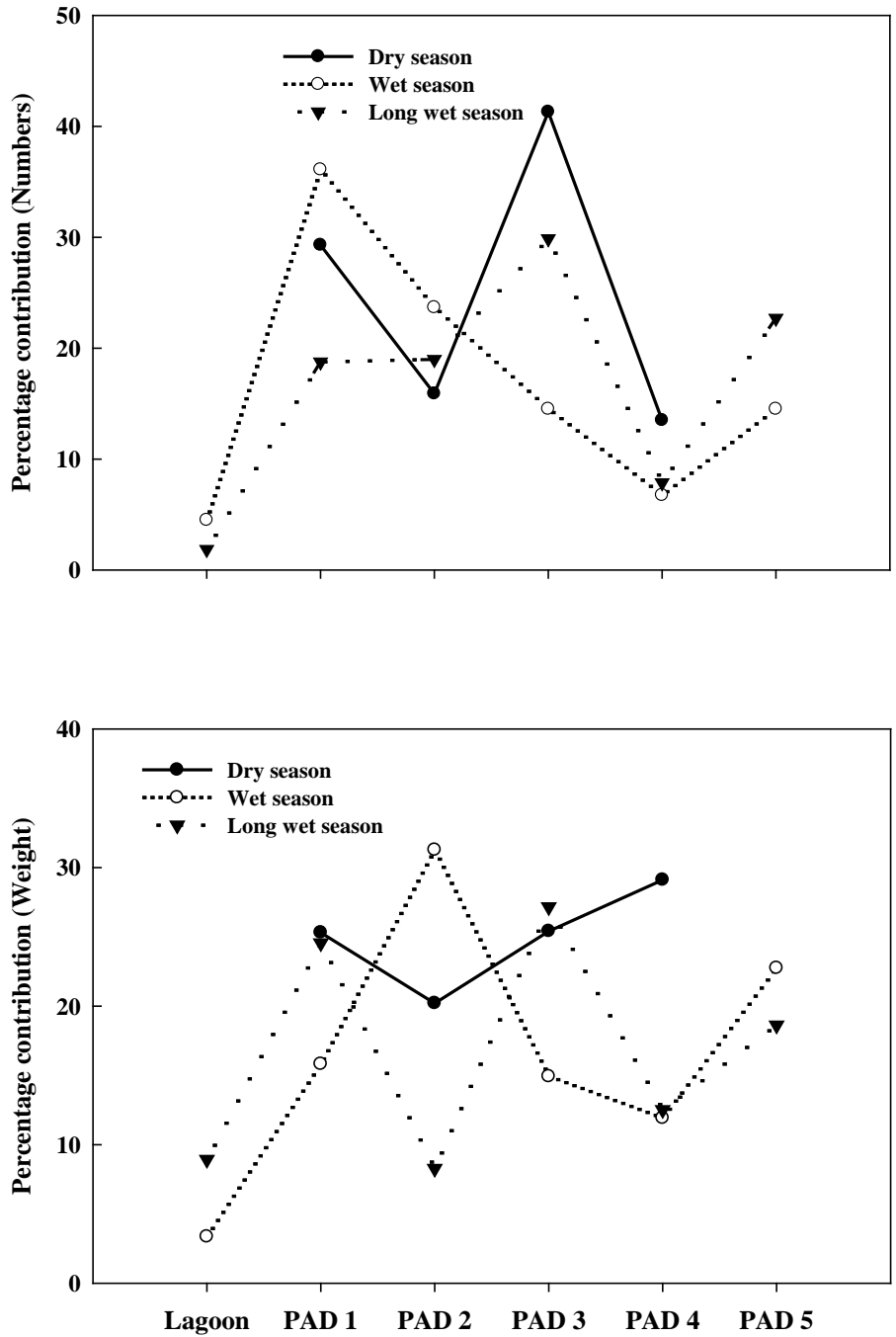
Figure 4.2 Seasonal relative abundance (% numbers) and (% weight (g)) of fish species caught in sampling sites in near shore waters along Kingfisher flats during the dry season (March), wet season 1(May) and wet season 2 (November), 2014

4.2   Species abundance (Catch rates)

Catch rates (number/weight of fish per net per night) were calculated based on a total number of gillnets used at that particular habitat.   Fish species were grouped into different categories depending on the numbers of nets deemed capable of capturing them. The species are categorized into two capture categories namely; Category A: Fishes that grow to small adult size – Caught in nets up to 2" Category B: Fishes growing to medium and large sized adults – Caught in nets up to 4".

Generally there were less fish recovered around Kingfisher flats during long wet season 2 compared to both wet season1 and the dry season. Overall catch rates in terms of number of fish per net per night during wet season 2 were highest at PAD-3 with 5.86 fish/net/night but lower than highest catch rates from PAD-1 with 9.5 fish/net/night during wet season 1 and higher than that of the dry season from PAD-3 (3.91 fish/net/night). The lowest number of fish was retrieved from the lagoon yielding only 0.36 fish/net/night, and 1.18 fish/net/night in the long wet and wet seasons respectively whereas during the dry season, least catch was from PAD-4-2 (2 fish/net/night). However, by weight PAD-3 yield the highest biomass (221.45g/net/night) during wet season 2 way lower than the highest biomass from PAD-2 (319.9g/net/night) in wet season 1 and from PAD-4 (326.1g/net/night) during the dry season (**Figure 4.3**).

There was a general increase in the catch rates of some key commercial fish species. Specific catch rates in near shore waters along Kingfisher Flats by numbers and weight were dominated by *Brycinus nurse* (Ragoge).with 19.88 fish/net/night and 306.63g/net/night respectively during wet season 2.   *Brycinus nurse* also contributed 18.31 fish/net/night in wet season 1 and only 8.5 fish/net/night in the dry season. The Nile perch *Lates niloticus* (Mputa) also increased from 1.33 to 3.29 to 1.36 fish/net/night yielding 264.1 to 337.5 to 123.21 g /net/night in the dry, wet and long wet seasosns respectively. The other species including Nile tilapia *Oreochromis niloticus* fluctuated been 0.04, 0.29 and 0.68 fish/net/night and 3.3, 9.6 and 126.8g /net/night as the Tiger fish *Hydrocynus forskhalii* (Ngassa) fluctuated between 0.58, 0.57 and 0.64 fish/net/night yielding 115.3, 93.1 and 91 g/net/night across the dry, wet and long wet seasons respectively (Table 2&3). Commercial catches ranked *H. forskahlii Lates* spp. and *Alestes baremose* (Angara) as important fishes supporting Lake Albert fishery in addition to the dormant *B. nurse*
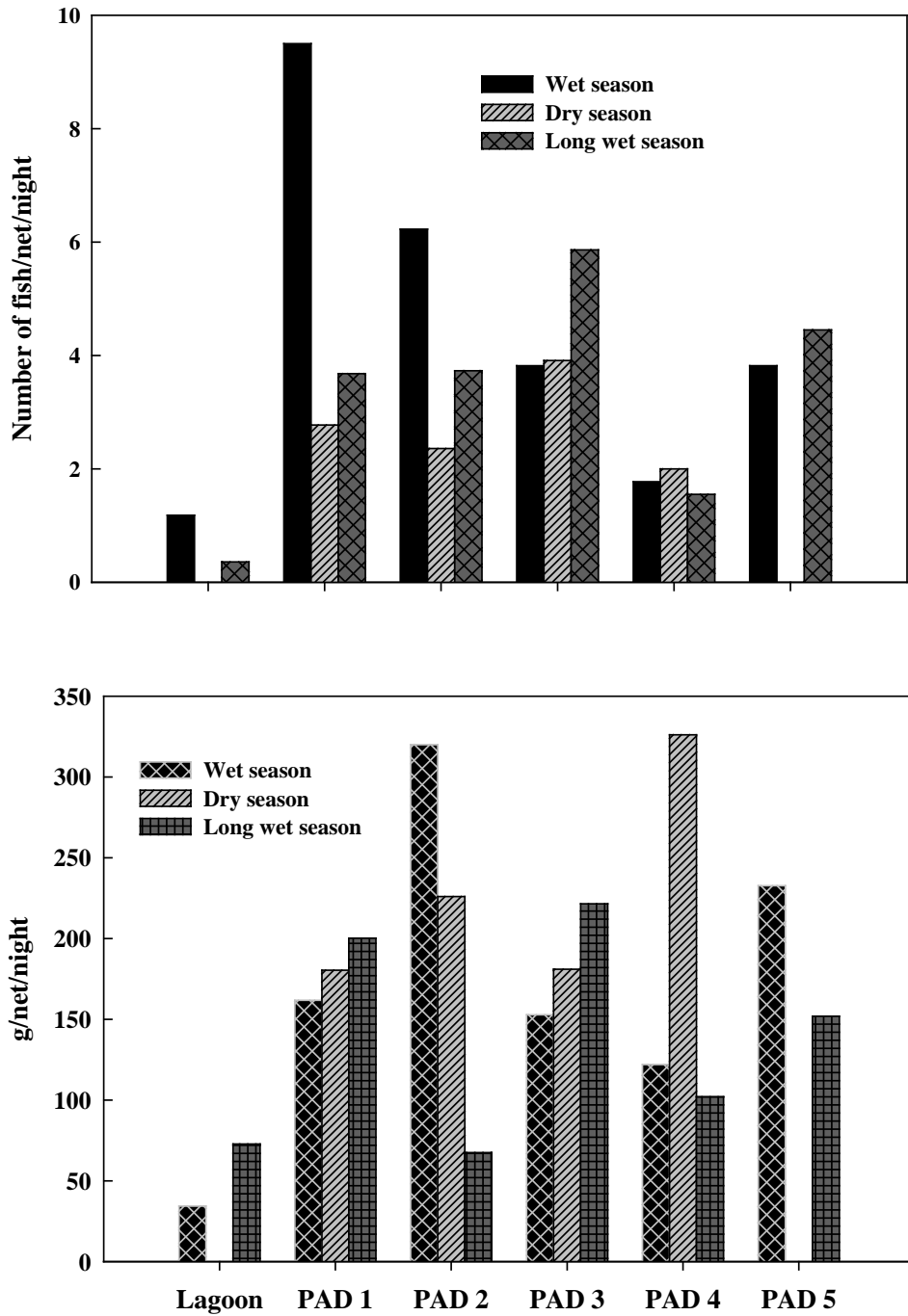
Figure 4.3 Over all catch rates (numbers and weight) of fish caught at various sampled habitats in the near shores waters of Kingfisher Flats during the dry season (March), wet season 1(May) and wet season 2 (November), 2014

Table 4.2 Seasonal species catch rates (number of fish per net per night) caught in experimental gillnets in near shore waters along Kingfisher Flats

Sampling period			Mar. 2014	May. 2014	Nov 2014
			Dry	Wet 1	wet 2
Family	Species	Site			
Polypteridae	*Polypterus senegalis*	Lagoon		0.07	
		PAD-1			
		PAD-2			
		PAD-3			
		PAD-4			
		PAD-5			
		All		**0.04**	
Characidae	*Hydrocynus forskahlii*	Lagoon			
		PAD-1		0.07	0.64
		PAD-2	0.80	0.50	0.14
		PAD-3	0.29	0.07	0.07
		PAD-4	0.20	0.14	0.29
		PAD-5		0.36	0.14
		All	**0.58**	**0.57**	**0.64**
	Alestes baremose	Lagoon		0.21	
		PAD-1	0.07	0.07	
		PAD-2	0.80	0.07	0.07
		PAD-3	0.50	0.14	0.29
		PAD-4	0.20		
		PAD-5		0.14	0.07
		All	**0.75**	**0.32**	**0.21**
	Alestes macrolepidotus	Lagoon		0.75	
		PAD-1			
		PAD-2			
		PAD-3		1.00	
		PAD-4			
		PAD-5		0.50	
		All		1.13	
	Brycinus nurse	Lagoon			
		PAD-1	2.38	17.88	6.13
		PAD-2	2.75	9.00	9.88
		PAD-3	7.88	5.75	12.50
		PAD-4	2.25	3.13	1.00
		PAD-5		0.88	10.25
		All	**8.50**	**18.31**	**19.88**
Cyprinidae	*Labeo horie*	Lagoon			
		PAD-1			
		PAD-2			
		PAD-3			
		PAD-4			
		PAD-5			0.14
		All			**0.07**
	Barilus niloticus	Lagoon			
		PAD-1		0.13	
		PAD-2			
		PAD-3			
		PAD-4			
		PAD-5			
		All		**0.06**	

	Barbus bynni	Lagoon			
		PAD-1		0.13	0.07
		PAD-2		0.13	
		PAD-3			
		PAD-4			
		PAD-5			0.14
		All		**0.13**	**0.11**
	Barbus perince	Lagoon			
		PAD-1	0.50		
		PAD-2			
		PAD-3			
		PAD-4			
		PAD-5			
		All	**0.33**		
	Neobola bredoi	Lagoon			
		PAD-1		2.13	
		PAD-2			
		PAD-3			
		PAD-4			
		PAD-5			
		All		**1.06**	
Bagridae	*Bagrus bayad*	Lagoon		0.07	
		PAD-1	0.14		0.21
		PAD-2			
		PAD-3	0.07	0.21	0.14
		PAD-4	0.10		
		PAD-5		0.07	
		All	**0.17**	**0.18**	**0.18**
	Auchenoglanis occidentalis	Lagoon			
		PAD-1		0.21	0.07
		PAD-2			
		PAD-3			
		PAD-4			
		PAD-5			
		All		**0.11**	**0.04**
Mochockidae	*Synodontis frontosus*	Lagoon			
		PAD-1			0.21
		PAD-2			
		PAD-3			
		PAD-4			
		PAD-5			
		All			**0.11**
Mochockidae	*Synodontis schall*	Lagoon			
		PAD-1	0.14		0.13
		PAD-2			
		PAD-3			
		PAD-4	0.50		
		PAD-5			
		All	**0.29**		**0.06**
Schilbeidae	*Schilbe mystus*	Lagoon			
		PAD-1			
		PAD-2		1.21	
		PAD-3			0.07
		PAD-4		0.07	
		PAD-5			

Family	Species				
		All		**0.64**	**0.04**
Clariidae	*Clarias gariepinus*	Lagoon			
		PAD-1		0.07	
		PAD-2			
		PAD-3			
		PAD-4			
		PAD-5			
		All		0.04	
Centropomidae	*Lates niloticus*	Lagoon			
		PAD-1	0.71		0.21
		PAD-2	0.60	2.79	
		PAD-3	0.50	1.57	1.00
		PAD-4	0.90	0.79	1.43
		PAD-5		1.43	0.07
		All	**1.33**	**3.29**	**1.36**
Cichlidae	*Oreochromis niloticus*	Lagoon		0.57	0.57
		PAD-1	0.07		
		PAD-2			
		PAD-3			0.50
		PAD-4			0.14
		PAD-5			0.14
		All		**0.29**	**0.68**
	Oreochromis leucostictus	Lagoon		0.29	
		PAD-1	0.29		
		PAD-2			
		PAD-3			
		PAD-4			
		PAD-5			0.14
		All	**0.17**	**0.14**	**0.07**
	Sarotherodon galilaeus	Lagoon			
		PAD-1	0.07		
		PAD-2			
		PAD-3			
		PAD-4			
		PAD-5			0.07
		All	**0.04**		**0.04**
	Haplochromines	Lagoon		0.38	
		PAD-1	2.14	5.13	
		PAD-2			
		PAD-3	0.50	0.25	
		PAD-4			
		PAD-5		5.63	
		All	**0.58**	**5.69**	
Overall Rates		Lagoon		1.18	0.36
		PAD-1	2.77	9.50	3.68
		PAD-2	2.36	6.23	3.73
		PAD-3	3.91	3.82	5.86
		PAD-4	2.00	1.77	1.55
		PAD-5		3.82	4.45
		All	**5.78**	**13.16**	**9.82**

Table 4.3Seasonal species catch rates (weight per net per night (g)) of fish caught in experimental gillnets in near shore waters along Kingfisher Flats

Sampling period			Mar. 2014	May. 2014	Nov 2014
			Dry	Wet	Long wet
Family	Species	Site	**g/net/night**		
Polypteridae	*Polypterus senegalis*	Lagoon		8.6	
		PAD-1			
		PAD-2			
		PAD-3			
		PAD-4			
		PAD-5			
		All		4.3	
Characidae	*Hydrocynus forskahlii*	Lagoon			
		PAD-1		4.2	99.71
		PAD-2	125.8	58.0	23.00
		PAD-3	37.9	5.0	3.57
		PAD-4	97.8	20.7	47.14
		PAD-5		98.4	8.57
		All	**115.3**	**93.1**	**91.00**
	Alestes baremose	Lagoon		4.4	
		PAD-1	4.7	8.0	
		PAD-2	75.0	6.1	11.43
		PAD-3	33.4	11.3	10.00
		PAD-4	16.2		
		PAD-5		38.5	1.43
		All	**60.3**	**34.1**	**11.43**
	Alestes macrolepidotus	Lagoon		16.6	
		PAD-1			
		PAD-2			
		PAD-3		16.6	
		PAD-4			
		PAD-5		7.8	
		All		20.5	
	Brycinus nurse	Lagoon			
		PAD-1	33.3	225.1	96.50
		PAD-2	38.0	127.9	125.25
		PAD-3	107.5	69.9	188.75
		PAD-4	27.0	35.0	15.25
		PAD-5		10.9	187.50
		All	**115.3**	**234.4**	**306.63**
Cyprinidae	*Labeo horie*	Lagoon			
		PAD-1			
		PAD-2			
		PAD-3			
		PAD-4			
		PAD-5			39.29
		All			**19.64**
	Barilus niloticus	Lagoon			
		PAD-1		5.5	
		PAD-2			
		PAD-3			
		PAD-4			
		PAD-5			

Family	Species	Site			
		All		2.8	
	Barbus bynni	Lagoon			
		PAD-1		15.1	17.71
		PAD-2		11.8	
		PAD-3			
		PAD-4			
		PAD-5			23.57
		All		**13.4**	**20.64**
	Barbus perince	Lagoon			
		PAD-1	5.5		
		PAD-2			
		PAD-3			
		PAD-4			
		PAD-5			
		All	**3.7**		
	Neobola bredoi	Lagoon			
		PAD-1		0.8	
		PAD-2			
		PAD-3			
		PAD-4			
		PAD-5			
		All		**0.4**	
Bagridae	*Bagrus bayad*	Lagoon		0.9	
		PAD-1	43.6		48.00
		PAD-2			
		PAD-3	5.0	39.4	7.29
		PAD-4	64.8		
		PAD-5		12.2	
		All	**55.3**	**26.3**	**27.64**
	Auchenoglanis occidentalis	Lagoon			
		PAD-1		43.1	13.57
		PAD-2			
		PAD-3			
		PAD-4			
		PAD-5			
		All		**21.5**	**6.79**
Mochockidae	*Synodontis frontosus*	Lagoon			
		PAD-1			41.43
		PAD-2			
		PAD-3			
		PAD-4			
		PAD-5			
		All			**20.71**
	Synodontis schall	Lagoon			
		PAD-1	36.3		2.50
		PAD-2			
		PAD-3			
		PAD-4	83.2		
		PAD-5			
		All	**55.8**		**1.25**
Schilbeidae	*Schilbe mystus*	Lagoon			
		PAD-1			
		PAD-2		89.7	
		PAD-3			5.71
		PAD-4		8.1	

		PAD-5			
		All		**48.9**	**2.86**
Clariidae	*Clarias gariepinus*	Lagoon			
		PAD-1		5.2	
		PAD-2			
		PAD-3			
		PAD-4			
		PAD-5			
		All		**2.6**	
Centropomidae	*Lates niloticus*	Lagoon			
		PAD-1	109.1		30.57
		PAD-2	100.4	269.1	
		PAD-3	140.7	132.5	125.00
		PAD-4	183.7	142.7	80.14
		PAD-5		130.6	10.71
		All	**264.1**	**337.5**	**123.21**
Cichlidae	*Oreochromis niloticus*	Lagoon		19.2	114.29
		PAD-1	5.7		
		PAD-2			
		PAD-3			88.57
		PAD-4			24.29
		PAD-5			26.43
		All	**3.3**	**9.6**	**126.79**
	Oreochromis leucostictus	Lagoon		9.9	
		PAD-1	30.3		
		PAD-2			
		PAD-3			
		PAD-4			
		PAD-5			12.14
		All	**17.7**	**4.9**	**6.07**
	Sarotherodon galilaeus	Lagoon			
		PAD-1	18.4		
		PAD-2			
		PAD-3			
		PAD-4			
		PAD-5			7.14
		All	**10.8**		**3.57**
	Haplochromines	Lagoon		2.6	
		PAD-1	23.1	92.6	12.25
		PAD-2			
		PAD-3	10.5	4.1	
		PAD-4			
		PAD-5		131.6	3.75
		All	**12.0**	**115.5**	**8.00**
Overall Rates		Lagoon		34.3	72.73
		PAD-1	180.4	161.8	200.18
		PAD-2	226.0	319.9	67.45
		PAD-3	181.0	152.7	221.45
		PAD-4	326.1	121.9	102.00
		PAD-5		232.6	151.82
		All	**435.5**	**511.6**	**407.82**

4.3 Biology of dominant fish species

Selected biological parameters of dominant fish species namely *Tilapia, Alestes baremose, Brycinus nurse, Bagrus bayad, Hydrocynus forskahlii, Lates niloticus,* and *Schilbe intermedius* caught in experimental gillnets in near-shore waters along Kingfisher Flats are tabulated in Table 4 below. Most of these dominant fish during the wet season comprised mature and immature populations, good relative condition factor but with maximum sizes slightly smaller than those in the dry season. Almost all the Nile tilapia retrieved from the Lagoon, PAD-3 and PAD-5 were mature and in breeding conditions. These habitats have to be protected since they are both breeding and nursery grounds for fish.

Table 4.4 Selected biological parameters of dominant fish species caught in experimental gillnets in near shore waters along Kingfisher Flats in the dry season (March 2014), wet season 1 (May, 2014) and wet season 2 (November, 2014)

Date of sampling		Mar-2014	May, 2014	Nov, 2014
Species/Season				
Alestes baremose	Size range (cm)	14.8 – 25.4	23.2 – 30.6	13.5 -29.0
	Mean length (cm TL)	20.1	26.4	20.73±1.6
	Maturity (%)	21%	33.4%	-
	Main food type (Increasing importance)	Povilla, Odonata, Detritus	Povilla, Odonata nymphs	-
	Mean condition factor	1.014±0.03	0.85±0.03	1.00±0.042
	Sample size (No.)	19	9	3
Brycinus nurse	Size range (cm)	7.8 – 12.1	8.6 – 9.4	7.8 -14.4
	Mean length (cm TL)	9.06	9.0	9.4±1.24
	Maturity (%)	59	50	37.5
	Main food type (Increasing importance)	Povilla, Odonata, *Caridina nilotica*	Insect remains	Povilla, *Caridina nilotica,* Insect remains
	Mean condition factor	1.014±0.02	0.90±0.006	0.99±0.122
	Sample size (No.)	61	85	72
Bagrus bayad	Size range (cm)	21.5 – 39.4	10.5 – 33.0	11.6 - 34.5
	Mean length (cm TL)	30.1	23.3	22.68±2.4
	Maturity (%)	25	Nil	-
	Main food type (Increasing importance)	Povilla, Odonata nymphs, Fish	Fish	Fish, *Caridina nilotica,*
	Mean condition factor	1.001±0.03	1.00±0.02	1.01±0.064
	Sample size (No.)	4	6	5
Hydrocynus forskahlii	Size range (cm)	11.5 – 35.5	14.5 – 45.3	12.2 -30.8
	Mean length (cm TL)	25.1	22.8	23.3±4.86

	Maturity (%)	61.5	27.8	41.2
	Main food type (Increasing importance)	Fish, Caridina nilotica, Povilla	Fish, , Povilla	Fish
	Mean condition factor	1.00±0.02	1.01±0.03	1.00±0.07
	Sample size (No)	13	18	17
Lates niloticus	Size range (cm)	10.5 - 35	8.4 – 38.4	7.3 – 31.4
	Mean length (cm TL)	24.8	19.4	18.9±6.88
	Maturity (%)	12.5	9.3	2.8
	Main food type (Increasing importance)	Fish, Caridina nilotica	Fish, Caridina nilotica	Caridina *nilotica,* Fish
	Mean condition factor	1.00±0.01	1.00±0.001	1.02±0.02
	Sample size (No.)	32	75	35
O. niloticus	Size range (cm)		6.8 – 18.8	18.1 – 23.3
	Mean length (cm TL)		10.2	20.9±1.4
	Maturity (%)		0	42.1
	Main food type (Increasing importance)		Algae	-
	Mean condition factor		1.00±0.06	1.00±0.1
	Sample size (No.)		7	19
Schilbe mystus	Size range (cm)		15.4 – 22.6	
	Mean length (cm TL)		19.1	
	Maturity (%)		27.8	
	Main food type (Increasing importance)		Fish, Povilla, Odonata, Caridina nilotica	
	Mean condition factor		1.02±0.01	
	Sample size (No.)		18	

4.4 Species recovery

Species recovery from the near shore waters of kingfisher flats increased from 13 during the dry season sampling to 19 during the wet season but later decreased to 15 species during this long wet season. Fish species that from the basis of the artisanal fishery of Lake Albert including *B. nurse, Lates sp, Bagrus bayad, O. niloticus, A. baremose* and *H. forskahlii* widely distributed in the lake were all recovered. Two new species *Synodontis frontosus* and *Labeo horie* were recovered during this long wet season in adition to the six new species (*Polyperus senegalis, Alestes macrolepidotus, Barilus niloticus, Auchenoglanis occidentalis, Schilbe intermedius, Neobola bredoi* and *Thorachromis wingatii*) recovered during the wet season. This brings the overall species recovery in the kingfisher inshore waters to 24 species contributing at least 45.2% of the 53 species reported in Lake Albert (Greenwood, 1966) (Table 4.5).

There are at least 54 species of fish of fish in Lake Albert therefore the fisheries management issues include but not limited to the two types of Nile Perch: *Lates niloticus* and *Lates macrophthalmus* (the latter grows to a smaller size and occurs mostly in offshore areas), previously fished with long lines and 6"- 7" gill-nets; *Alestes baremose* (Ngara) targeted by the 2.5" gill-net, and *Hydrocunus forskhalii* (Ngassia) targeted by the 2.5"-3" gill-nets; The catfishes: *Bagrus bayad* and *Bagrus docmak* originally captured in 6" gill-nets; Tilapias especially the Nile Tilapia (originally fished with 4" gill-nets but currently targeted with 3-3.5" gill-nets; The small palagic fishes (*Neobola bredoi* (< 10cm long) and *Brycinus nurse*) also

Table 4.5 Total number of fish species recovered during the dry season (March), wet season 1 (May) and wet season 2 (November), 2014 from the near shore waters of Kingfisher Flats

Family	Species	March 2014	May 2014	November 2014
Polypteridae	*Polypterus senegalis*		P	
Characidae	*Hydrocynus forskahlii*	P	P	P
	Alestes baremose	P	P	P
	Alestes macrolepidotus		P	
	Brycinus nurse	P	P	P
Cyprinidae	*Labeo horie*			P
	Barilus niloticus		P	
	Barbus bynii		P	P
	Barbus prince	P		
	Neobola bredoi		P	
Bagridae	*Bagrus bayad*	P	P	P
	Auchenoglanis occidentalis		P	P
Mochockidae	*Synodontis schall*	P		P
	Synodontis frontosus			P
Schilbeidae	*Schilbe mystus*		P	P
Clariidae	*Clarias gariepinus*		P	
Centropomidae	*Lates niloticus*	P	P	P
Cichlidae	*Oreochromis niloticus*	P	P	P
	Oreochromis leucostictus	P	P	P
	Sarotherodon galilaeus	P		P
	Neochromis sp	P	P	
	Thoracochromis avium	P	P	P
	Thoracochromis wingatii	P	P	
	Astatotilapia "scarlet anal"		P	
Total 9	**24**	**13**	**19**	**15**

P= Fish species recovered during that sampling.

locally known as "Muziri" and "Ragoge". These two currently makeup more than 80% of the overall catch. They were however often under represeted in the catch statistics including species frequency records due to type of fishing gear used.

5 Aquatic biodiversity feature of Wetlands of Kingfisher Flats

5.1 Introduction

The wetlands of Kingfisher Flats are comprised by:

- The submerged, floating and emergent wetland flora along the shores of Lake Albert;

- The Kingfisher Lagoon wetlands;

- The floodplain wetlands of River Masika, "Airport stream" and "Pad 2 stream";

During dry season and wet season 1 surveys the aquatic biodiversity Team compiled information on water quality, phytoplankton and macro-invertebrate diversity and distribution of the wetland habitats. The terms of reference of wet season 2 (November) 2014 refocused the survey to assessing the extent of wetland habitats of Kingfisher Flats as well as their dominant flora and macro-invertebrate fauna. This section outlines in general terms the features of the assessment with particular focus on wetland extent, floral diversity and distribution. Data and discussion on macro-invertebrates in the riverine habitats was presented in Chapter 2 of this report, together with data from inshore sites of Lake Albert.

5.2 The fringing wetland zone of submerged, floating and emergent flora

Fringing emergent, floating and submerged wetland flora was found to characterize shallow water zones of Lake Albert shores sheltered from prevailing offshore winds. The bottom substrate of such zones is often clay and sandy clay soils. Extensive fringing wetland flora was found in the study zone of Kingfisher flats stretching from the Kingfisher Lagoon to the delta of River Masika. Submerged *Vallisneria sp* followed by *Najas horida* occupy the lake-ward side of the fringe but their full lateral extent is not known. The two macrophytes appear to be widespread along the shores of Kigfisher Flats. Onshore waves driven by prevailing winds routinely deposit large quantities to the shore especially at the Jetty (Figure 5.1). Other submerged machrophytes found in the fringing wetland zone of Kingfisher included *Potamogeton sp* and *Ceratophyllum sp*. The most commonly found emergent, particularly imposing fringing wetland flora was the giant sedge *Cyperus laevigatus*. The sedge stands, averaging about 10 to 20 m wide, dominate the shoreline almost continuously from PAD 3 to the end of the study zone at the mouth of River Masika (Figure 5.2). The near-shore backwaters protected by the sedge fringe are often covered by a variety of floating macrophytes such as *Pistia stratiotes*. On the other hand the lake-ward side is lined by a mix of the submerged *Potamogeton sp* and *Najas horrida*, exposed to the rough open lake.

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Figure 5.1 A mixture of dislodged *Vallisneria sp* and *Najas horida* stranded at Jetty shoreline

Figure 5.2 A fringe of *Cyprus laevigatus* along the shore of Pad 3at Kingfisher flats. Note the calm back waters suitable for fish nurseries

5.3 The Kingfisher Lagoon wetlands

The Kingfisher Lagoon is almost unique along the Uganda shores of the southern half of Lake Albert but not so along the northern half where several lagoons occur. The apparent uniqueness conferred a touch of mysticism about the Kingfisher Lagoon, within the native communities. The aquatic biodiversity Team did not encounter anything extra ordinary during the three seasonal surveys of the Lagoon. Information on water quality, diversity and productivity of phytoplankton; and diversity and distribution of macro-invertebrates were successfully collected during the dry season (March) and wet season-1 (May)-2014 surveys. Surveys for the fishes were not very successful due to several challenges including presence of fish predators especially crocodiles and otters that prey on the catch and destroy fishing gears. Presence of hippos was a deterrent to structured sampling. To fill information gaps on resident fauna especially the fish species, wet season-2 survey in the Lagoon included gathering supplementary data from three native fishermen – Chandia Samuel, Mugisha and Kabobi Jamali- who regularly fished in the Kingfisher Lagoon.

Kingfisher Lagoon is separated from main Lake Albert by a wide sand bar -at least 100 m across to the main entrance located to the western side. The vegetation on the lake-ward side of the sand bar is dominated by heavily grazed grassland dominated by *Cynodon sp* with scattered short shrubs (Figure 5.3). The flora changes to include stands of *Phragmites sp*. and later to a dense cover of a combination with *Typha domingensis* . Kingfisher Lagoon consists of roughly round expanse of shallow open water

Figure 5.3. Portion of the sand bar between Lake Albert and Kingfisher Lagoon

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at least 300 m in diameter and 1.5 to 4 m deep, surrounded by expansive permanent wetlands of uncharted dimensions. The open water is bordered by hippograss *Vossia cuspidata* (Figure 5,4). Occasional stands of *Cyperus papyrus, Typha sp* and *Phragmites sp* break the Hippogras ring. Floating islands of hippogras and payrus commonly patrol the openwaters of the lagoon especially during the rainy season, making the use of gillnets to fish inadvisable. Virtually continuous stands of *Phragmites* and *Typha* sp lie behind the Vossia ring, and constitute the dominant flora of the rest of the permanent wetland component of the lagoon merges into a semi-permanent floodplain wetland of heavily grazed grassland dominated by tufts of *Miscanthidium sp*.to the north east. To the east and south east lies the expansive semi-permanent floodplain grassland of Airport Stream.

Figure 5.4 Western entry point to Kingfisher Lagoon. Note the type of suitable canoes and the dominant *Vossia sp* and *Phragmites sp* - tall , in flower.

Vossia ring, and constitute the dominant flora of the rest of the permanent wetland component of Kingfisher Lagoon which merges into a semi-permanent floodplain wetland of heavily grazed grassland dominated by tufts of *Miscanthidium sp*.to the north east. To the east and south east lies the expansive semi-permanent floodplain grassland of Airport Stream.

Interviews with native fishers who regularly operate on Kingfisher Lagoon revealed interesting information on resident fauna on the lagoon. Most fish species caught in main Lake were reported to occur in the Lagoon . Gear selection is key to successful sampling. The Tilapias especially Nile tilapia, mudfish (*Clarias*) and Nile perch (*Lates niloticus*) are the most important commercial species. The lagoon is a vital nursery and feeding ground for the Tilapias. Large turtles - up to eight kgs occur and may be caught during the dry season. Crocodiles, monitor lizards and snakes including deadly ones are common.

5.4   The floodplain wetlands of River Masika, Airport stream and Pad 2 stream

River Masika, Airport stream and Pad 2 stream drain catchments beyond the escarpment.to flow into Lake Albert.

5.4.1   River Masika

River Masika plashes down the escarpment (Figure 5.5).to descend rapidly through woodland into an extensive floodplain literally merged with the river delta. The riverbed is barely three metres wide at transition into the floodplain zone where it rapidly spreads out widely to merge with the fringing emergent wetland along the shores of Lake Albert The floodplain is heavily modified with intense cattle grazing and subsistence gardening. Patches of seasonally flooded grassland dominated by over grazed *Cynodon spp* with *Sporoborus sp* and *Chloris sp*. occur especially close to Lake Alert. The river valley and delta proper are covered with *Phragmites sp* dotted with stands of *Typha domingensis* plus several expanses of *Cypreus papyrus* (papyrus) – reported to occur. During this survey the river valley of Masika carried about two feet of water at the deepest point across the community track.

Figure 5.5 River Masika base

The floodplain is heavily modified with intense cattle grazing and subsistence gardening. Patches of seasonally flooded grassland dominated by over grazed *Cynodon spp* with *Sporoborus sp* and **Chloris sp.** occur especially close to Lake Alert. The river valley and delta proper are covered with *Phragmites sp* dotted with stands of *Typha domingensis* plus a large expanse of *Cypreus papyrus* (papyrus)

Airport stream

Airport stream flows down the escarpment with much less discharge than River Masika. While it flows for most of the year, it reduces to a trickle during much of the dry season and may run dry in the lower reaches of the floodplain. During the wet season Airport stream floods across a

comparatively extensive floodplain east of Kingfisher Lagoon. It is the main source of inflow into the Lagoon. From the base of the escarpment the stream descends to the floodplain through a shallow river valley covered in woodland and thick bush that extends well beyond the valley proper. Human activity (airstrip and road construction) appears to have obliterated the original path of the stream to the extent that during the survey of wet season-2, the water from the stream had spread-out across a large expanse of the floodplain to the east of Kingfisher Lagoon. Mitigation measures to enable original water flow connectivity from the stream, to the floodplain wetland and lake interface would be essential.

5.4.2 Pad 2 Stream

Pad 2 stream discharge was even less than that of Airport stream. While the stream was reported to flow down the escarpment all year round, the survey of wet season- 1, 2014 reported that the water flow disappeared at the bridge constructed across the stream channel in the floodplain During the wet season-2 2014 survey the bridge had been strengthened and the access channel widened but dry. Traced from the base of the escarpment, stream flow disappeared into the construction rabble of the new road being constructed up the escarpment at the time. Restoration of stream flow along the natural stream-bed to water the original floodplain would be desirable.

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APPENDIX D
Land Cover Classification

TECHNICAL MEMORANDUM

DATE 19/08/2014   **PROJECT No.** 13615730

TO Mervyn Mason
Golder Associates

CC

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CNOOC SPOT DERIVED LAND-COVER (CIRCA) 2013 – SUMMARY REPORT

1.0 METHOD

Six (6) meter resolution SPOT6 satellite imagery acquired during the period 2013 has been used to create a 20 x class land-cover classification of the client defined "CNOOC" study area in Uganda south of Lake Albert. The primary image date used for classification purposes was 2013, which consisted of two SPOT6 satellite covering the east and west portions of the study area. Both images were cloud affected in some parts. Additional coverage from a 2005 SPOT 4 satellite image was used to assist in the classification of cloud affected areas on the SPOT6 data.

The SPOT 4 multi-spectral imagery was re-sampled from its original resolution to 6 m prior to all classification to match the SPOT 6 data format. Note that the SPOT 4 imagery also had cloud obscured areas and was not able to provide cloud free coverage over all SPOT 6 cloud affected areas, which has resulted in the necessary inclusion of a "cloud obscured" class in the final land-cover legend.

All mapping was completed as a desk-top only interpretation and classification process. No field verification of the classified output has been completed.

The final land-cover dataset is based on 6 m raster cells (equivalent to the original SPOT6 data), and is in UTM 36 north (WGS84) map projection. The format of the classified land-cover data means that it is typically suitable for GIS-based modeling activities based on mapping scales of approximately 1:25,000 or coarser, with a theoretical minimum mapping unit of ± 0.25 ha.

2.0 SPOT DATA

The following SPOT4 and SPOT6 images were used to compile the land-cover dataset

- SPOT 6   22 January 2013

- SPOT 6   5 February 2013

- SPOT 4   21 December 2005

All SPOT image data was sourced and supplied by the client.

3.0   GEOGRAPHIC EXTENT

The geographic extent of the landcover mapping is reflected in the map below:
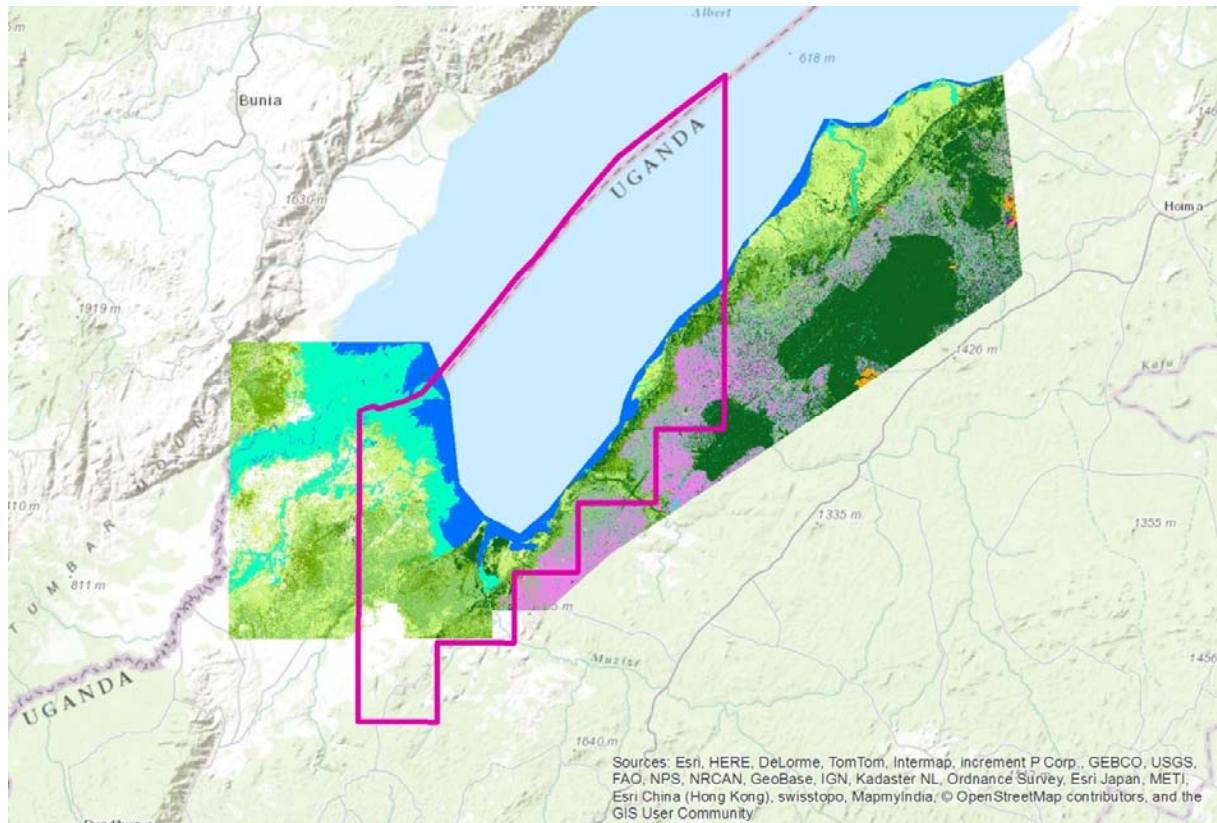
4.0   LANDCOVER CLASSES

The following raw landcover classes were determined using supervised classification and desktop image processing methods. These classes could be aggregated as desired by Ecologists or other environmental scientists, and used in specialist studies and modelling in the development of impact assessment.

Class	Class Name	Description
1	*Tree1*	Tall dense closed canopy (cc) forest/jungle
2	*Tree2*	Dense forest and taller dense bush dominated areas with 75-100% canopy cover, trees not as tall as Tree1 class
3	*Dense Bush*	Dense bush and low forest dominated land, typically 50-100% canopy cover
4	*Open Bush*	Open and scattered low tree and bush dominated landscape with a typically 10-50% canopy cover
5	*Forest Glades*	Areas of lower, more open forest and bush than the surrounding tall forest/jungle (Tree1), forming "clearings" within these large forests. Possible wetland conditions exist within these clearings
6	*Grass1*	Areas of grassland with typically < 10 % tree or bush cover
7	*Grass2*	Areas of grassland with typically < 10 % tree or bush cover and often higher grass cover than Grass1

8	*Bare1*	Very low or no vegetation cover, bare soil, sand
9	*Bare2*	Sparse Grassland to no vegetation cover
10	*Degraded Bush*	Bush land or forest heavily utilized by surrounding subsistence farming
11	*Wetland1*	Wetland area with low vegetation, shorter grass, and close proximity to surface water in some areas
12	*Wetland2*	Wetland area generally covered by grass and reeds.
13	*Wetland3*	Wetland area with large woody component (bush, thick reeds) and high biomass
14	*Water*	Natural or man made areas of surface water
15	*Mining*	Non vegetated areas of mining excavation and dumps
16	*Urban*	Human settlement areas of villages and towns
17	*Plantation*	Large scale, commercial man made and managed forests
18	*Commercial Cropland*	Areas of commercial agriculture with large, well managed crop fields
19	*Subsistence Cropland*	Subsistence agriculture with small sized and irregular shaped crop fields
20	*Clouds*	Obscured by clouds, no classification possible

5.0   METADATA

Golders CNOOC Land-Cover (2013) : CORE METADATA ELEMENTS (SANS1878)

1(M) Dataset title: CNOOC Uganda Land-cover 2013

2(M) Dataset reference date: April 2014

3(O) Dataset responsible party: Produced by GeoTerra Image (GTI) Pty Ltd (Mark Thompson, www.geoterraimage.com) for Golders, South Africa.

4(C) Geographic location of the dataset. MBR

WestBoundLongitude: 192447.00 (Upper Left X)

EastBoundLongitude: 101079.00 (Lower Right X)

NorthBoundLongitude: 212001.00 (Upper Left Y)

SouthBoundLongitude: 308883.00 (Lower Right Y)

Projection coordinates based on Universal Transverse Mercator UTM 36 North, WGS84 (datum), meters.

5(M) Dataset language : "English" (eng)

6(C) Dataset character set: UTF8 (8-bit data)

7(M)Dataset topic category: 010 = Base Map earth coverage

8(O) Scale of the dataset: Land-cover mapped from 6m resolution SPOT imagery therefore recommended for ± 1:25,000 scale or coarse mapping & modeling applications.

Golder
Associates

9(M) Abstract describing the dataset: Raster-based land-cover dataset derived from primarily 2013 SPOT 6 satellite digital imagery, using desk-top digital classification procedures. Western Uganda study site predefined by client. Land-cover dataset contains 20 x information classes for GIS modeling applications.

10(O) Dataset format name: ERDAS Imagine *img raster formats

11(O) Dataset format version: version 7b

Temporal Extent: Datasets generated in April 2014, based on 2013 SPOT 6 and 2005 SPOT 4 imagery.

12(O) Lineage statement: Land-cover dataset generated in-house by GeoTerraImage (Pretoria) in April 2014, based on 2013 SPOT 6 and 2005 SPOT 4 imagery. SPOT imagery sourced from client (Golder South Africa) in a ortho-corrected format. SPOT 6data used "as-is". SPOT 4 data resampled to 6m pixel size.

Brendan Hart
GIS Division Leader

BH/MM

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APPENDIX E

Impact Assessment Approach and Methods

Reasoned Narrative

The written analysis section for each key question first presents an outline of the methods used to estimate a change in condition for each valued component associated with that key question. Changes in condition were defined, for example, as changes to the size or function of a population, habitat, ecosystem, or ecosystem service from the baseline condition. Methods to estimate change in condition included calculations, and qualitative analyses based on available information from reports, scientific literature, and expert consultation. Methods used in the analysis section were specific to groups of valued components, or individual valued components.

After outlining the methods, the analysis was structured using indicators. Indicators are quantifiable (that is, measurable) expressions of change to a valued component, which were used to answer the key questions. The indicators selected for a valued component (see Table 1, Section 3.4.1 of the main report) were those that helped to understand whether the fundamental properties of a valued component that should be conserved, such as self-sustaining and ecologically-effective populations of plants and animals, and would be meaningfully affected by the development of the Project. As noted in the assessment timeframe (Section 3.1.2 of the main report), indicators were evaluated and described for the construction case, the operation case, and the decommissioning case.

For each indicator, the effect attributes described below were used to guide the assessment and description of the intensity, or magnitude, of the impact. These included direction, geographic extent, duration, and frequency. These criteria were considered together to determine the overall magnitude of the effect of the Project on a valued component, and these effects were described using a reasoned narrative. Where possible, magnitude was quantified as a specific value, such as change in population size or number of hectares of critical habitat lost.

The potential effect of the development in the CHAA was described with respect to the known, or inferred, ability of each valued component to absorb or otherwise accommodate disturbance. The ability of a valued component to accommodate disturbance was evaluated using the concepts of ecological adaptability and ecological resilience. Adaptable valued components are those that can change their behaviour, physiology, or population characteristics (for example, birth rate) in response to a disturbance such that the property of the valued component that should be conserved remains more or less unchanged. For example, certain animal and plant populations can accommodate loss of some individuals without a change in overall population status or trajectory (known as compensatory mortality), or can adjust their behaviour to accommodate disturbance (Cooley et al. 2009). Less adaptable valued components will be affected more than valued components with higher adaptability.

A concept closely related to ecological adaptability is ecological resilience. Ecosystems and populations often have inertia and will continue to function after disturbance up to the point where the disturbance becomes severe enough that the system or population changes. Adaptability influences the time it takes for this to happen, whereas resilience is the ability of a species or ecosystem to recover or bounce back from a disturbance (Mellin et al. 2014). Highly resilient valued components have the potential to recover quickly after rehabilitation, whereas valued components with low resilience will recover more slowly or may not recover at all.

The ability to absorb or accommodate disturbance through adaptability and resilience is a property of the valued component within the CHAA, and is not necessarily related to global conservation status. For example, a species that is highly threatened globally may also have low adaptability and resilience at the CHAA scale, or it may have a robust population that is both adaptable and resilient. Adaptability and resilience were, therefore, considered for each valued component at the CHAA scale, without taking global threat status into account.

At the species level, the concept of a self-sustaining, ecologically-effective population was used as a benchmark when describing level of effect. By definition, self-sustaining populations are not populations at the brink of extirpation; they are healthy, robust populations capable of withstanding environmental change and accommodating random population processes (Reed et al. 2003). For valued components that have

strong effects on ecosystem structure and function (that is, highly interactive species), the concept of ecologically effective populations was also considered (Soulé et al. 2003). An ecologically effective population of a highly interactive species is one that is large or influential enough to maintain ecosystem function through its behaviours, that is, they could act as ecosystem engineers (Chapman et al. 2013, Nummi and Kuuluvainen 2013).

The level of effect to each valued component depended substantially on mitigations applied as part of the Project design, including the mitigation hierarchy. These mitigations were considered when describing the Project effect for each development stage; that is, construction case, operation case and decommissioning case. Rehabilitation of biodiversity values through habitat rehabilitation and offsets was considered when assigning residual impacts for the post-rehabilitation case.

After considering all mitigation, except rehabilitation, effects at maximum disturbance for each case were evaluated with a special focus on the potential for the Project to cause unacceptable loss of valued components in the CHAA, prior to decommissioning and rehabilitation. That is, the potential for the Project to breach an ecological threshold for a valued component. Most ecological threshold values in the literature point to a 40% or greater loss of habitat before irreversible decline occurs in populations of species or ecosystems (for example, Rompré et al. 2010, Swift and Hannon 2010). However, the amount of change due to the development of the Project, prior to meeting an ecological threshold, will depend on historical conditions and trends (that is, current drivers of change) with respect to a particular valued component. For the intents of this impact assessment, a conservative threshold value of 10% was set given the Project's expected small physical footprint, and unknown implications of induced impacts. This value was also set because of the IFC PS6 requirement of ensuring not only species persistence, but also to be able to plan for no-net-loss and eventual net gain as the Project proceeds. Larger impacts are less likely to be offset, so a low value of 10% was set with this in mind.

By the far future, reclamation and rehabilitation is expected to improve for most valued components relative to the construction and operations phases. Any residual adverse effects to unique and highly vulnerable valued components, for which critical habitat is predicted to be affected by the Project, must be offset to achieve net positive gain and to meet the target of compliance with IFC PS6. The Business and Biodiversity Offset Program (BBOP 2012, pg. 13) defines offsets as "measurable conservation outcomes resulting from actions designed to compensate for significant residual adverse biodiversity impacts arising from project development after appropriate mitigation measures have been taken". Offsets occur along a continuum of compensation actions, and are achieved once a level of no-net-loss or better is reached. Any action that contributes to achieving no-net-loss or net gain can be considered part of the offset.

Whether or not offsetting would be necessary to comply with PS6 was identified for each valued component, and the magnitude of the predicted effect to that valued component was used to define the amount of offsetting required. Magnitude used to define offsetting requirements was taken either from the maximum disturbance case for construction and operation, or the decommissioning case, depending on the confidence in reclamation success. The case used to define offset requirements varied by individual valued component and a rationale for the selected case was provided for each valued component.

The objective of offsetting is to achieve, at least, no-net-loss and preferably net gains for the valued component for which it is applied. Therefore, where offsetting is successfully applied, the effects of the Project and its contribution to any existing and future cumulative effects will be positive. Where offsetting would be required, and sufficient information was available, specific actions that could contribute to achieving an offset for a particular valued component were identified. The likelihood that the offset would be achieved was also discussed. Given that offsets are designed to achieve a positive effect of the Project for the valued component in question, the purpose of the assessment with respect to offsetting was to evaluate the risk that the offset might not be achieved.

Part of the risk of achieving an offset relates to the size of the effect that must be offset. The extent to which critical habitat was affected by the Project, and hence the amount of loss that must be offset, was conservatively estimated for each valued component. This was accomplished by identifying critical habitat as broad spatial units containing habitats potentially used by the valued component for which critical habitat is present in the CHAA. Identifying locations where a particular species was found during baseline data collection

and designating only those locations as critical habitat is not considered appropriate. Most species may be present in locations that were not sampled, or may move into different areas over time. Defining only areas where a particular species was found during baseline surveys as critical habitat also would have failed to consider supporting ecological functions that may come from outside of the areas identified (for example, habitat supporting the prey consumed by a predator). Critical habitat was, therefore, defined broadly based on appropriate ecological constraints, and the breadth of critical habitat designation increased with uncertainty about the distribution and ecological requirements of a valued component. Hence, the total amount of critical habitat (that is, number of hectares) affected by the Project, and the offset requirements in order to achieve net gains, may have been overestimated but was not likely underestimated.

However, inappropriate conclusions are possible when broad definitions of critical habitat are used to infer changes in valued component status based on the proportion of critical habitat in the CHAA affected by the Project. Broad critical habitat designation may overestimate the actual critical habitat for the valued component across the entire CHAA, and underestimate the proportion affected by the Project if the true distribution of critical habitat is concentrated in the Project footprint. When evaluating population level effects, therefore, the proportion of critical habitat lost was considered in context of all other information available, including the proportion a population or series of populations estimated inside and outside the footprint, and within the wider CHAA. In some cases where critical habitat was broadly mapped due to high uncertainty about species-habitat associations, the proportion of the known population within the CHAA affected by the Project was used to predict population-level consequences of the Project, if and when such information was available.

Impact Classification

A formal impact assessment rating was completed using the results described in the reasoned-narrative analysis above. The purpose of the impact classification was to provide a system for ranking the significance of impacts, based on the intensity of the impact and the sensitivity of the receptor (described below), in a clear and repeatable way that permits comparison among valued components, and categorises the overall impact level for each valued component in light of the suggested mitigation measures described in Section 8.0 of the main report.

Magnitude of Impact

The first step in the impact significance classification was to determine the intensity, or magnitude, of the effect of the Project within the LSA and CHAA. The effect was quantified by combining the rankings of the criteria for direction, geographic extent, duration, and reversibility into a single measure of magnitude for each key question and valued component.

Magnitude describes the significance or intensity of the effect. To classify magnitude using an ordinal scale (that is, negligible, low, medium, or high) in a manner meaningful for biodiversity valued components, the effect size must be placed in the context of the valued component. That is, classifying magnitude in a meaningful way depends on the historical and ecological context of the valued component, which includes effects of previous and existing developments and population trajectories of the valued component in the CHAA, and were valued component-specific. For example, a 20% additional habitat loss from the baseline condition in the CHAA may be required to cause a high magnitude effect on some valued components, whereas a 2% habitat loss may be sufficient for others, depending on context. Fixed quantitative thresholds to define ordinal magnitude categories were therefore not applied. Instead, qualitative descriptions of the potential for an effect of a given size to contribute to a substantial change in the structural integrity (for example, self-sustaining population) or ecological function were used (Table F1).

All of these steps were deliberately kept transparent so that the impact assessment process can be readily understood by stakeholders.

To help readers understand the results of the impact assessments, each assessment answered the same questions to derive the magnitude:

a)   Is the effect good or bad? This is the <u>direction</u> of an effect.

b) How large an area will be affected? How far will the effect reach? This is the geographic extent of an effect.

c) How long will the effect last? This is the duration of an effect.

d) Will the effect be reversible or not?

Each of these is discussed in more detail below.

■ **Direction**

Direction describes the trend of the effect compared with baseline conditions. There are three options for direction:

- Adverse – effect is worsening or is undesirable.

- Neutral – effect is not changing compared with baseline conditions and trends.

- Positive – effect is improving or is desirable.

■ **Geographic Extent**

Geographic extent describes the quantitative measurement of area within which an effect occurs. Effects are described in terms of whether they are limited to the LSA, the CHAA, or extend farther:

- Local – effect is limited to the LSA.

- Regional – effect extends beyond the LSA, but is limited to the CHAA.

- Beyond regional – effect extends beyond the CHAA.

■ **Duration**

Duration refers to how long an effect lasts. Duration is described in relation to the phases of the development of the Project within the CHAA, although effects may last longer than the phases of the Project for some valued components. The following framework was used: construction, operations, decommissioning, and far-future.

For the purposes of this impact assessment, the far future is a duration criterion that is meant to capture effects lasting several generations after decommissioning and rehabilitation. This relates to effects that the Project may have on the area's environmental and social sustainability (or not), including cumulative impacts.

- Short-term – effect is limited to the construction period (~2 years), or the period of decommissioning activities (~2 years).

- Medium-term – effect extends throughout the project operations, that is, 25 years.

- Long-term – effect extends beyond the 25 years of operation.

- Far future – effect extends more than 30 years after closure.

■ **Reversibility**

This criterion describes whether the effect is reversible or not. This can be associated with duration, as many effects eventually could be considered to be reversible (that is, in geological time). However, the extinction of a species can be considered as irreversible.

Table F1: Intensity assessment rating scale for CHAA-level impacts

Criterion	Rating scales
Negligible 1	Where the impact affects the environment in such a way that natural, and /or cultural and social functions and processes are negligibly affected and valued, important, sensitive or vulnerable systems or communities are negligibly affected.
Low 2	Where the impact affects the environment in such a way that natural, and/or cultural and social functions and processes are minimally affected and valued, important, sensitive or vulnerable systems or communities are minimally affected. No obvious changes prevail on the natural, and / or cultural/ social functions/ process as a result of project implementation
Medium 3	Where the affected environment is altered but natural, and/or cultural and social functions and processes continue albeit in a modified way, and valued, important, sensitive or vulnerable systems or communities are moderately affected. Near the limits of the ability of the valued component to adapt.
High 4	Where natural and/or cultural or social functions and processes are altered to the extent that they will temporarily or permanently cease, and valued, important, sensitive or vulnerable systems or communities are substantially affected. The changes to the natural and/or cultural / social- economic processes and functions are drastic and commonly irreversible.

In light of the above, it should be noted that defining quantitative ecological benchmarks to bound regional effect-level categories for biodiversity is challenging, and each valued component and situation requires specific analysis (Fahrig 2003, Petchey and Gaston 2006). Ideally, effect threshold values are known, and indicators can be quantified accurately with a high degree of confidence; however, critical thresholds and target levels for indicators, such as habitat quality, quantity, and configuration (for example, patch size, number and isolation), are frequently not available for biodiversity. This was certainly the case for the majority of valued components of the CHAA. Moreover, thresholds vary by species, landscape type, and spatial scale (Fahrig 2001), and some species that avoid human features in relatively undisturbed landscapes can change their behaviour to accommodate disturbance where it is more prevalent (Martin and Blackburn 2010).

Intensity classification was, therefore, based on the inferred or known ability of the valued component to accommodate the predicted change in condition due to the Project based on available scientific literature and consultation with experts. Where ecologically defensible valued component-specific thresholds could be identified, they were applied to indicators to classify effect. Definitions of the different levels of Project effect at the CHAA-scale are presented in Table F1. Intensity classes relate to the level of change compared to natural variation, plus the valued components' ability to absorb or otherwise accommodate the predicted amount of change.

Sensitivity of Receptor

To derive an overall level of impact significance, which also reflected the expected conservation outcome for the particular valued component in a global context (*sensu* IFC 2012a), the predicted effect intensity was combined with a sensitivity value for the valued component.

For the intents of this biodiversity impact assessment, sensitivity represents the valued component's irreplaceability and vulnerability. It was based on, amongst other aspects, the valued components resilience, as well as national and global conservation status. As such, sensitivity was based on scientific principles of biodiversity conservation and human values regarding valued components associated with ecosystem services.

Sensitivity for each valued component ranged from very low to high according to increasing level of threat (Table F2).

Table F2: Sensitivity assessment rating scale

Criterion	Rating scales
Negligible 1	■ None of the below.
Low 2	■ Where natural recovery of the impacted area to the baseline or pre-project condition is expected in the short-term (1-2 years), or where the potentially impacted area is already disturbed by non-project related activities occurring on a scale similar to or larger than the proposed activity. ■ Biome or ecoregion endemic. ■ At baseline, ecosystem's or species's distribution significantly reduced from historical extent, but is currently stable. ■ Ecosystem service is readily substitutable or replaceable.
Medium 3	■ Where natural recovery to the baseline condition is expected in the medium term (2-5 years), and where marginal disturbance or modification of the receiving environment by existing activities is present. ■ Ugandan and/or IUCN status of Vulnerable, Near Threatened, or Data Deficient. ■ Regional endemic. ■ At baseline, ecosystem's and/or species's distribution fragmented and/or under stress. ■ Ecosystem service is substitutable or replaceable.
High 4	■ Where natural recovery of the receiving environment is expected in the long-term (>5 years) or cannot be readily predicted due to uncertainty over the nature of the potential impact, and where unique or highly valued ecological, social or cultural resources could be adversely affected. ■ Locally endemic or range is restricted to the CHAA. ■ Ugandan and/or IUCN status of Critically Endangered or Endangered. ■ Local temporal concentrations of individuals significant to global population ■ At baseline, a much reduced and/or highly fragmented ecosystem and/or species distribution compared to historical extent. ■ Ecosystem representation whose presence or processes support Critically Endangered or Endangered species's habitat, or buffers it. ■ Keystone species. ■ Species new to science. ■ Ecosystem service is not substitutable and/or irreplaceable.

Impact Significance

Sensitivity was combined with the CHAA-level intensity classification to obtain an overall impact significance using the matrix presented in Table F3. Overall impact severities were classified for the construction, operation and decommissioning cases. Descriptors of the impact significance levels are presented in Table F4.

Table F3: Determination of impact severity

			Sensitivity of receptor			
			Negligible	Low	Medium	High
			1	2	3	4
Intensity of Impact in CHAA	Negligible	1	1 Negligible	2 Minor	3 Minor	4 Minor
Intensity of Impact in CHAA	Low	2	2 Minor	4 Minor	6 Moderate	8 Moderate
Intensity of Impact in CHAA	Medium	3	3 Minor	6 Moderate	9 Moderate	12 Major
Intensity of Impact in CHAA	High	4	4 Minor	8 Moderate	12 Major	16 Major

Table F4: Overall impact level

Attribute	Definition
Negligible	■ No adverse impacts to valued components from the Project.
Minor	■ Impact level is acceptable to viability or integrity of valued components. ■ Mitigation is adequate and achievable and monitoring may be necessary.
Moderate	■ Impact level requires follow up action, including the possibility of offsetting. ■ Monitoring necessary to evaluate continued viability or integrity of valued components and provide opportunities for adaptive management
Major	■ Impact level is unacceptable. Depending on valued component, impact level requires careful, specific, higher-level mitigation design (e.g., offsetting). ■ Resilience of valued components stressed to the extent that recovery may not be considered possible ■ Exceedance of legal standards and widely-accepted conservation good practice. ■ Implies proximity to, and uncertain risk of exceedance of, Project design thresholds.

As noted above, overall impact severity was derived separately for the construction, operation and decommissioning cases. For example, a high CHAA-level impact intensity scored against a high-ranked sensitivity for a valued component would result in a major overall impact severity. A major overall impact severity level means that, with current baseline understanding and current Project designs, the requirements of IFC PS6 and a no-net-loss and/or NPI are predicted to be exceeded. Such a situation would necessitate one or more of: a complete design change; additional mitigation; or additional understanding of baseline conditions that would lead to a predicted lower consequence. Major overall impact severity levels are obtained from several combinations of CHAA-level impact ranking and sensitivity, and have a potential to exceed no-net-loss and NPI requirements. These impacts may require a design change or additional

understanding of baseline conditions. Additional requirements, if required, were described in detail in the Analysis Sections of the assessment for each Key Question and valued component.

Where the overall impact severity levels were moderate or major, and in light of the currently proposed decommissioning and rehabilitation, offsets were considered. This was done on a case-by-case basis for the individual valued components. The intensity, or magnitude, of effect from the case selected was used to define requirements for augmentation.

Successful application of offsets means that the overall impact severity level becomes negligible or positive for the valued component considered. A positive overall result for highly sensitive and unique biodiversity values is the target that CNOOC is progressively working to achieve. However, understanding the likelihood of achieving an offset has important implications for managing risk, because failure to achieve an offset may result in unacceptable outcomes for biodiversity values. The likelihood of achieving an offset (offset feasibility) was used in conjunction with the overall impact severity level to define an overall post-offset risk level (Table F5). Offsetting requirements for those valued components triggering them were ranked according to the following prediction confidence levels to facilitate this classification:

■ Certain – proven mechanism, no risks of failure.

■ Likely – highly feasible and, with good levels of risk management, should achieve desired outcomes.

■ Possible – a reasonable mechanism and strategy exists, but significant risks are present (for example, technical uncertainties or third-party actions beyond Project control affect outcomes).

■ Unlikely – in theory, a potential offset mechanism exists but considering technical difficulty, ecological uncertainty, or, economic, political or social challenges, or any combination of the above, with information available, it is considered unlikely to succeed.

■ Impossible – no offset mechanism or opportunity exists for the valued component in question.

Table F5: Overall post-offset risk level matrix as a function of offset feasibility and overall impact severity level

Risk Level (post-offsetting)		Offset Feasibility				
		Certain	**Likely**	**Possible**	**Unlikely**	**Impossible**
Overall Impact Severity Level	**Major**	No Risk	Moderate Risk	High Risk	High Risk	Unacceptable Risk
	Moderate	No Risk	Low Risk	Moderate Risk	High Risk	Unacceptable Risk

Offset feasibility was conservatively identified for this assessment. Where information about offset options was scarce, offset feasibility was usually ranked unlikely, based on a precautionary approach. This assessment may change as more information is gathered and additional consultation with experts has taken place during the operation of the Project. In general, sufficient information was not available to assign offset feasibility to impossible or certain categories.

If offset feasibility was identified as impossible based on available information, risk to the valued component was unacceptable and the Project cannot proceed in a manner consistent with IFC PS6. As previously mentioned, such a situation would necessitate one or more of: a Project design change; additional mitigation, including additional study of offsetting potential; or additional understanding of baseline conditions that would lead to a lower predicted impact level. Where a high risk was identified, there is a chance that the proposed

design criteria would be exceeded, and additional research to improve prediction confidence concerning offset feasibility or changes to Project design to reduce overall impact level at the maximum disturbance or decommissioning cases would be required. Moderate and low risk classifications represent acceptable risk levels with a reasonable chance of achieving a positive impact level for a valued component as a result of the Project. However, continuing efforts are recommended, as appropriate, to achieve as much certainty about offset success as possible, particularly in cases where a very high overall impact level was identified. Given uncertainty at this stage of the impact assessment, an offset feasibility assessment should be planned to improve prediction confidence for valued components for which offsetting was identified as a requirement.

Prediction Confidence

Identified impacts were discussed in light of confidence in impact predictions based on data quality, model accuracy and any uncertainty about ecological processes or efficacy of mitigation, including rehabilitation.

APPENDIX F
Critical Habitat Screening and Appraisal

Table G1: Probability analysis for identified species of concern to actually occur in the CHAA

Species	Common Name	Status					Potential Critical Habitat Trigger	Assessment Criteria and Evidence	Likelihood of occurrence in the CHAA
		Uganda*	IUCN**	CMS***	CITES#	Other			
Plants									
Afrothismia winkleri var. *budongensis*	Budongo Afrothismia	Restricted	DD	-	-	-	No	■ The type species of this tree is listed as Critically Endangered in Cameroon (IUCN SSC 2013a). The variety recorded from Budonga Central Forest Reserve (GBIF 2017), is listed as Data Deficient (IUCN SSC 2013b). It has not yet been recorded from Bugoma Central Forest Reserve (Plumptre et al. 2010, 2011). ■ The population trend of this species is unknown (IUCN SSC 2013b)	Possible
Aloe sp. (Aloaceae)	Aloe	-	?	-	App. II	-	No	■ Recorded in the CHAA (APPENDIX A, GBIF 2017) in thickets on the Buhuka Flats. ■ All *Aloe* species are listed under Appendix II of CITES (UNEP 2014).	Probable
Cordia millenii (Boraginaceae)	Drum Tree/West African Cordelia	Restricted	LR/LC	-	-	-	No	■ Recorded in the CHAA (APPENDIX A, GBIF 2017) in cultivated land on the plateau. ■ Less common and more seriously threatened in the eastern parts of its range through widespread exploitation for timber (ARW 1998).	Probable
Euphorbia candelabrum (Euphorbiaceae)	Candelabra Tree	-	NE	-	App. II	-	No	■ Recorded in the CHAA (APPENDIX A) in thickets on the Buhuka Flats. ■ All *Euphorbia* species are listed under Appendix II of CITES (UNEP (2017).	Probable
Milicia excelsa (Moraceae)	Mvule Tree/African Teak	Restricted	LR/NT	-	-	-	No	■ Recorded in the CHAA in fallow land, Bushland and Wooded Grassland. (APPENDIX A) ■ A common species known to occur in the regions of Bunyoro, Mengo, Masaka, Mubende, Toro, West Nile, Madi, Acholi, Lango, Teso, Mbale and Busoga, and is widespread in Africa (Kalema and Beentje 2012, WCMC1998).	Probable
Polypogon schimperianus	Grass	-	DD	-	-	-	No	■ This species has not been recorded in the CHAA (GBIF 2017, APPENDIX A). ■ No information in this species habitat preferences or populations within Uganda are known (Lansdown et al. 2013).	Possible
Tamarindus indica	Tamarind	Restricted	NE	-	-	-	No	■ Recorded in the CHAA (Appendix B) in Woodland and Wooded Grassland on the escarpment. ■ This is a widespread species (Board of Trustees Kew 2014).	Probable
Macro-invertebrates									
Bellamya rubicunda	Snail	-	NT			Range restricted	Yes Criterion 2	■ This species is endemic to Lake Albert, and has an EOO of <5000 km^2, and is close to meeting the criteria for an Endangered listing based on its EOO (Kyambadde 2010b). ■ It has not been found in the CHAA (GBIF 2017, APPENDIX A), although it sister species *B. unicolor* was a very abundant species in the lake (APPENDIX A).	Possible

Species	Common Name	Status					Potential Critical Habitat Trigger	Assessment Criteria and Evidence	Likelihood of occurrence in the CHAA
		Uganda*	IUCN**	CMS***	CITES#	Other			
								■ The population trend of this species is unknown, and its known habitat is declining in quality (Kyambadde 2010b).	
Gabbiella candida	Mud Snail	-	CR	-	-	Range restricted	Yes Criterion 1 and 2	■ This species is only known from a small area around Butiaba, and has a predicted AOO of <10 km² (Kyambadde 2010a). ■ It has not been found in the CHAA (GBIF 2017, APPENDIX A). ■ The population trend of this species is unknown, and its known habitat is declining in quality (Kyambadde 2010a).	Possible
Potamonautes bipartitus	Crab	-	DD	-	-	Range restricted	Yes Criterion 3	■ This species has not been recorded from the CHAA (GBIF 2017). ■ It is known only from five localities: Alibuaki, 900 m asl, west of Issango; Undussuma; Mbeni (Fort Mbeni in the Semliki Forest); Bundeko, south of Lake Albert, Semiliki Valley; Koganos, and has been collected since 1892 (Cumberlidge 2008). ■ The population trend of this species is unknown (Cumberlidge 2008).	Unlikely
Fish									
Alestes macrolepidotus	*Imberi*	Restricted	LC	-	-	Commercially important	Yes Criterion 13	■ Recorded in the CHAA and the wider Lake Albert (GBIF 2017, APPENDIX B). ■ Found more commonly in rivers than in lakes where it feeds on insects, crustaceans, small fish, vegetation and debris (Azeroual et al. 2010a). ■ The populations of this species are unknown, however, heavy fishing pressure, including from commercial fisheries, may threaten populations of this species (Azeroual et al. 2010a, Taabu-Manyahu et al. 2012).	Probable
Alestes baremose	*Angara*	-	LC	-	-	Commercially important	Yes Criterion 13	■ Recorded in the CHAA and the wider Lake Albert (GBIF 2017, APPENDIX B). ■ Typically found in inshore zones of lakes, but is also potamodromous and benthopelagic. It has a very cosmopolitan diet and shifts from zooplankton to zoobenthos, detritus and macrophytes as plankton densities decline. Breeding fishes of both sexes are found in sheltered bays around the lakes shores (Akinyi et al. 2010a). ■ The populations of this species are unknown, however, heavy fishing pressure, including from commercial fisheries, may threaten populations of this species (Akinyi et al. 2010a).	Probable
Alestes dentex	*Angara*	-	LC	-	-	Commercially important	Yes Criterion 13	■ Recorded in the CHAA and the wider Lake Albert (GBIF 2017) ■ Typically found in inshore zones of lakes, but is also potamodromous and benthopelagic. It has a cosmopolitan diet and shifts from zooplankton to zoobenthos, detritus and macrophytes as plankton densities decline (Akinyi et al. 2010c). ■ The populations of this species are unknown, however, heavy fishing pressure, including from commercial fisheries, may threaten populations of this species (Akinyi et al. 2010c). ■ Reported by Wandera and Balirwa (2010) to be extremely rare in the lake.	Possible
Citharinus latus	*Mpoi*	-	LC	-	-	Commercially important	Yes Criterion 13	■ Recorded in Lake Albert (GBIF 2017).	Possible

Species	Common Name	Status					Potential Critical Habitat Trigger	Assessment Criteria and Evidence	Likelihood of occurrence in the CHAA
		Uganda*	IUCN**	CMS***	CITES#	Other			
								■ Occurs in open water and vegetation beds of lakes and flowing water. Ingests mud containing benthic and sediment algae, as well as phytoplankton and benthic invertebrates (Azeroual et al. 2010b). ■ The populations of this species are unknown, however, heavy fishing pressure, including from commercial fisheries, may threaten populations of this species (Azeroual et al. 2010b). ■ Reported by Wandera and Balirwa (2010) to be almost extinct in the lake.	
Citherinus citherius	*Mpoi*	-	NE	-	-	Commercially important	Yes Criterion 13	■ Occurs in open water and vegetation beds of lakes and flowing water. Ingests mud containing benthic and sediment algae, as well as phytoplankton and benthic invertebrates (Azeroual et al. 2010b). ■ The populations of this species are unknown, however, heavy fishing pressure, including from commercial fisheries, may threaten populations of this species (Azeroual et al. 2010b). ■ Reported by Wandera and Balirwa (2010) to be almost extinct in the lake.	Possible
Clarias lazera	African Catfish	-	LC	-	-	Commercially important	Yes Criterion 13	■ Recorded in Lake Albert (GBIF 2017). ■ A bottom dwelling species with a diet dominated by larvae of mayflies, non-biting midges, and caddis flies. This species undergoes lateral migration into swamps for feeding and spawning. (Lalèyè et al. 2010). ■ The populations of this species are unknown, however, heavy fishing pressure, including from commercial fisheries, agricultural development and dams pose threats (Lalèyè et al. 2010).	Probable
Distichodus niloticus	*Mpoi*	-	LC	-	-	Commercially important	Yes Criterion 13	■ Recorded in the CHAA and the wider Lake Albert (APPENDIX B, GBIF 2017). ■ A macro-herbivorous species that feeds on submerged water plants, water hyacinth roots and periphyton. It is found in shallow inshore zones, especially in river deltas, but also sometimes in pelagic zones (Akinyi et al. 2010b). ■ The populations of this species are unknown, however, heavy fishing pressure, including from commercial fisheries, may threaten populations of this species (Akinyi et al. 2010b, Taabu-Manyahu et al. 2012). ■ Reported by Wandera and Balirwa (2010) to be extremely rare in the lake.	Probable
Hydrocynus vittatus	*Ngassa*	Restricted	LC	-	-	Commercially important	Yes Criterion 13	■ Recorded in the CHAA and the wider Lake Albert (APPENDIX B, GBIF 2017). ■ This species feeds on whatever prey is most abundant. Breeding takes place on a few days each year, when the first good rains have swollen rivers and streams, at which time it undertakes a spawning migration up rivers and into small streams (Azeroual et al. 2010c). ■ The populations of this species are unknown, however, unregulated gillnet fisheries locally threaten the species. East African populations are threatened by heavy fishing pressure, silt loading due to agricultural activities/ deforestation, and pollution due to pesticides for agricultural use. (Azeroual et al. 2010c). ■ Reported by Wandera and Balirwa (2010) to be rare in the lake.	Possible

Species	Common Name	Status					Potential Critical Habitat Trigger	Assessment Criteria and Evidence	Likelihood of occurrence in the CHAA
		Uganda*	IUCN**	CMS***	CITES#	Other			
Malapterurus electricus	African Electric Catfish	Threatened	LC	-	-	-	No	■ Recorded in the wider Lake Albert (GBIF 2017). ■ Widespread, it lives in shallow water, with muddy or sandy bottom neighbouring rocky areas, and favours sluggish or standing water (Azeroual et al. 2010d). ■ The populations of this species are unknown; however, this species is threatened by overfishing in eastern Africa. (Azeroual et al. 2010d).	Possible
Oreochromis niloticus	Nile Tilapia	-	NE	-	-	Commercially important	Yes Criterion 13	■ Recorded in wider Lake Albert and the CHAA (GBIF 2017, APPENDIX B). ■ It feeds on both plankton and aquatic plants and prefers shallow water.	Probable
Sarotherodon galilaea	Mango Tilapia	-	NE	-	-	Commercially important	Yes Criterion 13	■ Recorded in wider Lake Albert and the CHAA (APPENDIX B). ■ It feeds on both plankton and aquatic plants and prefers shallow water.	Probable
Schilbe niloticus	African Butter Catfish	-	LC	-	-	Commercially important	Yes Criterion 13	■ Recorded in the CHAA and the wider Lake Albert (GBIF 2017). ■ This species prefers standing or slowly flowing open water with emergent or submerged vegetation, it is also abundant in shallow swamps, and occasionally in shallow flood plains. It feeds from mid-water and surface waters on a wide variety of foods including fish, insects, shrimps, snails, plant seeds, and fruit. Migrates into the tributaries of rivers and streams during the rainy season to breed (Azeroual et al. 2010e). ■ The populations of this species are unknown, however, heavy fishing pressure, including from commercial fisheries, may threaten populations of this species (Azeroual et al. 2010e). ■ Reported by Wandera and Balirwa (2010) to be extremely rare in the lake.	Possible
Synodontis nigrita	Shield-head Catfish	-	LC	-	-	Commercially important	Yes Criterion 13	■ Recorded in the wider Lake Albert (GBIF 2017). ■ The populations of this species are unknown (Awaïss et al. 2010), and it is reported by Wandera and Balirwa (2010) to be extremely rare in the lake.	Possible
Tilapia zillii	Zill's Tilapia	-	NE	-	-	Commercially important	Yes Criterion 13	■ Recorded in wider Lake Albert and the CHAA (APPENDIX B). ■ It feeds on both plankton and aquatic plants and prefers shallow water.	Probable
Butterflies									
Acleros neavei	-	-	NE	-	-	Albertine Rift endemic	No	■ This species has not been recorded within the CHAA (GBIF 2017). ■ Although it is an Albertine Rift endemic species, indications are that, within the CHAA, it is restricted to the Budongo Central Forest Reserve; although it has also been reported in the DRC and other areas of the Albertine Rift. (Davenport 2003).	Unlikely
Cymothoe ochreata	Blood-red Glider	-	NE	-	-	Albertine Rift endemic	No	■ This species has been recorded within the CHAA (GBIF 2017). ■ Although it is an Albertine Rift endemic species, indications are that, within the CHAA and wider area, it is restricted to the Budongo and Bugoma Central Forest Reserves (Davenport 2003). Elsewhere, it has been recorded in suitable habitat in the southern rift and the DRC (Davenport 2003).	Possible

Species	Common Name	Status					Potential Critical Habitat Trigger	Assessment Criteria and Evidence	Likelihood of occurrence in the CHAA
		Uganda*	IUCN**	CMS***	CITES#	Other			
Micropentila bunyoro	-	-	DD	-	-	Albertine Rift endemic	No	■ This species has not been recorded within the CHAA (GBIF 2017). ■ Although it is an Albertine Rift endemic species, its EOO is around 70,000 km² (Larsen 2011e), indications are that, within the wider area, it is restricted to the primary forests of Budongo Central Forest Reserve (Davenport 2003). ■ The threats to this species are largely unknown at present, although as a species of primary forest, it is presumably threatened by deforestation and habitat degradation brought about by fuel wood collection, livestock grazing, shifting agriculture and illegal logging (Larsen 2011e).	Possible
Dragonflies and Damselflies									
Agriocnemis palaeforma	Damselfly	-	NT	-	-	Albertine Rift endemic	Yes Criterion 2	■ This species has not been recorded from the CHAA (GBIF 2017, APPENDIX B). ■ It appears to a papyrus swamp specialist (Claustinitzer 2010a). ■ Currently, its population trend is unknown, and it has only been recorded from Bwindi, western Uganda (in papyrus swamps in the Victoria basin) (Claustinitzer 2010a). ■ The papyrus swamps in Uganda have experienced a rapid decline recently, which gives cause for concern, and the habitat of this species could be rapidly lost (Claustinitzer 2010a).	Unlikely
Tetrathemis corduliformis	Dragonfly	-	LC	-	-	Albertine Rift endemic	No	■ This species has not been recorded in the CHAA (GBIF 2017, APPENDIX A), although records do exists from Budongo Central Forest Reserve (Claustinitzer 2002). ■ This is a widespread species that tends to prefer pools and slow streams in rainforest (Claustinitzer 2010b). ■ Major threats to this species include forest destruction caused by agriculture and non-woody vegetation collection (Claustinitzer 2010).	Possible
Amphibians									
Amietia desaegeri	DeSaeger's River Frog	-	LC	-	-	Range restricted?	No	■ Recorded in the CHAA in the wetlands associated with the Kamansinig River, and other localities on the Buhuka Flats (APPENDIX A). ■ This is a range restricted species with and EOO of 8805 km², although it may have a much larger extent and requires further investigation considering that published accounts record it from only montane areas of the Virungas, and hence its range restricted status (IUCN SSC Amphibian Specialist group 2014b). However, this current record from the CHAA is approximately 100 km north-east of that known distribution, and may well increase the known EOO of the species by an order of magnitude. ■ This species has not been considered as a critical habitat trigger for this impact assessment given that its range is possibly far larger than believed (*viz.*, IUCN SSC Amphibian Specialist group 2014b).	Probable
Amietophrynus vittatus	Lake Victoria Toad	-	DD	-	-	-	No	■ Recorded in the CHAA (APPENDIX A) in the wetlands associated with the Kamansinig River, and other localities on the Buhuka Flats (APPENDIX A, AWE 2008a, 2008b, 2013a).	Probable

Species	Common Name	Status					Potential Critical Habitat Trigger	Assessment Criteria and Evidence	Likelihood of occurrence in the CHAA
		Uganda*	IUCN**	CMS***	CITES#	Other			
								■ A species with an unknown population trend that appears to be restricted to localities within Uganda; other records in the region require confirmation, as does its taxonomy (IUCN SSC Amphibian Specialist group 2014a). ■ This species favours marshy areas (Channing and Howell 2006), and occurs in large numbers in suitable habitat (APPENDIX A).	
Ptychadena christyi	Christy's Grass Frog	-	DD	-	-	-	No	■ Not recorded in the CHAA (GBIF 2017). ■ This is a very poorly known species which is taxonomically confused; with little know about its ecology and population trends (Largen and Howell 2004). ■ It favours lowland rainforest habitat, where it breeds in temporary water bodies (Channing and Howell 2006), such as areas along the pipeline route.	Possible
Reptiles									
Chamaeleo gracilis	Graceful Chamaeleon	-	NE	-	App. II	-	No	■ Recorded in the CHAA (APPENDIX A, GBIF 2017). ■ It occurs in a wide variety of habitats, preferring moist and dry savannah, although its population trends are unknown (Spawls et al. 2004).	Probable
Chamaeleo laevigatus	Smooth Chamaeleon	-	NE	-	App. II	-	No	■ Recorded in the CHAA (APPENDIX A, GBIF 2017). ■ It occurs in a wide variety of habitats, preferring moist and dry savannah, although its population trends are unknown (Spawls et al. 2004).	Probable
Crocodylus niloticus	Nile Crocodile	-	LR/LC	-	App. II	-	No	■ Recorded in the CHAA (APPENDIX A, GBIF 2017). ■ The populations in Uganda are listed under CITES Appendix II, and appear stable (CSG 1996).	Probable
Kinixys erosa	Serrated Hinge-back Tortoise	-	DD		App. II		No	■ Recorded in the CHAA (AWE 2008a, b, c, 2013a, b, 2014a, b). ■ Prefers forest habitat, and is widespread in suitable habitat, and probably not under direct threat, although its population trends are unknown (Spawls et al. 2004). ■ Listed under CITES Appendix II (TFTSG (1996).	Probable
Pelomedusa neumannii	Neumann's Helmeted Terrapin	-	?	-	-	-	No	■ The original taxon, *P. subrufa*, has been recorded in the CHAA (GBIF 2017). ■ This species is newly described, and, although not yet recorded in Uganda, it is expected from the forest areas of western Uganda (WR Branch pers. comm., Petzold et al. 2014). ■ Found in a large variety of waterbodies, although rarely in larger rivers and lakes, preferring stagnant, smaller waterbodies like puddles, rock pools, swamps, pans, small streams (Spawls et al. 2004).	Possible
Pelomedusa schweinfurthi	Schweinfurth's Helmeted Terrapin	-	?	-	-	-	No	■ The original taxon, *P. subrufa*, has been recorded in the CHAA (GBIF 2017). ■ This species is newly described, and, although not yet recorded in Uganda, it is expected from the savannah areas of western Uganda (WR Branch pers. comm., Petzold et al. 2014).	Possible

Species	Common Name	Status					Potential Critical Habitat Trigger	Assessment Criteria and Evidence	Likelihood of occurrence in the CHAA
		Uganda*	IUCN**	CMS***	CITES#	Other			
								■ Found in a large variety of waterbodies, although rarely in larger rivers and lakes, preferring stagnant, smaller waterbodies like puddles, rock pools, swamps, pans, small streams (Spawls et al. 2004).	
Stigmochelys pardalis	Leopard Tortoise	-	NE	-	App. II	-	No	■ Recorded in the CHAA (AWE 2008a, b, 2013a, 2014a). ■ Prefers dry and moist savannah, woodlands and thickets, not in forest (Spawls et al. 2004). ■ Although current populations are unknown, it is not believed to currently be under any threat, and is very widely distributed (Spawls et al. 2004).	Probable
Trionyx triunguis	Nile Soft-shelled Turtle	-	NE	-	-	Under local threat	No	■ Recorded in the CHAA (APPENDIX A, AWE 2008a, b, 2013a, 2014a). ■ Although this species is yet to be evaluated by the IUCN, the population within Lake Albert is threatened by human activities including: eating adults and eggs as a delicacy, and for medicinal purposes; its carapace is sold for high value (APPENDIX A). ■ Prefers permanent lakes and dams, large and small rivers (Spawls et al. 2004). ■ Within Uganda, it is only known from Lake Albert and the White Nile (Spawls et al. 2004).	Probable
Varanus niloticus	Nile Monitor	-	NE	-	App. II	-	No	■ Recorded in the CHAA (APPENDIX A, AWE 2008a, b, 2013a, 2014a). ■ Usually found near watercourses, and widespread (Spawls et al. 2004). ■ In parts of Africa they are exploited for their skins, yet no their populations appear to be stable (Spawls et al. 2004).	Probable
Birds									
Acrocephalus schoenobaenus	Sedge Warbler	-	LC	App. II	-	-	No	■ Recorded in the CHAA (APPENDIX A, AWE 2008a, b, 2013a, 2014a, EAC 2013, 2014). ■ It has an extremely large range; it overwinters in East Africa preferring reed beds, marshes and lakeside vegetation (Stevenson and Fanshawe 2002). ■ The population trend for this species appears to be stable, (BirdLife International 2014g).	Probable
Ardea cinerea	Grey Heron	Schedule 1A, NT	LC	-	-	-	No	■ Recorded in the CHAA (APPENDIX A, AWE 2008a, b, 2013a, 2014a, EAC 2013, 2014). ■ This species is a generalist in its habitat use, it inhabits any kind of shallow water, fresh, brackish or saline, either standing or flowing, and shows a preference for areas with trees as it is commonly an arboreal rooster and nester. (BirdLife International 2012e).	Probable
Ardea purpurea	Purple Heron	Schedule 1A, NT	LC	App. II	-	-	No	■ Recorded in the CHAA (APPENDIX A). ■ This species is a wetland habitat generalist inhabiting densely vegetated swamps, shore lines and artificial water bodies (BirdLife International 2012f). ■ Indications are that the populations are decreasing (BirdLife International 2012f).	Probable

Species	Common Name	Status					Potential Critical Habitat Trigger	Assessment Criteria and Evidence	Likelihood of occurrence in the CHAA
		Uganda*	IUCN**	CMS***	CITES#	Other			
Ardeola idae	Madagascar Pond-Heron	Schedule 1A, VU	EN	App. I/II	-	-	Yes Criterion 1	■ This species has not been recorded from the CHAA (GBIF 2017). Non-breeding individuals have the potential to occur in suitable habitat within the CHAA. ■ In its non-breeding range, it is commonly found along the banks of small streams, including those inside forests (BirdLife International 2012a). ■ The populations of this species appear to be declining (BirdLife International 2012a).	Possible
Balaeniceps rex	Shoebill	Schedule 1A, VU	VU	-	App. II	-	Yes Criterion 5	■ This species has not been recorded from the CHAA. Non-breeding individuals have the potential to occur in suitable habitat within the CHAA. ■ This species if a wetland specialist; It breeds and forages in seasonally flooded marshes or Papyrus swamps, although it tends to avoid areas where the vegetation is taller than itself (BirdLife International 2012g). ■ The populations of this species appear to be declining (BirdLife International 2012g). ■ This species is recognised as an evolutionarily distinct species (Jetz et al. 2014, ZSL 2014).	Possible
Balearica regulorum	Grey Crowned-Crane	Schedule 1A, EN	EN	-	-	-	Yes Criterion 1	■ Recorded in the CHAA (APPENDIX A, EAC 2013). Mature individuals have been observed on the Buhuka Flats, with individuals appearing to begin to pair up in May (R Skeen pers. comm.). ■ In east Africa, the populations tend to have peak breeding during the dry season (BirdLife International 2014d). Typically, this species nests in solitary, territorial pairs at the edges of wetlands and in marshes with water at least 1 m deep and tall, emergent vegetation (Morrison and Bothma 1998, BirdLife International 2013a, 2014d). ■ The populations of this species appear to be declining (BirdLife International 2013a).	Probable
Bycanistes cylindricus	Brown-cheeked Hornbill	-	VU	-	-	-	No	■ This species has been recorded in the CHAA (GBIF 2017, Plumptre et al. 2010). ■ It prefers primary and mature secondary forest, although it has been recorded but generally prefers undisturbed forest. It has also been recorded in plantations, but it is not known whether these represent viable breeding populations. It is dependent on the presence of large emergent trees and dead standing trees for nest sites (BirdLife International 2012af). ■ The population trend of this species appears to be undergoing a rapid decline owing to the impacts of habitat destruction and degradation, and hunting pressure (BirdLife International 2012af).	Probable
Charadrius hiaticula	Common Ringed Plover	-	LC	App II	-	-	Yes Criterion 3	■ Recorded in the CHAA (APPENDIX A, AWE 2008a, b, 2013a, 2014a, EAC 2013, 2014). Less than 100 individuals were recorded in the LSA during March when Palearctic migrants were expected to be common. It is noted that September may be a better time to identify numbers of Palearctic migrants in the CHAA (APPENDIX B). ■ This is a specialist shore bird; it prefers to nest on shores and sandbars of inland rivers and lakes, or on short grassland, farmland and other well-drained sites. Non-breeding birds tend to inhabit to the shores of inland waterbodies and coastal areas (BirdLife International 2012h).	Probable

Species	Common Name	Status					Potential Critical Habitat Trigger	Assessment Criteria and Evidence	Likelihood of occurrence in the CHAA
		Uganda*	IUCN**	CMS***	CITES#	Other			
								■ The populations of this species appear to be declining (BirdLife International 2012h). ■	
Charadrius pecuarius	Kittlitz's Plover	-	LC	App II	-	-	Yes Criterion 3	■ Recorded in the CHAA (APPENDIX A, AWE 2008a, b, 2013a, 2014a, EAC 2013, 2014). Less than 50 individuals were recorded in the LSA during March when Palearctic migrants were expected to be common. It is noted that September may be a better time to identify numbers of Palearctic migrants in the CHAA (APPENDIX A). ■ This species primarily inhabits dry ground near the margins of lakes, reservoirs and rivers, or on small permanent and temporary pools, flood plains, dry sandy riverbeds (BirdLife International 2012i). ■ The populations of this species are unknown (BirdLife International 2012i).	Probable
Chlidonias leucopterus	White-winged Tern	-	LC	App. II	-	-	Yes Criterion 3	■ Recorded in the CHAA (APPENDIX A, AWE 2008a, b, 2013a, 2014a, EAC 2013, 2014). Less than 10 individuals were recorded in the LSA during March when Palearctic migrants were expected to be common. It is noted that September may be a better time to identify numbers of Palearctic migrants in the CHAA (APPENDIX A). ■ This species primarily inhabits freshwater lakes, swampy standing water, rivers and shallow naturally flooded grassland (BirdLife International 2012j). ■ The populations of this species are stable (BirdLife International 2012j).	Probable
Circus macrourus	Pallid Harrier	-	NT	-	-	-	No	■ This species has not been recorded in the CHAA (GBIF 2017); however, it may occur in the area within suitable habitat. ■ The species is migratory, with most birds wintering in sub-Saharan Africa or south-east Asia where semi-desert, scrub, savannah and wetland habitat is preferred (BirdLife International 2013c). ■ The populations of this species are decreasing (BirdLife International 2013c).	Possible
Cisticola carruthersi	Carruther's Cisiticola	NT	LC	-	-	-	No	■ This species has not been recorded in the CHAA; however, it may occur within suitable habitat. ■ The populations of this species are decreasing (BirdLife International 2012k).	Possible
Columba albinucha	White-naped Pigeon	-	NT	-	-	-	No	■ This species has not been recorded in the CHAA (Plumptre et al. 2011, GBIF 2017). ■ This species prefers dense lowland forest and forested slopes, with an altitudinal range in Uganda of between 700 and 1800 m (BirdLife International 2012ah). ■ The population trend of this species is unknown, with main threats presumed to be forest clearance for small-holder cultivation and grazing and subsistence-level logging (BirdLife International 2012ah)..	Unlikely
Coracias garrulus	European Roller	-	NT	App. II	-	-	No	■ This species has not been recorded in the CHAA (GBIF, APPENDIX A); however, it is very likely to occur given the suitable habitat.	Possible

Species	Common Name	Status					Potential Critical Habitat Trigger	Assessment Criteria and Evidence	Likelihood of occurrence in the CHAA
		Uganda*	IUCN**	CMS***	CITES#	Other			
								■ A migrant that overwinters in East Africa preferring dry wooded savanna and bushy plains and wooded grassland (Stevenson and Fanshawe 2002, BirdLife International 2002). ■ The current population trend appears to be declining globally, with major threats occurring in the summer breeding ranges in Europe and Asia Minor ■ (BirdLife International 2012ao)	
Ephippiorhynchus senegalensis	Saddle-billed Stork	Schedule 1A; VU	LC	-	-	-	No	■ Recorded in the LSA (APPENDIX A, AWE 2008a, b, 2013a, 2014a, EAC 2013, 2014). ■ Tends to prefer wetlands and the margins of water bodies (BirdLife International 2012d). ■ This species has an extremely large range. Its population trend appears to be decreasing (BirdLife International 2012d).	Probable
Falco vespertinus	Red-footed Falcon	-	NT	App. II	-	-	No	■ This species has not been recorded in the CHAA (GBIF 2017). ■ It prefers open lowlands with trees and plenty of insects, on which it feeds, including steppe and forest-steppe, open woodland, cultivation and pastureland with fringing trees, agricultural areas (BirdLife International 2013f) ■ This species has an extremely large range; it spends winters in southern Africa north to Kenya (BirdLife International 2013f), and is a very rare migrant in Uganda (Stevenson and Fanshawe 2002). ■ Its population trend appears to be decreasing, with between 300,000 and 800,000 individuals (BirdLife International 2013f).	Unlikely
Ficedula semitorquata	Semi-collared Flycatcher	-	NT	App. II	-	-	No	■ This species has not been recorded within the CHAA (GBIF 2017). ■ This migratory species overwinters in East Africa, where it can be locally common (Stevenson and Fanshawe 2002, BirdLife International 2012aj). ■ Its population trend appears to be decreasing, with between 15,000 and 53,000 breeding pairs, where habitat destruction in some areas is likely to be responsible for recent declines (BirdLife International 2012aj).	Possible
Hieraaetus ayresii	Ayres's Hawk-Eagle	Schedule 1A; VU	LC	-	-	-	No	■ This species has not been recorded in the CHAA (GBIF 2017). ■ It prefers woodland and forest (Stevenson and Fanshawe 2002), yet is considered to be very scarce in the Western Ugandan forests Plumptre et al. 2010). ■ This species has an extremely large range. Its population trend appears to be stable (BirdLife International 2012ag).	Possible
Hirundo atrocaerulea	Blue Swallow	-	VU	App. I/II	-	-	No	■ This species has not been recorded in the CHAA (GBIF 2017). ■ This is an intra-African migratory species that breed in southern Africa. It is a non-breeding migrant in Uganda favouring wet grasslands, cultivation and swamp edges (Stevenson and Fanshawe 2002, BirdLife International 2012al). ■ The population trend of this species is decreasing, with the main threats affecting breeding habitat in southern Africa (BirdLife International 2012al).	Unlikely

Species	Common Name	Status					Potential Critical Habitat Trigger	Assessment Criteria and Evidence	Likelihood of occurrence in the CHAA
		Uganda*	IUCN**	CMS***	CITES#	Other			
Gallinago media	Great Snipe	-	NT	App. II	-	-	Yes Criterion 3	■ This species has not been recorded in the CHAA; however, it may occur within suitable habitat. It is noted that September may be a better time to identify numbers of Palearctic migrants in the CHAA (APPENDIX A). ■ Non-breeding, migrant individuals tend to frequent wetland areas, including marshlands and short grass or sedges on lake edges, or in old cultivation (BirdLife International 2012l). ■ The populations of this species are decreasing (BirdLife International 2012l).	Possible
Glareola nordmanni	Black-winged Pratincole	-	NT	App. II	-	-	Yes Criterion 3	■ This species has not been recorded in the CHAA (GBIF 2017); however, it may occur within suitable habitat. It is noted that September may be a better time to identify numbers of Palearctic migrants in the CHAA (APPENDIX A). ■ Non-breeding, migrant individuals tend to frequent seasonally wet grasslands, savannahs, and sandbanks along large river (BirdLife International 2012m). ■ The populations of this species are decreasing (BirdLife International 2012m).	Possible
Glareola pratincola	Collared Pratincole	-	LC	App. II			Yes Criterion 3	■ Recorded in the CHAA (APPENDIX A). ■ This species has an extremely large range, and the populations in northern Africa are nomadic or migratory. Their population trend appears to be decreasing (BirdLife International 2012c).	Probable
Gyps africanus	White-backed Vulture	-	EN	-	-	-	Yes Criterion 1	■ Recorded in the CHAA (APPENDIX A). ■ This species prefers open wooded savannah, where it requires tall trees for nesting (BirdLife International 2012b). ■ Their population trend is decreasing (BirdLife International 2012b).	Probable
Lamprotornis purpureus	Purple Glossy Starling	-	LC	-	-	Biome restricted	No	■ This species has not been recorded in the CHAA. It is likely to occur in the CHAA within suitable habitat. ■ Prefers open woodland and cultivated habitats (Stevenson and Fanshawe 2002). ■ Their population trend appears to be stable (BirdLife International 2012n).	Possible
Laniarius mufumbiri	Papyrus Gonolek	NT	NT	-	-	-	No	■ This species has not been recorded in the CHAA (GBIF 2017). ■ It is restricted to restricted to papyrus swamps (BirdLife International 2013g). ■ The population trend appears to be decreasing, with major threats arising from drainage, burning and the over-exploitation of wetlands, as well as pollution caused by fertiliser run-off from agricultural fields, leading to algal blooms (BirdLife International 2013g)	Possible
Limosa limosa	Black-tailed Godwit	-	NT	App. II	-	-	Yes Criterion 3	■ This species has been recorded in the CHAA (AWE 2008a, b, 2013a, 2014a, EAC 2013, 2014). It is noted that September may be a better time to identify numbers of Palearctic migrants in the CHAA (APPENDIX A).	Probable

Species	Common Name	Status					Potential Critical Habitat Trigger	Assessment Criteria and Evidence	Likelihood of occurrence in the CHAA
		Uganda*	IUCN**	CMS***	CITES#	Other			
								■ Non-breeding migrants tend to prefer freshwater habitats, including swampy lake shores, pools, and flooded grassland (BirdLife International 2012o). ■ Their population trend appears to be stable (BirdLife International 2012o).	
Malimbus malimbicus	Crested Malimbe	-	LC	-	-	Biome restricted	No	■ This species has not been recorded in the CHAA. It could likely occur in the CHAA within suitable habitat. ■ This species prefers subtropical or tropical moist lowland forests (Stevenson and Fanshawe 2002). ■ Their population trend appears to be stable (BirdLife International 2012p).	Possible
Merops oreobates	Cinnamon-chested Bee-eater	Schedule 1A, NT	LC	-	-	-	No	■ This species has not been recorded in the CHAA. It could likely occur in the CHAA within suitable habitat. ■ This species prefers associated with wooded hillsides and forest edges (Stevenson and Fanshawe 2002). ■ Their population trend is unknown (BirdLife International 2012q).	Possible
Necrosyrtes monachus	Hooded Vulture	-	EN	-	-	-	Yes Criterion 1	■ This species has not been recorded in the CHAA (GBIF 2017). It may occur in the CHAA within suitable habitat. ■ This species is often associated with human settlements, but is also found in open grassland, forest edge, wooded savannah, and desert (BirdLife International 2014f). ■ Their population trend is decreasing (BirdLife International 2012r).	Possible
Nectarinia erythrocerca	Red-chested Sunbird	Schedule 1A; NT	LC	-	-	-	-	■ This species has been recorded within the CHAA (AWE 2008a, b, 2013a, 2014a, EAC 2013, 2014, APPENDIX A). ■ This species prefers associated with wooded hillsides and forest edges (Stevenson and Fanshawe 2002). ■ Their population trend appears to be stable (BirdLife International 2012s).	Probable
Numenius arquata	Eurasian Curlew	-	NT	App. II	-	-	Yes Criterion 3	■ This species has been recorded in the CHAA (AWE 2008a, b, 2013a, 2014a, EAC 2013, 2014). It is noted that September may be a better time to identify numbers of Palearctic migrants in the CHAA (APPENDIX A). ■ Non-breeding migrants prefer inland lakes and rivers, wet grassland and arable fields during migration (BirdLife International 2012t). ■ Their population trend is decreasing (BirdLife International 2012t).	Probable
Phoeniconaias minor	Lesser Flamingo	-	NT	-	-	-	Yes Criterion 2	■ This species has not been recorded in the wider CHAA (GBIF 2017). ■ This species breeds exclusively in three main breeding sites in the saline Rift Valley Lakes where it forms very large colonies. When not breeding, it disperses widely to suitable wetland habitat, and can be quite rare (Stevenson and Fanshawe 2002, BirdLife International 2012am). ■ The population trend appears to be decreasing, with the main threat from proposed soda-ash mining and hydroelectric power schemes affecting the main breeding site, Lake Natron in Tanzania, although currently put on hold, could cause rapid overall population declines owing to	Unlikely

Species	Common Name	Status					Potential Critical Habitat Trigger	Assessment Criteria and Evidence	Likelihood of occurrence in the CHAA
		Uganda*	IUCN**	CMS***	CITES#	Other			
								disturbance and the introduction of an alien brine shrimp to clean the soda of algae (BirdLife International 2012am).	
Polemaetus bellicosus	Martial Eagle	Schedule 1A	VU	-	-	-	No	■ This species has been recorded in the CHAA (APPENDIX A). ■ This species prefers open woodland, wooded savannah, bushy grassland, thorn bush and, in southern Africa, more open country and even sub-desert, and requires large trees for breeding (BirdLife International 2013d). ■ Their population trend is decreasing (BirdLife International 2013d).	Probable
Psalidoprocne albiceps	White-headed Saw-wing	-	LC	-	-	Biome restricted	No	■ This species has been recorded in the CHAA (APPENDIX A). ■ This species prefers Savannah, woodland, scrub and forest in upland areas, including miombo woodland and montane areas (Stevenson and Fanshawe 2002). ■ Their population trend appears to be stable (BirdLife International 2012u).	Probable
Psittacus erithacus	Grey Parrot	Schedule 1A	VU	-	App. II	-	No	■ This species has been recorded in the CHAA, from the Bugoma Central Forest Reserve (Plumptre et al. 2010). ■ This species tends to prefer dense forest, they are commonly observed at forest edges, clearings, gallery forest, mangroves, wooded savannah, cultivated areas, and even gardens (BirdLife International 2013e). ■ Their population trend is decreasing (BirdLife International 2013e).	Possible
Ptilopachus nahani	Nahan's Francolin	Schedule 1A; VU	VU	-	-	-	Yes Criterion 5 Possibly 2	■ This species has been recorded in the CHAA, particularly, Bugoma Central Forest Reserve (Plumptre et al. 2010, GBIF 2017) ■ It is confined to dense, mature, moist, sometimes swampy medium-altitude forest below 1,500m; and is reasonably common in Budongo Central Forest Reserve (Plumptre et al. 2010, 2011). ■ It appears to have a very restricted EOO, although populations in the wider DRC are unknown, hence its distribution may be larger than thought (BirdLife International 2012ad). ■ Large trees with appropriate buttress formation are important for breeding sites for this species (Sande et al. 2009a). Forest disturbance appears to reduce the home range of this species (Sande et al. 2009b). ■ The population trend of this species appears to be decreasing, with the primary threats thought to be habitat loss through logging and clearance of forest for charcoal burning and agriculture. Fragmentation alone probably does not appear to adversely affect the species, but it does appear to be affected by habitat changes associated with human-induced fragmentation, such as the extensive removal of large trees (BirdLife International 2012ad).	Probable
Ptilostomus afer	Piapiac	-	LC	-	-	Biome restricted	No	■ This species has been recorded from the CHAA (AWE 2008a, b, 2013a, 2014a, EAC 2013, 2014). ■ It favours more open country of cultivated land with fields and pasture and small associated towns and villages (Stevenson and Fanshawe 2002).	Probable

Species	Common Name	Status					Potential Critical Habitat Trigger	Assessment Criteria and Evidence	Likelihood of occurrence in the CHAA
		Uganda*	IUCN**	CMS***	CITES#	Other			
								■ Their population trend appears to be stable (BirdLife International 2012v).	
Rynchops flavirostris	African Skimmer	-	NT	App. II	-	-	Yes Criterion 3	■ This has been recorded from the CHAA (AWE 2008a, b, 2013a, 2014a, EAC 2013, 2014, APPENDIX A). ■ It favours expanses of calm water for feeding, while it breeds along broad rivers on large, dry sandbars that are largely free from vegetation (Stevenson and Fanshawe 2002). ■ Their population trend appears to be decreasing (BirdLife International 2012w).	Probable
Sagittarius serpentarius	Secretarybird	-	VU	-	App. II	-	Yes Criterion 5	■ This species has not been recorded in the CHAA (GBIF 2017). ■ It inhabits grasslands, ranging from open plains to lightly wooded savanna, but is also found in agricultural areas and sub-desert (BirdLife International 2013h), although current distribution records do not indicate that it occurs in the southern portion of Lake Albert (Stevenson and Fanshawe 2002). ■ The population trend for this species appears to be decreasing, with major threats coming from the excessive burning of grasslands, which may suppress populations of prey species, intensive grazing of livestock is also probably degrading otherwise suitable habitat (BirdLife International 2013h).	Possible
Scotopelia peli	Pel's Fishing-owl	Schedule 1A; VU	LC	-	-	-	No	■ This species has been recorded in the CHAA (Plumptre et al. 2010, 2011). ■ It preferred habitat is around rivers, especially in clumps of large riparian trees with branches overhanging the water, which provide dense shade, and riverine forest (Plumptre et al. 2010). ■ Their population trend appears to be decreasing (BirdLife International 2012ae).	Probable
Scleroptila streptophora	Ring-necked Francolin	-	NT	-	-	-	No	■ This species has not been recorded in the CHAA (GBIF 2017). ■ This species is regularly recorded in Murchison Falls National Park, where it prefers bushed, wooded grassland, stony hillsides with sparse grass and shrub cover, and wooded grasslands (Stevenson and Fanshawe 2002, BirdLife International 2012ak) ■ The population trend appears to be decreasing, and the reasons for this decrease are not known, although habitat loss is suspected (BirdLife International 2012ak).	Possible
Stephanoaetus coronatus	African Crowned Eagle	Schedule 1A; VU	NT	-	-	-	No	■ This species has not been recorded from the CHAA (GBIF 2017). It may occur in suitable habitat. ■ Prefers forest, woodland, savannah and shrub land, as well as some modified habitats, such as plantations and secondary growth (Stevenson and Fanshawe 2002). ■ Their population trend appears to be decreasing (BirdLife International 2012x).	Possible
Terathopius ecaudatus	Bateleur	-	NT	-	-	-	No	■ This species has not been recorded in the CHAA (GBIF 2017), but it could occur given the suitable habitat.	Possible

Species	Common Name	Status					Potential Critical Habitat Trigger	Assessment Criteria and Evidence	Likelihood of occurrence in the CHAA
		Uganda*	IUCN**	CMS***	CITES#	Other			
								■ It prefers inhabits open country, including grasslands, savanna and sub-desert thornbush. It is generally considered resident, but some adults, as well as immature individuals, are nomadic (BirdLife International 2012an). The nest is built in the canopy of a large tree (Stevenson and Fanshawe 2002). ■ The population trend appears to be decreasing, with threats from many areas, including poisoned baits, which appears to be the major cause of the decline caused by farming communities, pesticides, trapping for international trade, nest disturbance from spreading human settlements, and increased intensification and degradation of agricultural land (BirdLife International 2012an).	
Tricholaema lacrymosa	Spot-flanked Barbet	-	LC	-	-	Range restricted	No	■ This species has been recorded in the CHAA (APPENDIX A). ■ Inhabits wet woodland, wetter areas in dry woodland, also riverine woods, patches of forest (Stevenson and Fanshawe 2002). ■ Their population trend appears to be stable (BirdLife International 2012y).	Probable
Trigonoceps occipitalis	White-headed Vulture	-	VU	-	-	-	No	■ This species has not been recorded in the CHAA (GBIF 2017). ■ It has an extremely large range in sub-Saharan Africa preferring mixed, dry woodland, avoiding semi-arid thorn belt areas (Stevenson and Fanshawe 2002, BirdLife International 2012ai). ■ The population trend appears to be decreasing, with an estimate of between 7000 and 12,500 mature individuals extrapolated from a number of regional estimates. This equates to between 10,500 and 18,750 individuals in total (BirdLife International 2012ai). Reductions in populations of medium-sized mammals and wild ungulates, as well as habitat conversion throughout its range best explain the current decline (BirdLife International 2012ai).	Possible
Tringa hypoleucos	Common Sandpiper	-	LC	App. II	-	-	Yes Criterion 3	■ Recorded in the CHAA (APPENDIX A, AWE 2008a, b, 2013a, 2014a, EAC 2013, 2014). Less than 50 individuals were recorded in the CHAA during March when Palearctic migrants were expected to be common. It is noted that September may be a better time to identify numbers of Palearctic migrants in the CHAA (APPENDIX A). ■ Non-breeding migrants frequent a wide variety of habitats, such as small pools, ditches, riverbanks, streams, lake shores, marshy areas (BirdLife International 2012z). ■ The populations of this species are decreasing (BirdLife International 2012z).	Probable
Turdoides sharpei	Black-lored Babbler	-	LC	-	-	Range restricted	No	■ This species has been recorded in the CHAA (APPENDIX A). ■ It prefers forest-edge thickets and scrub, wooded plains and acacia savannah, dense Bushland, riverine woodland (Stevenson and Fanshawe 2002). ■ The populations of this species are decreasing (BirdLife International 2012aa).	Probable
Vanellus senegallus	African Wattled Lapwing	-	LC	App II	-	-	Yes Criterion 3	■ Recorded in the CHAA (APPENDIX A, AWE 2008a, b, 2013a, 2014a, EAC 2013, 2014). Less than 20 individuals were recorded in the CHAA during March when Palearctic migrants were expected to be common. It	Probable

Species	Common Name	Status					Potential Critical Habitat Trigger	Assessment Criteria and Evidence	Likelihood of occurrence in the CHAA
		Uganda*	IUCN**	CMS***	CITES#	Other			
								■ is noted that September may be a better time to identify numbers of Palearctic migrants in the CHAA (APPENDIX A). ■ This species demonstrates ecological plasticity, in some areas occupying the same habitat all year round, in others changing habitat seasonally and opportunistically, although it tends to frequent marshes, damp grass and muddy or sandy ground beside lakes, rivers and streams, inundated grassland, and temporary pools (BirdLife International 2012ab). ■ The populations of this species are stable (BirdLife International 2012ab).	
Vanellus spinosus	Spur-winged Lapwing	-	LC	App II	-	-	Yes Criterion 3	■ Recorded in the CHAA (APPENDIX A, AWE 2008a, b, 2013a, 2014a, EAC 2013, 2014). Less than 20 individuals were recorded in the CHAA during March when Palearctic migrants were expected to be common. It is noted that September may be a better time to identify numbers of Palearctic migrants in the CHAA (APPENDIX A). ■ This species frequents dry ground close to fresh or saline pools, lakes, rivers, lagoons or marshes, as well as burnt grassland, cultivated, flooded or irrigated fields, marshes, damp grass and muddy or sandy ground beside lakes, rivers and streams, inundated grassland, and temporary pools (BirdLife International 2012ac). ■ The populations of this species are increasing (BirdLife International 2012ac).	Probable
Mammals									
Crocidura selina	Ugandan Lowland Shrew	-	DD	-	-	-	No	■ This species has not been recorded in the CHAA (GBIF 2017). ■ It prefers lowland evergreen forest (Mabira, Kibanda, and Mbanga Forest) (Hutterer 2013). ■ This species has only been recorded from three lowland forests in Uganda (including the type locality of Mabira Forest), and there is a possible record from an isolated forest patch in the Kyulu Hills of southern (Hutterer et al. 2008). ■ The population trend is unknown, and no threats are known for this species (Hutterer et al. 2008).	Unlikely
Dologale dybowskii	Pousargues' Mongoose	-	DD	-	-	-	No	■ This species has not been recorded from the CHAA (GBIF 2017), and is known from 31 museum specimens ■ This species is very poorly known. It is apparently confined to a narrow belt of savanna-forest mosaic north of the Equator, and is known to occupy the thicketed shores of Lake Albert, as well as montane forest grasslands (Stuart et al. 2008, Stuart and Stuart 2013). ■ The population trend is unknown, and no threats are known for this species (Stuart et al. 2008).	Possible
Eidolon helvum	African Straw-coloured Fruit-bat	-	NT	App. II	-	-	Yes Criterion 3	■ This species has not been recorded in the CHAA (GBIF 2017). ■ This is a widespread and adaptable species, which inhabits all forest and woodland savannah habitats (Thomas and Henry 2013). ■ It forms large colonies of thousands to even millions of individuals, with colonies showing extreme roost-site fidelity (Mickleburgh et al. 2008, Thomas and Henry 2013). It also migrates (Thomas and Henry 2013).	Possible

Species	Common Name	Status					Potential Critical Habitat Trigger	Assessment Criteria and Evidence	Likelihood of occurrence in the CHAA
		Uganda*	IUCN**	CMS***	CITES#	Other			
								■ The population trend appears to be decreasing, yet no major threats are known, It is locally threatened in parts of its range by severe deforestation, and hunting for food and medicinal use. Large pre-migration colonies are considered particularly vulnerable to any threats (Mickleburgh et al. 2008). A well-known colony in Kampala declined in numbers over a forty-year period from ca. 250,000 animals to 40,000 in 2007 (Monadjem et al. 2010).	
Glauconycteris humeralis	Allen's Spotted Bat	-	DD	-	-	-	No	■ This species has not been recorded in the CHAA (GBIF 2017). ■ It appears to be associated with lowland tropical rainforest (Happold 2013d). Presumably it roosts within hollow trees and dense vegetation, although this needs confirmation (Schlitter 2008b). ■ Little is known of this species's population trend, although habitat loss, through deforestation resulting from logging and mining activities, and the conversion of forest to farmland, is suspected to be a main threat (Schlitter 2008b).	Possible
Hippopotamus amphibius	Hippopotamus	Schedule 1C	VU	-	App. II	-	No	■ This species has been recorded in the CHAA (APPENDIX A, AWE 2008a, b, 2013a, 2014a, EAC 2013, 2014). ■ This species's habitat is restricted to suitable grassland and grassland-bushland mosaics adjacent to rivers, lakes and swamps (Klingel 2013). ■ Major threats to this species include poaching, habitat loss and fragmentation (Lewinson and Oliver 2008, Klingel 2013). ■ Although this species's population trend is decreasing, within Uganda, it is recognised as having a restricted distribution, although it is locally abundant; as such, it is fully protected under the law (Lewinson and Oliver 2008)	Probable
Loxodonta africana	African Elephant	Schedule 1A, VU	VU	App. II	App. I	-	Yes Criterion 3	■ This species has been recorded in the CHAA, specifically within Bugoma Central Forest Reserve (Plumptre et al. 2010, 2011). ■ It is a very wide ranging species, found in many habitat types including dense forest, open and closed savanna, swamps, gallery and montane forests, grassland and arid deserts (Blanc 2008, Poole et al. 2013). ■ Major threats are primarily from illegal poaching and habitat loss (Blanc 2008). ■ Current indications are that the global population trend is decreasing (Wittemyer et al. 2014), although recent census data from Uganda suggest that these populations (of between 2000 and 3000 individuals) are increasing (Poole et al. 2013).	Probable
Miniopterus sp.	Bent-wing Bat	-	?	App. II	-	-	Yes Criterion 3	■ Bent-wing, or long-fingered bats are obligate cave roosters, and they can form enormous colonies (Dietz et al. 2009, Happold 2013b) (for example, *M. natalensis* is known to form roosting colonies of upwards of 260,000 individuals in de Hoop Guano cave (Monadjem et al. 2010)). ■ These bats are also known migratory species, with species migrating from winter hibernacula to maternity roosts, which may be separated by up to 150 km (Monadjem et al. 2010). ■ African species of *Miniopterus* are very difficult to distinguish (Happold 2013b), yet further investigation is warranted to diagnose the species recorded in the CHAA. Most likely, the Lesser Long-fingered Bat (*M.	Probable

Species	Common Name	Status					Potential Critical Habitat Trigger	Assessment Criteria and Evidence	Likelihood of occurrence in the CHAA
		Uganda*	IUCN**	CMS***	CITES#	Other			
								fraterculus) (IUCN LC, Schlitter et al. 2008), or the Greater Long-fingered Bat (*M. inflatus*) (IUCN LC, Schlitter 2008a) could occur.	
Otomops martiensseni	Large-eared Free-tailed Bat	-	NT	App. II	-	-	Yes Criterion 3	■ This species has not been recorded in the CHAA (GBIF 2017). ■ Found in a wide variety of habitats, from semi-arid scrub to montane forests, urban and agricultural areas (Yalden and Happold 2013). ■ The population trend appears to be decreasing, with the major threat roost disturbance. Indeed, the major colonies of this species (consisting of hundreds of bats) from caves in East Africa have declined severely and now have few or no bats (Mickleburgh et al. 2008c).	Possible
Pan troglodytes schweinfurthii	Eastern Chimpanzee	Schedule 1A, VU	EN	-	App. I	-	Yes Criterion 1	■ This species has been recorded in the CHAA, in particular, Bugoma Central Forest Reserve (Plumptre et al. 2010, 2011). ■ Preferred habitat includes predominantly mature moist and dry forests, either evergreen or semi-deciduous, and forest galleries extending into savanna woodlands (Wilson et al. 2008). ■ The population trend of this species is decreasing, with recent estimates identifying between 4000 and 5700 individuals in Uganda (Thompson and Wrangham 2013). ■ Major threats include habitat destruction and degradation (slash and burn agriculture, deforestation, logging), poaching (bush meat, pet trade, traditional medicine, crop protection), and disease (Oates et al. 2008).	Probable
Panthera pardus	Leopard	-	NT	-	App. I	-	No	■ This species has not been recorded from the CHAA (GBIF 2017), although it may be present. ■ It has a wide habitat tolerance and is the only African cat to occupy rainforest and desert, yet they prefer woodland, grassland savannah, and forest, mountainous habitats, shrubland and semi-desert (Hunter et al. 2013). ■ They are very tolerant of habitat conversion, and, provided cover and prey is present, they can persist in close proximity to large human populations (Hunter et al. 2013). ■ The global population trend for this species appears to be decreasing, with major threats from intense persecution and habitat degradation, particularly prey numbers (Henschel et al. 2008).	Possible
Phataginus tricuspis	White-bellied Pangolin	-	VU	-	App. II	-	No	■ This species has not been recorded in the CHAA (GBIF 2017). ■ It prefers moist tropical lowland forests and secondary growth, but also occurs in dense woodlands, especially along water courses. Fallows and forest mosaics (Kingdon and Hoffman 2013, Waterman et al. 2014). ■ Although this is the most widespread of the pangolin species (Kingdon and Hoffman 2013), its populations are decreasing (Waterman et al. 2014). ■ Major threats to this species include bush meat hunting and an increased demand from the international markets, as Asian pangolin populations decline, smuggling syndicates become more sophisticated and economic ties between Africa and China strengthen (Waterman et al. 2014).	Possible
Profelis aurata	African Golden Cat	-	NT	-	App. II	-	No	■ This species has not been recorded from the CHAA (GBIF 2017), yet it is conceivable that it could occur (Plumptre et al. 2010).	Possible

Species	Common Name	Status					Potential Critical Habitat Trigger	Assessment Criteria and Evidence	Likelihood of occurrence in the CHAA
		Uganda*	IUCN**	CMS***	CITES#	Other			
								▪ This is a forest-dependent species that prefers primary moist forest, although on the periphery of its range it penetrates savanna regions along riverine forest, as well as montane forest and alpine moorland (Henschel et al. 2008, Ray and Butynski 2013). ▪ The population trend of this species is decreasing, with the main threats arising from habitat loss (in particular, deforestation, which has also reduced prey numbers), trapping for the medicinal trade (Henschel et al. 2008).	
Smutsia gigantea	Giant Ground Pangolin	-	VU	-	App. II	-	No	▪ This species has been recorded in Kaiso-Tonya Community Wildlife Area (GBIF 2017) about 8 km north-west of the CHAA. ▪ It prefers forest habitat, but will also frequent forest mosaics, high rainfall, secondary grasslands and the edges of swamps (Kingdon et al. 2013). ▪ The population trend for this species is decreasing, and it has become very rare in parts of its range (Waterman et al. 2014). ▪ Major threats to this species include bush meat hunting and an increased demand from the international markets, as Asian pangolin populations decline, smuggling syndicates become more sophisticated and economic ties between Africa and China strengthen (Waterman et al. 2014).	Possible
Tadarida trevori	Trevor's Free-tail Bat	-	DD	-	-	-	No	▪ This species has not been recorded in the CHAA (GBIF 2017), although it may potentially occur. ▪ It has been recorded from lowland forest, and may be a rainforest-savanna mosaic specialist (Mickleburgh et al. 2008, Happold 2013c). ▪ Little is known of this species's population trend, although habitat loss, from the conversion of land to agricultural use, and the extraction of firewood and timber, is suspected to be a main threat (Mickleburgh et al. 2008a).	Possible
Tadarida ventralis	African Giant Free-tailed Bat	-	DD	-	-	-	No	▪ This species has not been recorded from the CHAA (GBIF 2017), although it may potentially occur. ▪ This species is poorly known, although it is believed to be associated with dry woodland savanna areas containing rocky crevices and gorges wherein it prefers to roost (Cotterill 2013). ▪ The population trend is unknown, and may be threatened through the conversion of suitable habitat to agricultural land and the use of pesticides in these modified areas (Mickleburgh et al. 2008b).	Possible

REPORT – VOLUME 4, STUDY 9

CNOOC UGANDA LIMITED

KINGFISHER OIL PROJECT, HOIMA DISTRICT, UGANDA - ECOSYSTEMS SERVICES REVIEW AND ASSESSMENT

Submitted to:
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Executive Summary

This report consists of an Ecosystem Services Review and Impact Assessment for the proposed Kingfisher Development Area and Pipeline route to Kabaale, which CNOOC intends to develop (the Project). The objective of this study is to identify priority ecosystem services and goods currently supplied in the Project Area of Influence; qualify the relationship between ecosystem services, the ecosystems that provide them, and the condition of those systems and the current drivers of change of those systems; identify the beneficiaries who depend on priority ecosystem services; identify Project impacts on priority ecosystem services; and recommend appropriate mitigation measures.

The ecosystem services **Local Study Area** (LSA) for this assessment (Figure 4) generally aligns with the local study areas used for the socio-economic baseline assessment, which consisted of the Kingfisher Development Area study area (comprising 11 villages in the Buhuka Parish and villages on top of the escarpment), and the pipeline route study area (comprising 22 villages in the vicinity of the pipeline route).

Land cover mapping of the Local Study Area was carried out. A review of the biodiversity, socioeconomic and physical data and information gathered during the baseline phase of the ESIA was used to identify the specific ecosystem services associated with each of the mapped land cover types and determine the condition of the land cover types. This allowed a judgement on the condition of the land cover types to be made, and, therefore, their potential capacity to supply ecosystem services, based on the reported baseline condition of the habitat types supported therein. Ecosystem services provided by the various ecosystems within the Local Study Area were then listed and described. Priority ecosystem services upon which an impact assessment was conducted, were derived from this list of relevant ecosystem services. Priority ecosystem services are:

■ Services for which Project impacts could affect beneficiaries' livelihoods, health, safety or culture (Type I); and

■ Services that could prevent the Project from achieving operational performance (i.e., impact the Project) (Type II).

Beneficiaries for ecosystem services within the Local Study Area were defined as the Project, the inhabitants and herders of the Buhuka Flats, and subsistence farmers whose plots lie within the servitude of the proposed pipeline route. Priority ecosystem services supplied within the Local Study Area include:

■ Grazing for livestock

■ Capture fisheries

■ Wild Foods

■ Construction materials for traditionally-built houses

■ Natural aggregates for Project facility construction

■ Biomass Fuel

■ Fresh Water (Type I)

■ Fresh Water (Type II)

■ Regulating Air Quality (Type II)

■ Regulating Water Flows and Timing

■ Water Purification and Waste Treatment

■ Ethical and spiritual values

■ Educational and inspirational values

The key direct, indirect and induced Project impacts that have the potential to affect beneficiaries will be:

■ Changes in land cover and associated reductions in the supply or quality of ecosystem services due to the proposed construction of the Kingfisher Field facilities, the escarpment road, the oil export pipeline to Kabale, and all associated infrastructure.

■ Population influx of people seeking jobs during construction and operation of the Kingfisher Development Area; people seeking to provide commercial services to the increasing population in the vicinity of the Project, and the concurrent increase in demand for ecosystem services. This is likely to impact the quantity and quality of ecosystem service supply to existing beneficiaries.

■ Water abstraction from Lake Albert to provide make-up water for the oil extraction process is proposed as part of the Project; although this has the potential to affect water quantity and quality in Lake Albert and thus may affect the fisheries potential of those areas, and beneficiaries that rely on fishing in these areas for livelihoods; the proposed abstraction volumes are extremely low in the context of the available resource.

■ As a result of these Project influences, moderate to major impacts are predicted on priority **provisioning ecosystem services**, moderate impacts are predicted on priority **regulating ecosystem services**, and major impacts are predicted on priority **cultural ecosystem services**, within the Project Area of Influence.

Application of recommended mitigation measures is expected to reduce the significance of predicted impacts. Mitigation measures include:

■ Resettlement Action Plan

■ Livelihood Restoration Plan

■ Community Development Plan

■ Influx Management Plan

■ Corporate social responsibility initiatives

■ Support of scientific studies and monitoring programs

■ Worker and community education programmes

■ Basin-wide water management initiatives

■ Avoidance of sites of cultural heritage importance

Pre- and post-mitigation impacts on priority ecosystem services are summarised in the table below:

Priority Ecosystem Service	Significance Pre-mitigation	Significance Post-mitigation
Grazing for Livestock	Major – 16	Moderate – 6
Capture Fisheries	Major – 16	Moderate – 8
Wild Foods	Moderate – 9	Moderate – 6
Construction materials for traditionally-built houses	Major – 12	Moderate – 6
Natural aggregates for Project facility construction	Moderate – 9	Minor – 2
Biomass Fuel	Major – 16	Minor – 4
Fresh Water (Type I)	Major – 16	Moderate – 6
Fresh Water (Type II)	Minor – 4	Minor – 2
Regulating Air Quality (Type II)	Moderate – 8	Minor – 2
Regulating Water Flows and Timing	Moderate – 9	Moderate – 6
Water Purification and Waste Treatment	Major – 12	Moderate – 6
Ethical and spiritual values, and Inspirational values (Type I)	Major – 12	Moderate – 8
Ethical and spiritual values, and Inspirational values (Type II)	Major – 12	Moderate – 8

Potential impacts on the Project's social license to operate may occur due to negative public perception of the Project's *perceived* effect on air quality and fish stocks. Worker and community education programmes, as detailed in the mitigation measures, are deemed to be critical for the Project to maintain its social licence to operate over the lifetime of the Project.

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Prioritisation of ES according to Project Demand

DEFINITIONS

Term	Definition
Beach Management Units	Legally empowered community organisations for planning and management of fisheries resources in partnership with national and local governments, established by the East Africa Community Partner States (Kenya, Tanzania and Uganda).
Carrying capacity	Carrying capacity is the largest population size that an ecosystem can sustainably support without degrading the ecosystem
Critical Cultural Heritage	Includes natural areas with cultural and/or spiritual value such as sacred groves, sacred bodies of water and waterways, sacred trees, and sacred rocks. Natural areas with cultural value are equivalent to priority ecosystem cultural services as defined in Performance Standard 6
Cultural ecosystem service	The nonmaterial contributions of ecosystems to human well-being, such as recreation, spiritual values, and aesthetic enjoyment.
Customary land tenure	Customary land tenure/holdings are plots which are held by individual households. Rights over a plot include the right to build a house, cultivate and to graze animals. These rights can only be abrogated if the occupier abandons the property or commits a taboo. This system has led to land fragmentation and associated economic consequences.
Ecosystem Integrity	The structure, composition, and function of an ecosystem operating within the bounds of natural or historic range of variation.
Ecosystem Resilience	The capacity of an ecosystem to respond to a disturbance by resisting damage and recovering quickly.
Ecosystem Function	Refers to all of the natural ecological processes that occur within an ecosystem, and is dependent on the composition and extent of a particular habitat or combination of habitats; their integrity or intactness, and their resilience.
Irreplaceability	Relates to rarity or uniqueness of an ecosystem in the landscape.
Local Study Area	The spatial context for the study
Priority Ecosystem Services	Those services on which project impacts affect the livelihoods, health, safety, or culture of the ecosystem service beneficiaries, and those services that could prevent the project from achieving planned operational performance.
Project Area of Influence	The area relevant to the assessment of project impacts and dependencies on priority ecosystem services; it includes the ecosystems that supply the priority ecosystem services, and the locations where the Project and affected stakeholders access priority ecosystem services.
Provisioning Ecosystem Services	The goods or products obtained from ecosystems, such as food, timber, fibre, and freshwater

Term	Definition
Regulating Ecosystem Services	The contributions to human well-being arising from an ecosystem's control of natural processes, such as climate regulation, disease control, erosion prevention, water flow regulation, and protection from natural hazards.
Regulation of Air Quality	The influence ecosystems have on air quality by emitting chemicals to the atmosphere (i.e., serving as a "source") or extracting chemicals from the atmosphere (i.e., serving as a "sink")
Social Licence to Operate	Social Licence to Operate (SLO) refers to the acceptance within local communities of both companies and their projects. In order to obtain an SLO it is necessary to develop good relationships with all stakeholders, especially with local communities
Supporting Ecosystem Services	The natural processes such as nutrient cycling and primary production, which maintain the other services.
Spiritual ecosystem services	Sacred, religious, or other forms of spiritual inspiration derived from ecosystems.
Vulnerability	Refers to degree of threat to an ecosystem or species.

1.0   INTRODUCTION

This report consists of an Ecosystem Services Review and Impact Assessment for the proposed Kingfisher Development Area and Pipeline route to Kabale, which CNOOC intends to develop (the Project). The report describes the ecosystem services supplied by the various land cover types in the Project Area of Influence, and the benefits that the local community gains from them under existing conditions. The services that the Project itself will depend upon are identified, and existing drivers of ecosystem change discussed. The potential impacts of the Project on Priority[1] Ecosystem Services (Landsberg, et al., 2013) are assessed, and mitigation measures proposed for any adverse impacts on identified Priority Ecosystem Services.

1.1   The Concept of Ecosystem Services

Ecosystem services consist of all the natural products and processes that contribute to human well-being, as well as the personal and social enjoyment derived from nature (Landsberg, et al., 2013). For example, wetlands provide grazing for livestock and act as nursery areas for juvenile fish at the edges of large open water systems. Wetlands often support populations of waterfowl, which can provide tourism and recreation opportunities for bird watchers; they may also help to mitigate climate change by sequestering carbon, and help reduce floods by storing rainwater (Macfarlane, et al., 2008).

Since different ecosystems provide different ecosystem services, there are trade-offs and synergies amongst ecosystem services - for example, conversion of forest to agriculture lowers the wood supply and potentially the water flow regulation, but it increases food production from crops. On the other hand, restoring a wetland may remove more pollutants from drinking water supplies and increase recreation benefits for bird watching (Landsberg, et al., 2013).

The benefits of ecosystems are passed on at many levels, and to many different beneficiaries. Examples of the benefits provided at different scales include:

■ Local scale: ecosystem services may be the basis for rural livelihoods and subsistence; particularly for the poor; for example, artisanal fishing of inland lakes provides both cash income and food for low-income families.

■ Regional scale: the provision of water to communities and businesses from a forested watershed.

■ Global scale: ecosystems regulate climate and act as a reservoir of biodiversity that underpins biological production of all types, including agriculture.

1.2   Ecosystem Services and the International Finance Corporation

The International Finance Corporation's (IFC) Performance Standard 6 - Biodiversity Conservation and Sustainable Management of Living Natural Resources (PS6) (IFC, 2012a), and its Guidance Notes (IFC, 2012b) - defines ecosystem services as **the benefits that people, including businesses, derive from ecosystems**. The IFC define two types of ecosystem services:

■ Type I Ecosystem Services: Ecosystem Services on which the Project operations are most likely to have an impact and, therefore, which result in adverse impacts to affected communities (beneficiaries); and

■ Type II Ecosystem Services: Ecosystem Services on which the Project is directly dependent for its operations, for example, water.

Although ecosystem services are largely addressed by IFC PS 6, the assessment of ecosystem services is spread throughout the environmental and social Performance Standards (PS) because the potential effects of a project on ecosystem services relates to all aspects of peoples' relationship with the environment, including health and safety risks, land ownership or usage, and cultural heritage. The specific PS that contain provisions for ecosystem services assessment are Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts; Performance Standard 3: Resource Efficiency and Pollution Prevention; Performance Standard 4: Community Health, Safety, and Security; Performance Standard 5: Land

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[1] Priority ecosystem services are those where the significance of the project impact on the ecosystem services is considered likely to be high

Acquisition and Involuntary Resettlement; Performance Standard 7: Indigenous Peoples and Performance Standard 8: Cultural Heritage. These are described in Section 2.0.

1.3   Regional Ecosystem Services in the Context of the Project

The Albertine Graben is recognised as one of Africa's most important areas for biodiversity; it is an area of high endemism and threatened species, with over 50% of birds, 39% of mammals, 19% of amphibians and 14% of reptiles and plants of mainland Africa occurring in this region (Plumptre, 2002). The Graben is recognised as an area of global importance for conservation, which is reflected by the high density of areas protected or designated for biodiversity. As such, this biodiversity represents one of Uganda's most vital economic resources, with the services and products provided by biodiversity in the form of ecosystems, species and genetic resources contributing billions of shillings per year to Uganda's economy, and support some of the poorest and most vulnerable sectors of Uganda's population (NEMA, 2002). In particular, rural people, landless people, and women in certain areas are dependent on biological resource utilisation as a primary means of subsistence and livelihood, or as a supplementary resource during times of drought, or unemployment (NEMA, 2002).

The Kingfisher Development Area and pipeline route from there to Kabale is located in Hoima District, Kyangwali Sub-County, Western Uganda. Whilst subsistence farming and small-scale commercial farming are the main economic activities in the Hoima District, inhabitants of Buhuka Parish villages directly depend on subsistence fishing activities as a source of food, livelihoods and a cash income . The majority (approximately 98.9%) of the population in Hoima District use wood fuel and charcoal as the dominant source of energy, which is locally harvested ; locally harvested natural resources are also used to provide building materials. Evidence suggests an increasing population in the Project area - the Hoima District Development Plan (Hoima District Local Government, 2011) indicated that the population of urban dwellers has increased from 31,671 in 2002, to 42,813 in 2009 and projected that the population would increase to 51,741 in 2013; in fact, by 2014, the district population had increased to 572,986 people, of whom just over 77% lived in rural areas (Uganda Bureau of Statistics, 2014). In addition, there is observational evidence of expansion and urban growth in Hoima town itself, attributed to the oil and gas exploration activities. This urbanisation rate is expected to increase as oil and gas exploration activities proceed, which is anticipated to increase demand for ecosystem services in the Project area.

It is worth noting at this point that, although oil is a natural resource, it is not considered to be an ecosystem service. Although fossil fuels and some minerals come from organic material that was alive millions of years ago, their quantity and quality do not depend on the living component of *existing* ecosystems, and so are not considered to be benefits derived from existing ecosystems (Hanson, et al., 2012).

1.4   Report Structure

The report is structured sequentially:

- The terms of reference are introduced in Section 2.0 which provide the context for the study.

- Relevant international and national legislation and policy in terms of the Project's obligations to take ecosystem services into account are summarised in Section 3.0.

- The methods used in the determination of the Local Study Area, identification of ecosystem services and beneficiaries within the Local Study Area, prioritisation of ecosystem services and impact assessment of those priority ecosystem services are detailed in Section 4.0.

- Sections 5.0 and 6.0 provide the results of the Land Cover Classification exercise and literature review in order to identify ecosystem services and beneficiaries within the study area.

- Section 7.0 provides the process and results of the ecosystem service review for the local study area, and the prioritisation of ecosystem services exercise.

- The Project Area of Influence for priority ecosystem services is defined in Section 8.0.

■ Section 9.0 describes the assessment of Project impact on **Priority ecosystem services** within the Project Area of Influence.

■ Recommended mitigation and monitoring measures are outlined in Section 10.0.

■ Study conclusions are drawn in Section 11.0.

■ References for the study are given in Section 12.0.

2.0 TERMS OF REFERENCE

In determining the requirements of the Ecosystem Service Review and Impact Assessment for the Project, reference was made to the international guidance document 'Weaving Ecosystem Services into Impact Assessment' (Landsberg et al., 2013), appropriate Ugandan legislation and guidance, as well as international standards and guidance. National policy and international standards pertaining to the Project are detailed in Section 4.0.

The ecosystem services impact assessment concentrates on assessing predicted changes in ecosystems and ecosystem function, physical and aesthetic changes in the Lake Albert landscape, and changes in human population dynamics within the Project Area of Influence; and the concomitant effects that these changes will have on ecosystem service supply and demand within the same area.

2.1 Objectives

The aim of this Ecosystem Services Review and Impact Assessment is to:

■ Identify priority ecosystem services and goods currently supplied in the context of the area in which the Project will be located.

■ Qualify the relationship between ecosystem services, the ecosystems that provide them, and the condition of those systems, and the current drivers of change of those systems.

■ Identify beneficiaries of the services, that is, the Project and/or the people who benefit from the goods and services supplied, and their level of dependence on the ecosystem services.

■ Identify potential impacts on priority ecosystem services arising from the Project and propose mitigation measures.

■ Identify any necessary additional areas of investigation.

2.2 Scope

In order to address the above objectives, and in line with the Scoping Report (Golder Associates, 2014), a description and regional contextualisation of the baseline ecosystem services supplied and utilised within the Project Area of Influence was undertaken.

Using available regional data on ecosystem services in Western Uganda, and pertinent data gathered from the biodiversity, socioeconomic, surface water and cultural heritage baseline studies, an assessment of the predicted Project effects on the ecosystem services of the Project's area of influence was conducted to meet the requirements of IFC PS6.

2.3 Limitations

This assessment is a largely desk-based study, supplemented by the primary data gathered as part of the biodiversity, cultural heritage and socioeconomic baseline studies. Specific ecosystem service utilisation related questions were provided to the socioeconomic baseline team; and the data used to inform the prioritisation of the initial list of ecosystem services.

Study limitations include the following:

■ No ecosystem service supply and demand modelling was done for this study, as the economic and numerical modelling approaches that would be required were beyond the scope of the current study.

- Limitations encountered by the specialist studies that pertain to the ecosystem service-related information that could be derived from the baseline data include:

  - Access limitations due to health and safety considerations and site conditions.

  - The information gathered in relation to traditional cultural places and intangible heritage is limited to that which the community was willing to share with the field team. Some of the recorded sites are considered 'secret', and there may be places known only to a small section of the community and/or some which are too sensitive to share. Consequently, there is a potential for unidentified features of cultural importance to exist within the **Local Study Area**.

  - Transient populations and migratory population groups may not have been present during the period of socio-economic data collection. However, based on available research, the data collection period between November and December 2013 appears to be an optimal timeframe to encounter most of these transient population groups.

Despite these limitations to baseline data, the conclusions contained within this report are based upon a robust and transparent procedure, and represent an accurate evaluation and assessment of likely impacts.

3.0 LEGISLATIVE AND POLICY CONTEXT

3.1 Ugandan Legislation and Policy relating to Ecosystem Services

Currently, there is no specific legislation directly pertaining to ecosystem service utilisation in Uganda; however, in the wake of increasing ecosystem degradation and biodiversity loss, Uganda has enacted several legislative and policy interventions to conserve natural resources and ensure that these resources provide sustainable benefit to the local community (CRA, 2006). Those considered most relevant to this ecosystem services assessment are described below.

3.1.1 The Laws and Acts of Uganda

3.1.1.1 The Constitution of the Republic of Uganda (as at 15 February 2006)

The over-arching government policy on natural resource conservation, cultural heritage preservation and social and economic wellbeing in Uganda is provided for in the Constitution of the Republic of Uganda. The relevant constitutional provisions in the National Objectives and Directive Principles of State Policy include the following:

- **Principles of State Policy XXVII (iv)**: mandates the State (both central and local government) to create and develop parks, reserves and recreational areas, and to ensure conservation and promote the rational use of natural resources so as to safeguard and protect the biodiversity of Uganda.

- **Article 237 (2) (b)**: the Government or local government, as determined by Parliament by law, shall hold in trust for the people and protect, natural lakes, rivers, wetlands, forest reserves, game reserves, national parks and any land, to be reserved for ecological and touristic purposes for the common good of all citizens.

- **Article 245**: the utilisation of natural resources of Uganda shall be undertaken in such a way as to meet the development and environmental needs of present and future generations of Ugandans and, in particular, the State shall take all possible measures to prevent or minimise damage and destruction to land, air and water resources resulting from pollution and other causes.

- **Social and Economic Objective (XIV):** Under the general social and economic objective, the State shall endeavour to fulfill the fundamental rights of all Ugandans to social justice and economic development and shall, in particular, ensure that all developmental efforts are directed at ensuring the maximum social and cultural well-being of the people.

- **Cultural Objective (XXIV):** Cultural and customary values, which are consistent with fundamental rights and freedoms, human dignity, democracy, and with the Constitution, may be developed and incorporated

in aspects of Ugandan life. The State shall promote and preserve those cultural values and practices which enhance the dignity and well-being of Ugandans.

■ **Cultural Objective (XXV):** Preservation of Public Property and Heritage: The State and citizens shall endeavour to preserve and protect, and generally promote, the culture of preservation of public property and Uganda's heritage.

Project Relevance

The constitution of the Republic of Uganda obliges the state, Government and local governments of Uganda to conserve and protect natural and cultural heritage resources for the social and economic wellbeing of the people of Uganda. This has significance for the Project in terms of gaining the appropriate authorisations/licences/permits from Government authorities for the Project to proceed – the Government authorities will need to be satisfied that the obligations of the Constitution of the Republic of Uganda are fulfilled.

3.1.2 Uganda Wildlife Bill (2017)

The primary objectives of the Uganda Wildlife Bill are to provide for the conservation and sustainable management of wildlife, to strengthen wildlife conservation and management; to continue the Uganda Wildlife Authority; and to streamlines roles and responsibilities for institutions involved in wildlife conservation and management.

The Bill re-aligns the Uganda Wildlife Act Cap. 200 with the 2014 Uganda Wildlife Policy, the Oil and Gas policy and laws, the Land use policy and law, the National Environment Act, the Uganda Wildlife Education Centre Act, the Uganda Wildlife Research and Training Institute Act and all other laws of Uganda and developments which came into force after the enactment of the Uganda Wildlife Act in 1996.

For the first time, nationally-protected species were declared in the 2017 Uganda Wildlife Bill. Wildlife species listed in the Third Schedule of Act V are protected species in Uganda, in addition Act V states that wildlife species protected under any international convention or treaty to which Uganda is a part (and to which the regulations set out in section 86 applies), are protected species.

Project Relevance

Where the Project activities have the potential to affect wildlife reserves or community wildlife management areas, the appropriate permits must be sought. The Project will need to demonstrate that Project activities can be conducted in a sustainable manner that makes provisions to maintain the continued presence of wildlife within the area.

3.1.2.1 Uganda Wildlife Act (1996)

The Uganda Wildlife Act defines two types of conservation areas: "wildlife protected" and "wildlife managed" areas. Although the Act *made provision for* the declaration of protected species, no protected species were declared in the Act.

Wildlife Protected Areas

■ **National Park**: these are protected areas of international and national importance because of their biological diversity, landscape or national heritage, and in which biodiversity conservation, recreation, scenic viewing, scientific research and other economic activity may be permitted.

■ **Wildlife Reserve**: these are protected areas of importance for wildlife conservation and management and in which conservation of biological diversity, scenic viewing, recreation, scientific research, and regulated extractive utilisation of natural resources are permitted.

Wildlife Management Areas

■ **Community Wildlife Areas**: these are wildlife management areas where wildlife is protected, whilst taking into account the continued use of the land and the sustainable exploitation of wildlife in the area by people and communities ordinarily residing there. Sustainable exploitation of the natural resources of

the area, including by mining and other methods, is permitted - providing that it is in a manner compatible with the continued presence of wildlife in the area.

3.1.2.2   Uganda Wildlife Act Cap 200 of 2000

The Uganda Wildlife Act cap 200 of 2000 was enacted by an Act of Parliament to provide for sustainable management of wildlife (UWA 2014). The Act consolidated wildlife management law in Uganda and established the Uganda Wildlife Authority (UWA) as the responsible authority for wildlife management and conservation, and enforcement of wildlife laws and regulations. The Act covers all wildlife protected areas (PAs) and wildlife outside PAs, and specifically mandates UWA to control and monitor industrial and mining developments in wildlife protected areas.

3.1.2.3   Uganda Wildlife Policy (1999, 2014)

The Uganda Wildlife Policy generally promotes long-term conservation of wildlife and biodiversity in a cost-effective manner, which maximises the benefits to the people of Uganda in terms of ecology, economy, aesthetics, science and education. The policy aims at achieving this through promoting conservation and sustainable utilisation of wildlife throughout Uganda. The policy seeks to exclude industrial development, including mineral exploration and extraction, from wildlife protected areas (that is, national parks and wildlife reserves).

The Ugandan Government resolved to review Uganda's Wildlife Policy, to harmonise it with related instruments like the National Environment Policy, the Wetland Policy and the Constitution, in the form of the 2014 Uganda Wildlife Policy. New aspects incorporated in the policy included:

- To provide for incentives that supports the private sector to invest more in wildlife development in Uganda.

- To guarantee safety for tourists by enhancing security in in national parks and game reserves, under the expanded anti-terror surveillance in Uganda.

- To increase resource allocation to the tourism sector, specifically for extending and improving infrastructure to, within and around tourism sites.

- To reconcile the needs for wildlife conservation and human beings, particularly in areas that have been affected by insurgency and civil strife.

- To ensure that any infrastructural development within and around wildlife conservation areas does not compromise the support eco-systems for flora and fauna in the respective areas.

- Demands for land in national parks will not be entertained, except in very exceptional circumstances where survival of communities is involved.

3.1.3   National Environment Act (1995)

The National Environment Act provides for the sustainable management of the environment. It sets out principles of environmental management that assure all people living in the country the fundamental right to an environment adequate for their health and well-being. It addresses the sustainable use and conservation of the environment and natural resources of Uganda equitably, taking into account the rate of population growth and the productivity of the available resources; as well as the conservation of cultural heritage, for the benefit of both present and future generations. The NEA sets out to maintain stable functioning relations between the living and non-living parts of the environment through preserving biological diversity and respecting the principle of optimum sustainable yield in the use of natural resources.

3.1.4   Uganda Water Act (1997)

The Ugandan Water Act provides for the use, protection and management of water resources and supply, with the objectives of promoting the rational management and use of waters, provision of a clean, safe and sufficient supply of water for domestic purposes to all persons; allow for the orderly development and use of water resources for purposes other than domestic use; and control of pollution.

3.1.5 Uganda Forestry Policy (2001) and the National Forestry and Tree Planting Act (2003)

The Forestry Policy is implemented through the National Forestry and Tree Planting Act (2003). The Act provides for:

■ The conservation, sustainable management and development of forests.

■ The declaration of forest reserves for the purposes of protection and production of forests and forest produce.

■ The sustainable use of forest resources and enhancement of productive capacity of the forests.

■ The promotion of tree planning.

■ Consolidation of the law relating to the forestry sector and trade in forest produce.

Parts of Uganda's permanent forest estate carry dual status as National Parks, Wildlife Reserves and Animal Sanctuaries; such areas are subject to additional regulations under the Uganda Wildlife Act (1996).

Declared forest reserve categories include Central Forest Reserves (CFRs), Local Forest Reserves, Community Forests, private forests, and forests forming part of a wildlife conservation area (declared under the Uganda Wildlife Act, Cap 200).

CFRs fall in two main categories, namely those designated for production and those for protection. Such forest reserves are subsequently managed in a manner consistent with the purpose for which they were declared:

■ **Production forests**: includes savanna bushland and grassland areas - reserved for supply of forest products and future development of industrial plantations.

■ **Protection forests:** includes all the tropical high forests, savanna woodlands and/or grasslands – reserved forests include those that protect watersheds and water catchments, biodiversity, ecosystems and landscapes that are prone to degradation under uncontrolled human use.

CFRs are held in trust for the people of Uganda and managed by the National Forestry Authority (NFA) and are classified according to the following categories:

■ Site of special scientific interest;

■ Strict nature reserve;

■ Joint management forest reserve;

■ Recreation forest for purposes of eco-tourism; and

■ Any other area, for a purpose prescribed in the order.

In a forest reserve, it is prohibited to cut, disturb, damage, burn or destroy any forest produce, remove or receive any forest produce, or undertake activities not consistent with the specific management plan except under conditions set out in the Act or in accordance with a licence granted under the Act. The Act also makes provision for classification of trees as reserved/protected and therefore subject to specific controls. In addition, Section 38 of the Act requires that an environmental impact assessment be undertaken for any project or any activity which may, or is likely to have a significant impact on a forest.

3.1.6 The Land Act (1995)

Section 43 of the Land Act provides for management and utilisation of land in accordance with the Uganda Wildlife Act, and other laws. Section 44 (i) mandates the government or local governments to protect national parks, wetlands and forest reserves (amongst others) for ecological and tourism purposes, and hold these in trust for the people of Uganda.

3.1.7 Uganda National Land Policy (2013)

The Uganda National Land Policy makes provisions in relation to natural resource management and biodiversity. These include Government resolutions to ensure that land use practises conform to land use plans, and that the principles of sound environmental management including biodiversity preservation, soil and water protection, conservation and sustainable land management are applied. The policy commits the Government to take measures including to

- Provision of special protection for 'fragile' ecosystems (that is, unique and sensitive biodiversity features).

- Development of harmonised criteria for gazetting and de-gazetting conservation areas.

- Establishment and implementation of effective mechanisms for management of wildlife outside protected areas.

- Incentivise community participation in conservation on privately-owned land and co-management of conservation on public land.

- Regulate the use of hilltops and other sensitive ecosystems.

- Develop mechanisms to resolve human-wildlife conflict.

3.1.8 Uganda National Biodiversity Strategy and Action Plan (2015-2025)

Published by the Ugandan National Environmental Management Authority (NEMA) in October 2016, the National Biodiversity Strategy and Action Plan (NBSAP) provides a framework to guide the setting of conservation priorities, channelling of investments and building of the necessary capacity for the conservation and sustainable use of biodiversity in the country.

The overarching principles of the NBSAP are:

a) Sustainable development and environmental sustainability

b) Mainstreaming of biodiversity conservation, sustainable use of biological resources and equitable sharing of benefits from biological resources into existing policy, legislative, institutional and development frameworks as appropriate;

c) Stakeholder participation in the development and implementation of biodiversity strategy and action plans;

d) Awareness creation, education, training and capacity building at local, national and institutional levels to enhance effective participation and implementation of biodiversity measures;

e) Recognition, promotion and upholding of traditional and indigenous knowledge of biological resources and sustainable resource management and where benefits arise from the use of this knowledge;

f) Engagement and collaboration with international partners to enhance conservation and sustainable use of Uganda's biological diversity;

g) Integrated implementation of Multi-Lateral Environmental Agreements;

h) Equal consideration of the three objectives of the Convention on Biological Diversity – conservation; sustainable use; and benefit sharing arising from the use of biological resources

The Uganda NBSAP recognises that the services and products provided by biodiversity in form of ecosystems, species and genetic resources contribute billions of shillings per year to Uganda's economy, through economic output in the in the fisheries, forestry, tourism, agriculture and energy sectors; and support of the poorest and most vulnerable sectors of Uganda's population, who are highly dependent on biological resource utilisation. It emphasises the need to safeguard important ecosystem services, and the importance of social considerations in biodiversity conservation, and particularly in people's ownership of, or participation in, biodiversity management, and conservation and wise use of biological resources.

Project Relevance

Uganda's NBSAP commits the Government to develop national strategies, plans or programmes for the conservation and sustainable use of biological diversity, which directly relates to the use of and impacts on ecosystem services. The Project will need to demonstrate alignment with these instruments in order to satisfy Government obligations as a signatory to the CBD.

3.1.9 Uganda Oil Policy

The Oil and Gas Policy (2008) recognises that many areas with potential for petroleum production coincide with areas of important biodiversity, including national parks, water bodies, and forest reserves. It also acknowledges the risk of the oil and gas industry leading to significant in-migration of people looking for work, and seeks to enforce regulations restricting population movements and settlements in wildlife protected areas, with only a minimum of required infrastructure being allowed in such areas.

Project Relevance

The Project will need to demonstrate alignment with the objectives of the Uganda Oil Policy, through wise application of the mitigation hierarchy in areas of biodiversity importance, and development of appropriate population influx management planning for the lifetime of the Project.

3.1.10 The Uganda National Culture Policy, 2006

Cultural Heritage is defined in paragraph 2.2 of the Uganda National Culture Policy as:

> *"The cultural heritage of Uganda includes artistic and cultural expressions. These are; language and literary arts, performing arts, visual arts and handicrafts, indigenous knowledge, cultural beliefs, traditions and values, cultural sites monuments and antiquities".*

The Uganda National Culture Policy provides the framework for the promotion of cultural heritage; it is all-inclusive and advocates the rights of indigenous groups in Uganda. The core principle underlying this policy is respect for all cultures. The Culture Policy promotes social change and encourages new ideas and approaches within the laws of Uganda.

Project Relevance

The policy directly relates to the supply of cultural, spiritual and intangible services provided by the Lake Albert and escarpment landscape within the Project Area of Influence, and the associated traditions, folklore and ways of life of the people local to the area. The Project will need to demonstrate alignment with the policy to gain the necessary permits to proceed.

3.2 IFC Performance Standards 2012

At the project financing level, the assessment and management of ecosystem services is largely dealt with in PS 6 - Biodiversity Conservation and Sustainable Management of Living Natural Resources (IFC, 2012a); however, elements of PS 1, 3, 4, 5, 7 and 8 are also relevant to ES assessment. Relevant parts of the PSs are briefly summarised as follows.

PS 6 – Biodiversity Conservation and Sustainable Management of Living Natural Resources

PS 6 directly relates to the four types of ecosystem services, as one of the three major objectives of PS 6 is to maintain the benefits of ecosystem services. It establishes objectives and requirements to avoid, minimise and, where residual impacts remain, compensate/offset for risks and impacts to ecosystem services within a project's area of influence. It puts an onus on project developers (the 'client') to carry out a systematic review (including participation of beneficiaries) of all ecosystem services a project will impact, or is dependent upon, to identify priority ecosystem services, and avoid, minimise, and mitigate impacts on priority ecosystem services for which a client has direct management control or significant influence.

PS 1 – Assessment and Management of Environmental and Social Risks and Impacts

This PS requires that all reasonably expected risks and impacts related to ecosystem services are identified, and broader definition of a project's area of influence be used. Indirect project impacts on ecosystem services upon which beneficiaries' livelihoods are dependent should be included in the assessment.

PS 4 – Community Health, Safety and Security

This PS establishes the requirement for the assessment of impacts on priority ecosystem services that may result in adverse health and safety risks to beneficiaries.

PS 5 – Land Acquisition and Involuntary Resettlement

PS5 relates to project situations where restrictions on land use, access to natural resources, and use of natural resources, such as aquatic resources, timber products and fresh water, impact affected beneficiaries of ecosystem services. The client must assess impacts on, and compensate for, loss of provisioning ecosystem services resulting from land acquisition and involuntary resettlement.

PS 7 – Indigenous Peoples

PS7 addresses impacts on lands and natural resources that may be subject to traditional ownership, or under customary use. Such use may be seasonal/cyclical, and may be ceremonial, cultural, or economic in nature. PS7 requires that adverse impacts on affected Communities of Indigenous Peoples should be avoided where possible; or otherwise be subject to appropriate application of the mitigation hierarchy to minimise adverse impacts.

PS8 – Cultural Heritage

PS8 deals with the protection of tangible and intangible Cultural Heritage, and sets out requirements for avoidance, or the application of an appropriate mitigation hierarchy to minimise adverse impacts. When replicable cultural heritage is removed and avoidance is not possible, restoration measures including the maintenance of ecosystem services required to support the cultural heritage must be taken, either in situ or in a different location. Non-replicable cultural heritage should not be removed unless several specific conditions are met. The Project should not remove or significantly alter or damage critical cultural heritage.

Project Relevance

In the case of its direct investments (including project and corporate finance provided through financial intermediaries), the IFC requires its clients to apply the Performance Standards to manage environmental and social risks and impacts so that development opportunities are enhanced. Together, the Performance Standards establish standards that the Project is to meet throughout the life of an investment by IFC. As stated above, Performance Standards 1, 4, 5, 6, 7 and 8 have components that directly relate to ecosystem services and maintenance of their supply despite project impact. Therefore, in order to secure Project funding from IFC, the Project must demonstrate that it is in compliance with the requirements of each of the above-mentioned performance standards.

3.3 International Conventions

3.3.1 The Convention on Biological Diversity (1992)

Under the convention, each contracting party is expected to develop national strategies, plans or programmes for the conservation and sustainable use of biological diversity. Uganda is a signatory to the CBD, which aims for the conservation of biodiversity, its sustainable use, and sharing of the benefits of biodiversity. Uganda's commitments as a signatory to the CBD are provided for in the Uganda NBSAP (ref. Section 3.1.8).

Project Relevance

As a signatory to the CBD, Uganda's Government is committed to develop national strategies, plans or programmes for the conservation and sustainable use of biological diversity, implemented through a National Biodiversity Action Plan (ref. Section 3.1.8). The Project will need to demonstrate alignment with the provisions of the NBSAP in order to satisfy Government obligations as a signatory to the CBD.

3.3.2 The Convention for the Protection of the World's Cultural and Natural Heritage (1972)

Uganda is a signatory to the Convention on the Protection of the World Cultural and Natural Heritage (1972). To date, Uganda has three sites on the list of the World heritage sites namely: Kasubi tombs, enlisted in 2001; Bwindi Impenetrable Forest National Park; and Ruwenzori Mountains National Park. In 2005, UNESCO proclaimed the art of barkcloth making in Uganda a masterpiece of the oral and intangible heritage of humanity. Currently, five sites are on the World Heritage nomination list, including the ancient salt making sites at Kibiro that lies within the Albertine Graben, approximately 45 km north east of the Kingfisher Field development area.

Project Relevance

The Project will need to demonstrate alignment with the provisions of the convention in order to satisfy Government obligations as a signatory to the convention, through identifying and protecting cultural heritage by ensuring that internationally recognised practices for the protection, field-based study, and documentation of cultural heritage are implemented.

3.3.3 The Convention for the Safeguarding of the Intangible Cultural Heritage (2003)

Uganda has been a signatory to the United Nations Educational, Scientific and Cultural Organisation's (UNESCO's) Convention for the Safeguarding of Intangible Cultural Heritage since 2009. The Convention seeks to raise awareness of threats to intangible heritage and encourages member states in the identification, protection and management of such assets, ensuring respect for those individuals and communities concerned.

Project Relevance

The Project will need to demonstrate alignment with the provisions of the convention in order to satisfy Government obligations as a signatory to the convention, through identifying and protecting intangible cultural heritage and cultural practices by ensuring that internationally recognised practices for the protection, field-based study, and documentation of cultural heritage are implemented.

4.0   METHODOLOGY

Ecosystem services are the benefits that people and/or a project (the beneficiaries) obtain from ecosystems. In the strictest sense, without those beneficiaries, there are no ecosystem services. The benefits gained can be either physical or psychological, and can be obtained actively or passively, directly or indirectly. For the purposes of this assessment, the definitions of ecosystem services were based on those developed by the *Millennium Ecosystem Assessment* (MA, 2005), (Table 1). These definitions were chosen to keep consistency with the IFC's Performance Standards, and because they are widely recognised.

Ideally, the Project should maintain the value and functionality of priority ecosystem services to those beneficiaries directly dependent upon them, through direct management control. As such, ecosystem services whose beneficiaries are at the global scale, and to a lesser extent, the regional scale, are not covered by this assessment.

Table 1: Ecosystems services categories

Broad categories	Definition
Supporting services	Natural processes essential to resilience, and functioning of ecosystems. *e.g., primary production*
Regulating services	Control of the natural environment *e.g., maintenance of key ecological processes, protected areas, habitat of special value, groundwater recharge, catchments*
Provisioning services	Supporting human needs *e.g., traditional hunting grounds, medicinal plants and minerals, water sources, fishing grounds, fire wood*
Cultural services	Aesthetic, spiritual, recreational, and other cultural values. *e.g., sacred sites, recreation, sense of place*

As mentioned, without the beneficiaries (that is, the local community (Type I) and the Project (Type II)), there are no ecosystem services. In terms of a project's setting, that is, its location, an understanding of the ecosystem processes occurring in the area is important, as it enables an understanding of how those processes affect the supply and demand of the ecosystem services arising from such processes, and the value the ecosystem services eventually offer to beneficiaries (that is, the supply side). A conceptual ecosystem services flow path illustrating these supply linkages, using photosynthesis and the functions, services and benefits that flow from it as an example, is shown in Figure 1.

Figure 1: The flow of ecosystem services to beneficiaries

Given the above, and given that the assessment of ecosystem services is also concerned with the social aspects of the benefits of services (that is, the demand side), the assessment of ecosystem services relied upon data gathered during the stakeholder engagement processes carried out as part of the socio-economic baseline study and the cultural heritage baseline study . Other information for the ecosystem services assessment was gathered from the various specialist inputs to the baseline for the ESIA, during the Desktop Review (Section 3.3).

4.1   Local Study Area

An over-arching ecosystem services assessment for the entire Albertine Graben region is currently being completed by independent consultants. Therefore, the focus of this assessment is only on ecosystem services at the local scale to the Project, specifically, the Kingfisher Development Area where the main project footprint will be located, the proposed escarpment road, and the proposed pipeline route (Figure 2, Figure 3). This ecosystem services Local Study Area for this assessment (Figure 4) generally aligns with the local study areas used for the socio-economic baseline assessment , which consisted of the Kingfisher Development Area study area (comprising 11 villages in the Buhuka Parish and villages on top of the escarpment), and the pipeline route study area (comprising 22 villages in the vicinity of the pipeline route). Throughout the report, the various areas of the Local Study Area are discussed in terms of its unit components, that is, the Buhuka Flats, the escarpment, and the pipeline route.

4.2   Approach Overview

The approach taken to conducting the ecosystem services review is based on Steps 1 to 3 of the method put forward by Landsberg et al. (2013). Given that the current assessment is a desk-based study, the method was adapted to preclude additional baseline data gathering for priority ecosystem services once the initial list of relevant ecosystem services list was refined to focus on priority ecosystem services only. Instead, baseline data on all ecosystem services (priority and non-priority) was gathered during stakeholder engagement (Step 2) in order to determine how all ecosystem services currently contribute to stakeholders' livelihoods, health, safety or culture.

The approach to impact assessment consisted of a combination of the Project impact assessment on priority ecosystem services method in Landsberg et al. (2013), and the prescribed impact assessment method being used for the ESIA (Section 4.7).

4.3   Identification of Ecosystem Services Relevant to the Project

The ecosystem services that that Project could impact were identified by first defining which ecosystems could be affected, determining the ecosystem services supplied by and demanded from those ecosystems, and identifying the beneficiaries who use those services supplied by the ecosystems that could be affected, as per Step 1 of the guidance provided in (Landsberg, et al., 2013).

This was done by means examination of the land cover mapping exercise done during the biodiversity baseline assessment to identify the land cover types and thereby ecosystems that could be affected by the Project, and a desk study to identify the ecosystem services supplied by those land cover types, and the beneficiaries that use them.

4.3.1   Land Cover Mapping and Condition Assessment

A land-cover dataset was produced using existing multi-band, high-resolution satellite imagery (Figure 6). The locations of Project infrastructure and activities were mapped against the land cover types that potentially supply ecosystem services, to identify those land cover types may be impacted by the proposed construction, operation and decommissioning of the Project.

■   The land-cover dataset provided the following information:

■   Land-cover types that would be affected by loss in area to the Project footprint.

■   The area/extent (hectares) of loss of each land cover type identified. The size of each land cover type was measured from aerial photography via GIS, as was the area of each land cover type being lost to the Project footprint – allowing the proportion of loss within the different Project Area of Influence to be calculated.

■   Identification and location of communities dependent on services supplied within the Local Study Area.

■   Together with information from the existing biodiversity/social/physical baseline data (Section 4.2.2), the land cover dataset was used to identify ecosystems that could be impacted by the Project, and

subsequently the ecosystem services supplied by the potentially impacted ecosystems could be identified.

4.3.1.1 Land Cover Condition Assessment

Condition assessments are widely adopted as regulatory indicators of ecosystem function, and for some services (e.g., habitat) links between condition and function are often direct (McLaughlin & Cohen, 2013)

Ecosystem integrity, or the condition of the land cover types (and therefore their capacity to supply ecosystem services – ref. Figure 5) was therefore assessed, primarily based on the ecosystem integrity assessment of the various habitat types identified in the biodiversity baseline report . The integrity of ecosystems was determined based on the criteria put forward Table 2 (after: (Kent & Coker, 1992), (Treweek (ed), 1999), (Tucker, 2005), and (Secretariat of the Convention on Biological Diversity, 2006)).

Table 2: Criteria for assessing ecosystem integrity / land cover condition

Criterion	Description
Composition	Diversity and complexity - what is there and how abundant (in a particular time frame) it is
Structure (or pattern)	How biological units are organised in time and space. Ecosystem 'scale' refers to the space it occupies and the way it changes over time. The structure and interactions that shape the flow of energy and the distribution of biomass.
Linkages and corridors	To habitat of the same or different ecosystems, which provide an important 'playing field' for ecological processes and enable persistence. These linkages are in contrast to a highly fragmented landscape where patches of natural habitat are effectively isolated.
Key processes (including ecosystem function)	Which natural (that is, physical and/or biological) and/or human-induced processes are of key importance for the creation and/or maintenance of ecosystems. These are termed drivers of change, and include direct and indirect drivers. Examples of direct drivers include: changes in land use and land cover; fragmentation and isolation; extraction, harvest, or removal of species; external inputs such as emissions, effluents, chemicals; disturbance; introduction of invasive, alien and/or genetically modified species; and restoration. Examples of indirect drivers of change include: demographic; economic; socio-political; cultural; and technological processes or interventions.
Representativeness in the landscape	The uniqueness of the ecosystems within the LSA and the wider landscape; this rarity factor is related to the concepts of irreplaceability and vulnerability.
Resilience and stability	The ability of the ecosystem to absorb change, persist, and maintain the same form.

Based on the assessment of these criteria, the condition of the ecosystems and habitats was estimated and assigned a subjective class, as defined in the biodiversity baseline assessment :

- Pristine
- Near-pristine
- Slightly-degraded
- Moderately-degraded
- Heavily-degraded

- Note that not all ecosystem services supply dynamics are affected to the same degree by the condition of the land cover type; for example, harvest of wood for fuel takes place both in forest habitats in good condition, and in bushland that might be considered to be in a degraded condition due to overgrazing.

However, the bushland may be more important in terms of supply as a result of proximity to settlements and ease of access.

4.3.2 Desktop Review

A review of the biodiversity, socioeconomic and physical data and information gathered during the baseline phase of the ESIA was conducted, and a full literature review of available publications, reports and data relating to ecosystem services and biological resource use in the Albertine Graben and Western Uganda was done. Relevant information from the review was collated to identify the specific ecosystem services associated with each of the mapped land cover types and determine the condition of the land cover types, and thus their potential/capacity to supply the ecosystem services,

The socioeconomic baseline data enabled the identification of the people who depend on those potentially impacted ecosystem services for their livelihoods, health, safety, and culture, i.e. the beneficiaries. Beneficiaries are defined as those individuals, communities, institutions, and companies (including CNOOC) that could be positively or negatively affected as a result of Project impacts on ecosystem services (Landsberg, et al., 2013).

The baseline data for the Project footprint reviewed and presented in this report was sourced from the following specialist chapters of the baseline study for the Project ESIA:

- Cultural Heritage Baseline (Vol.2, Chapter 6.4);

- Socio-Economic Baseline (Vol.2, Chapter 6.3);

- Surface Water Baseline (Vol.2, Chapter 6.1.5);

- Soils and Land Capability Baseline (Vol.2, Chapter 6.1.7);

- Biodiversity baseline report .

Numerous reports relating to ecosystem service supply and natural resource utilisation in the Albertine Graben and Western Uganda were used to inform the study; these are referenced throughout the text.

4.3.3 Listing of relevant Ecosystem Services

- A comprehensive ecosystem services supply and demand list was then developed based on relevant information collated from the desktop review. This included: the land cover types and associated ecosystem services that could be directly impacted by the Project; the natural resources that the Project will require for its operation; information on water supply, energy use, economic activities and population movement and migration derived from the baseline socioeconomic study; and the cultural and spiritual traditions and beliefs of people in the Project area detailed in the baseline cultural heritage study.

- The ecosystem services used, and beneficiaries of those services, were described. No ranking of importance of the ecosystem services was done at this stage; instead, the list was carried through to the next step where ecosystem services were prioritised (Section 4.4).

4.4 Step 2: Prioritisation of Ecosystem Services

Priority ecosystem services, upon which the impact assessment was focused, were selected from the list of relevant ecosystem services generated in Step 1. Priority ecosystem services are:

- Services for which Project impacts could affect beneficiaries' livelihoods, health, safety or culture (Type I);

- Services that could prevent the Project from achieving operational performance (i.e. impact the Project) (Type II).

4.4.1 Stakeholder Engagement Approach

Collection of stakeholder input to the prioritisation of ecosystem services for which Project impacts could affect beneficiaries was undertaken via surveys of local residents within the area of influence, as part of the

socioeconomic and cultural heritage baseline data gathering fieldwork. The interviews gathered information on Type I priority ecosystem services as defined by the IFC (2012a).

The information gathered during the interviews was used to:

■ Identify what ecosystem services were being used by beneficiaries, and gain an understanding of how much of the particular services were used, how far people had to travel to obtain it, and the importance of that service to their livelihood, wellbeing, and culture.

■ Identify existing drivers of ecosystem change.

■ Assess current supply of priority ecosystem services, the degree of dependence that beneficiaries have on priority ecosystem services, and whether the services are readily substitutable, compensable, irreplaceable etc.

■ Estimate foreseeable supply of ecosystem services and their contribution to beneficiaries' well-being in the absence of the project.

The interviews were carried out by the social and cultural heritage specialists in December 2013 to April 2014, during the baseline data gathering phase of the ESIA. All conversations were facilitated by CNOOC's Community Liaison Officer (CLO).

Socio-economic baseline

Primary data collection for the socio-economic baseline study was conducted in the Local Study Area during December 2013 for the Kingfisher local study area, and March 2014 for the pipeline study. Data collection included focus group discussions, key stakeholder interviews, a sample household socio-economic survey and a land-use constraint mapping ground-truthing exercise.

Cultural Heritage baseline

A non-invasive field survey to record all cultural heritage sites within the Local Study Area was conducted between 20 January and 2 February 2014. During the field work, consultation with the affected communities (those villages within the respective discipline-specific LSAs) was undertaken. Consultation was done via transcribed interviews in order to capture places of local cultural and/or sacred importance (for example, ritual sites, burial grounds, churches and mosques) and any related intangible heritage practice (taboo, oral history, traditional plant and medicinal plant usage etc.).

4.4.2   Ecosystem Service Prioritisation Exercise

■ The ecosystem service prioritisation exercise was carried out systematically, using the WRI Impact and Dependence Scoping tools, and current guidance regarding conducting an Ecosystem Services Review (Landsberg, et al., 2013). In addition, ecosystem services guidance specifically pertaining to the oil and gas industry was applied for the assessment of potential dependencies and impacts of oil and gas projects and operations (IPIECA, 2011).

■ The list of priority ecosystem services supplied in the Project's area of influence was developed by identifying priority ecosystem services; that is, those where the significance of the Project's impact is considered high, specifically:

■ Type I priority ecosystem services were identified and defined by:

  ▪ Identifying potential Project-caused drivers of ecosystem change.

  ▪ Identifying potentially impacted ecosystems and associated ecosystem services, and potentially affected beneficiaries.

  ▪ Assessment of Project's impact on the ecosystem services.

■ Type II priority ecosystem services were identified and defined based on the Project's requirements as outlined in the Project Description.

■ The importance of each ES to communities, and their level of dependence upon the supply of the ecosystem services, was established via engagement with the socio-economic, cultural heritage, biodiversity and surface water specialists.

■ Identification of the availability of alternatives for the supply of identified ecosystem services, including the existence of, and access to, those alternatives, based on land cover mapping, stakeholder interviews and information derived from the baseline studies conducted for the ESIA.

4.5   Step 3: Delineation of the Project Area of Influence

The **Project area of influence** is the area relevant to the assessment of project impacts and dependencies on priority ecosystem services; it includes the ecosystems that supply the priority ecosystem services, and the locations where the Project and affected stakeholders access priority ecosystem services (Landsberg, et al., 2013).

The Project area of influence was set by firstly mapping the locations of Project infrastructure and activities against the land cover types that supply priority ecosystem services to identify those land cover types that may be impacted by the proposed construction, operation and decommissioning of the Project. Secondly, the locations where the beneficiaries of the identified priority ecosystem services (Figure 2, Figure 3) access those services were then mapped and used to define the boundary of the Project Area of Influence for Impact Assessment.

Figure 2: Locations of beneficiaries of ecosystem services that may be affected by the Kingfisher Development Area
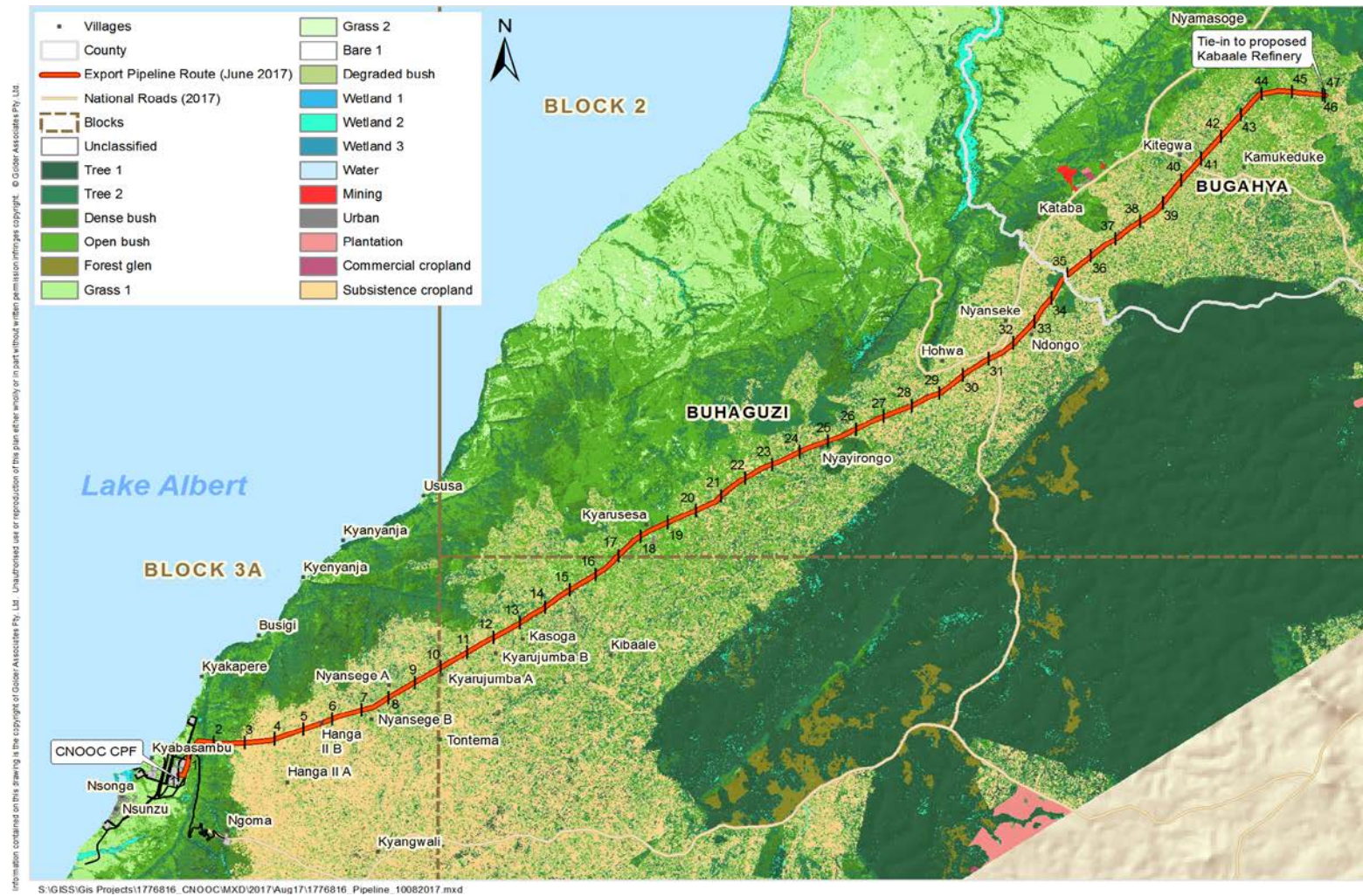
Figure 3: Locations of beneficiaries of ecosystem services that may be affected by the Pipeline route
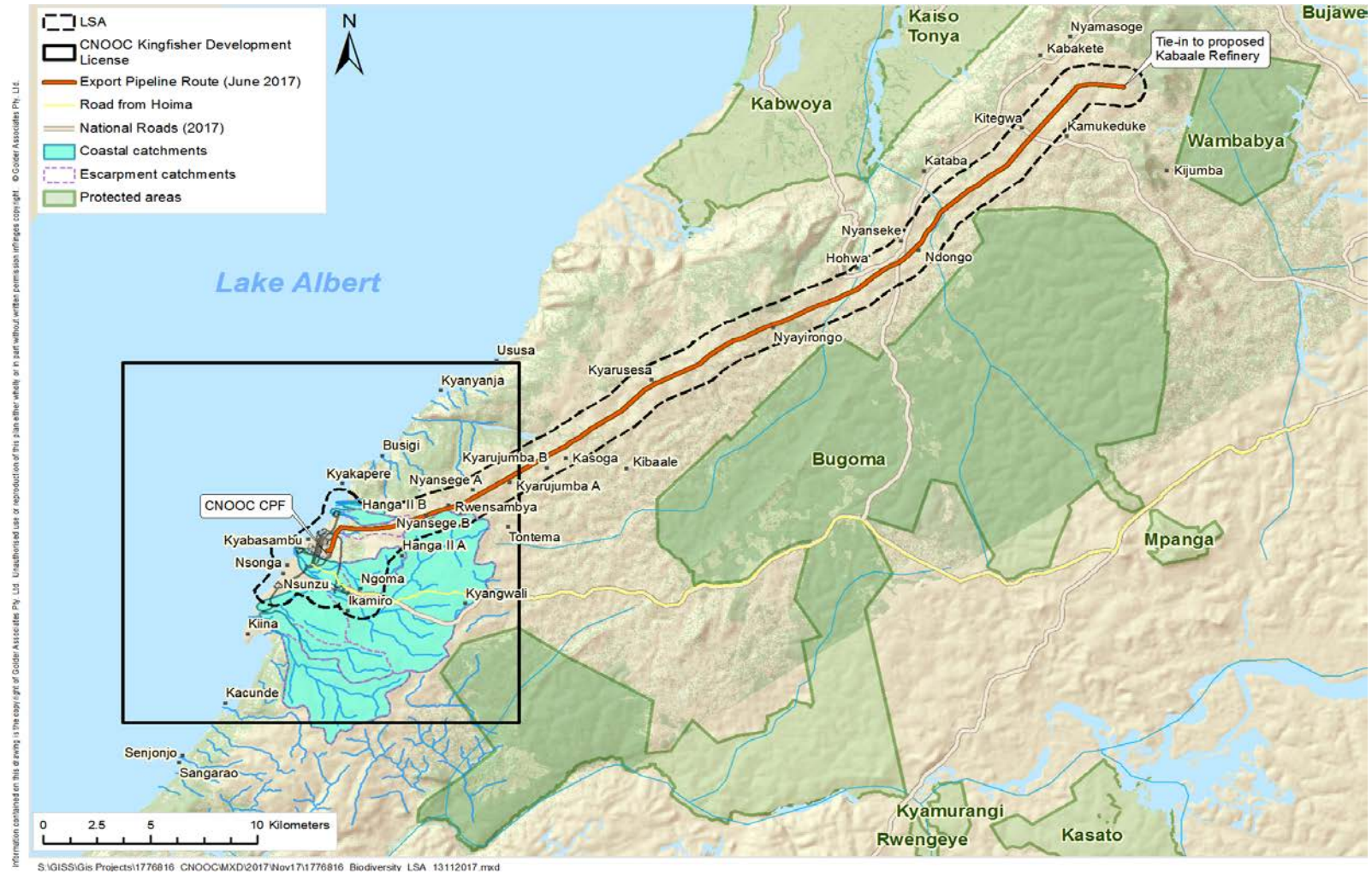
Figure 4: Local Study Area for Ecosystem Service Assessment

4.6 Step 4: Establishment of the baseline for priority ecosystem services

As mentioned previously, Landsberg *et al.'s* (2013) ecosystem service review method was adapted to preclude additional baseline data gathering for priority ecosystem services once the initial ecosystem services list was refined (Step 4). Instead, baseline data on all ecosystem services (priority and non-priority) was gathered during stakeholder engagement (ref. Section 4.4.1) in order to determine how all ecosystem services currently contribute to stakeholders' livelihoods, health, safety or culture.

4.7 Step 5: Assessing Project Impacts on Priority Ecosystem Services within the Project Area of Influence

The impact assessment identifies the magnitude of a particular impact from the Project and then compares that magnitude with the sensitivity of the receiving environment to derive an overall significance for the impact. This method relies on a detailed description of both the impact and the ecosystem service valued component that is the receptor. The magnitude of an impact depends on its characteristics, which includes factors such as its magnitude, duration, reversibility, area of extent, and nature in terms of whether positive, negative, direct, indirect or cumulative.

One of the main purposes of the impact assessment is to provide answers to questions that people have about how a project could affect something that matters to them, such as a valued component. To focus this assessment, and ensure that the impact assessment clearly addressed the key issues raised by the stakeholders (see Section 4.4.1), and the objectives set for this impact assessment (see Section 2.1), questions were formulated that captured the concerns relative to a particular issue. In this report, those concerns are expressed as a 'key question', which forms the basis of the investigations of potential effects and impacts of the Project*:

1) What impact could the Project have on the supply of priority ecosystem services to beneficiaries?

In order to answer the key question in relation to ecosystem services, the impact assessment involved the following steps:

1) Review and identification of the trends and external, non-project-related threats to current ecosystem services supply - current pressures on ecosystems and the resilience inherent in those ecosystems were identified.

2) Assessment of the replaceability/substitutability of ecosystem services, and/or spatial alternatives for confirmed vulnerable beneficiaries.

3) An impact significance assessment (ref. Section 4.7.3.3) was conducted on Type I and II priority ecosystem services before and after mitigation.

4) Identification of social/operational/financial/regulatory/reputational risks associated with the residual impacts.

5) Identification of potential alternatives to supply of services.

4.7.1 Impact Assessment Process

The impact assessment process compares the magnitude of the impact with the sensitivity of the receiving environment. This method relies on a detailed description of both the impact and the environmental or social component that is the receptor. The magnitude of an impact depends on its characteristics, which may include such factors as its duration, reversibility, area of extent, and nature in terms of whether positive, negative, direct, indirect or cumulative.

The impact assessment process was aligned with the World Resources Institute (WRI) approach (Landsberg, et al., 2013), consisting of a combination of those workers' approach to assessment of Project impact on priority ecosystem services and thereby assessment of impact on beneficiaries (Figure 5); and the prescribed impact assessment method being used for the ESIA (ref. Section 4.7.3).
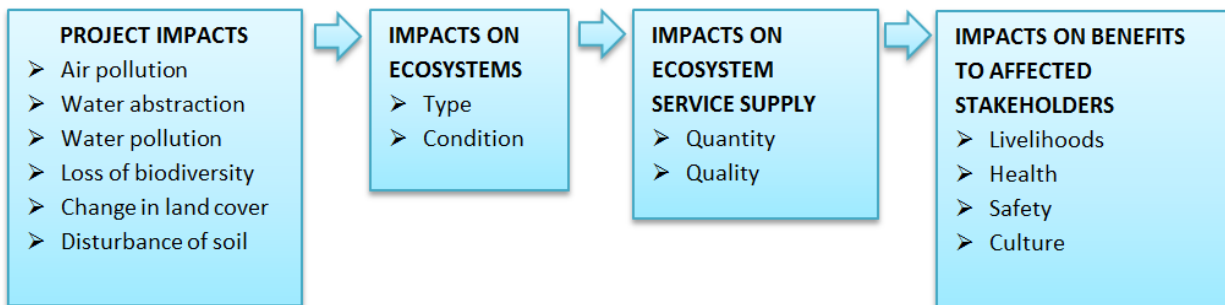
Figure 5: How assessment of Project impacts on ecosystems leads to assessing impacts on beneficiaries of ecosystem services (Landsberg et al., 2013)

4.7.2   Description of Potential Project Impacts

Interactions between the proposed Project activities and priority ecosystem services were identified through a review of the current Project Description in the context of the identified baseline environment in the Local Study Area (Section 6.0). In summary, Project activities will change the physical landscape and socio-economic context of the Project Area of Influence, which will result in direct and indirect impacts to priority ecosystem services. The key Project impacts affecting beneficiaries will be:

■ Changes in land cover and associated reductions in the supply of ecosystem services due to the proposed construction of the Production Facility, the oil export pipeline to Kabaale, and all associated infrastructure:

▪ The physical presence of the Project in the landscape will directly change the land surface and will potentially interact with cultural heritage features - these are 'direct impacts', which are likely to affect both beneficiaries within or adjacent to the Project footprint, and beneficiaries from further afield who may travel to avail of cultural heritage ecosystem services intrinsically linked with the Lake Albert and Escarpment landscape.

▪ Activities that will not affect the land surface directly may indirectly alter the setting in which a site is experienced (for example, by related dust and noise disturbance) or limit the supply of provisioning ecosystem services (e.g., oil development areas may be fenced off which could restrict access to grazing lands for cattle) – these are 'indirect impacts'. These are likely to affect beneficiaries within close proximity to the development.

■ Population influx of people seeking jobs during construction and operation of the Production Facility, and people seeking to provide commercial services to the increasing population in the vicinity of the Project, and the concurrent increase in demand for ecosystem services; this is likely to impact the quantity and quality of ecosystem service supply to existing beneficiaries.

■ Water abstraction from Lake Albert to provide make-up water for the oil extraction process is proposed as part of the Project; this has the potential to affect water quantity and quality in areas of Lake Albert and thus may affect the fisheries potential of those areas, affecting beneficiaries that rely on fishing in these areas for livelihoods.

The types of potential Project impacts considered appropriate for the ecosystem services assessment are summarised in Table 3.

Table 3: Types of Ecosystem Service Impact

Direct Impact	Impacts that result from a direct interaction between a planned Project activity and the receiving environment/receptors (e.g., destruction of a sacred site as a result of construction of well pads, loss of an ecosystem's capacity to supply an ecosystem service due to degradation from over-grazing).
Indirect impact	Secondary impacts that result from project activity and affect the environment in which the receiving receptor is experienced (e.g., job-seeking population influx to the area and concurrent increase in demand for ecosystem services).
Cumulative impact	Impacts that act together with other impacts (including those from concurrent or planned activities from other projects) to affect the same resources and/or receptors as the Project.

4.7.3 Assessing significance of Project impacts on affected Stakeholders

4.7.3.1 Determination of Magnitude of Impact

Magnitude or magnitude describes the significance of the effect. To classify magnitude using an ordinal scale (that is, negligible, low, medium, or high) in a manner meaningful for ecosystem services, the effect size (loss of land cover class that supplies the ecosystem services to the Project footprint) must be placed in the context of the availability of the land cover class and thus available supply of the ecosystem services within the Project's Area of Influence. The magnitude of the potential impact was gauged by considering the following factors:

Direction

Direction describes the trend of the effect compared with baseline conditions. There are three options for direction:

■ Adverse – effect is worsening or is undesirable.

■ Neutral – effect is not changing compared with baseline conditions and trends.

■ Positive – effect is improving or is desirable.

Geographic Extent

Geographic extent describes the quantitative measurement of area within which an effect occurs. Effects are described in terms of whether they are limited to the Project Footprint, Project Area of Influence, or extend farther:

■ Site – effect is limited to the Project footprint.

■ Local – effect extends beyond the Project footprint, but is limited to the Project Area of Influence Local Study Area.

■ Regional – effect extends beyond the Project Area of Influence.

Duration

Duration refers to how long an effect lasts. Duration is described in relation to the phases of the development of the Project within the RSA, although effects may last longer than the phases of the Project for some valued components. The following framework was used:

■ Short-term – effect is limited to the construction period (~2 years), or the period of decommissioning activities (~2 years).

■ Medium-term – effect extends throughout the project operations, that is, 25 years.

- Long-term – effect extends beyond the 25 years of operation.

- Far future – effect extends more than 30 years after closure.

Reversibility

This criterion describes whether the effect is reversible or not. This can be associated with duration, as many effects eventually could be considered to be reversible (that is, in geological time). However, the extinction of a species can be considered as irreversible.

Table 4: Magnitude assessment rating scale

Criterion	Rating scales
Negligible	Where the impact affects the environment in such a way that natural, and /or cultural and social functions and processes are negligibly affected and valued, important, sensitive or vulnerable systems or communities are negligibly affected.
Low	Where the impact affects the environment in such a way that natural, and/or cultural and social functions and processes are minimally affected and valued, important, sensitive or vulnerable systems or communities are minimally affected. No obvious changes prevail on the natural, and / or cultural/ social functions/ process as a result of project implementation
Medium	Where the affected environment is altered but natural, and/or cultural and social functions and processes continue albeit in a modified way, and valued, important, sensitive or vulnerable systems or communities are moderately affected.
High	Where natural and/or cultural or social functions and processes are altered to the extent that they will temporarily or permanently cease, and valued, important, sensitive or vulnerable systems or communities are substantially affected. The changes to the natural and/or cultural / social- economic processes and functions are drastic and commonly irreversible.

4.7.3.2   *Determination of Sensitivity of a Receptor*

Sensitivity for each Ecosystem Service supplied and/or demanded ranged from very low to high according to increasing level of threat (Table 5).

Table 5: Sensitivity assessment rating scale

Criterion	Rating scales
Negligible	None of the below
Low	Ecosystem service is readily substitutable or replaceable
Medium	Ecosystem service is substitutable or replaceable
High	Ecosystem service is not substitutable and/or irreplaceable

4.7.3.3   *Determination of Impact Significance*

Once the magnitude of the impact and the sensitivity of the receiving environment were described, the significance of the potential impact was determined. The determination of significance of an impact is largely subjective and primarily based on professional judgment.

To provide a relative illustration of impact significance, it is useful to assign numerical descriptors to the impact magnitude and receptor sensitivity for each potential impact. Each is assigned a numerical descriptor of 1, 2, 3, or 4, equivalent to very low, low, medium or high. The significance of impact is then indicated by the product of the two numerical descriptors, with significance being described as negligible, minor, moderate or major, as in Table 6. This is a semi-quantitative method designed to provide a broad ranking of the different impacts of a project.

Table 6: Determination of impact significance

			Sensitivity of receptor			
			Negligible	**Low**	**Medium**	**High**
			1	**2**	**3**	**4**
Magnitude of Impact	**Negligible**	**1**	1 Negligible	2 Minor	3 Minor	4 Minor
	Low	**2**	2 Minor	4 Minor	6 Moderate	8 Moderate
	Medium	**3**	3 Minor	6 Moderate	9 Moderate	12 Major
	High	**4**	4 Minor	8 Moderate	12 Major	16 Major

5.0   LAND COVER MAPPING AND CONDITION ASSESSMENT

The land cover types within the Local Study Area are illustrated in Figure 6.
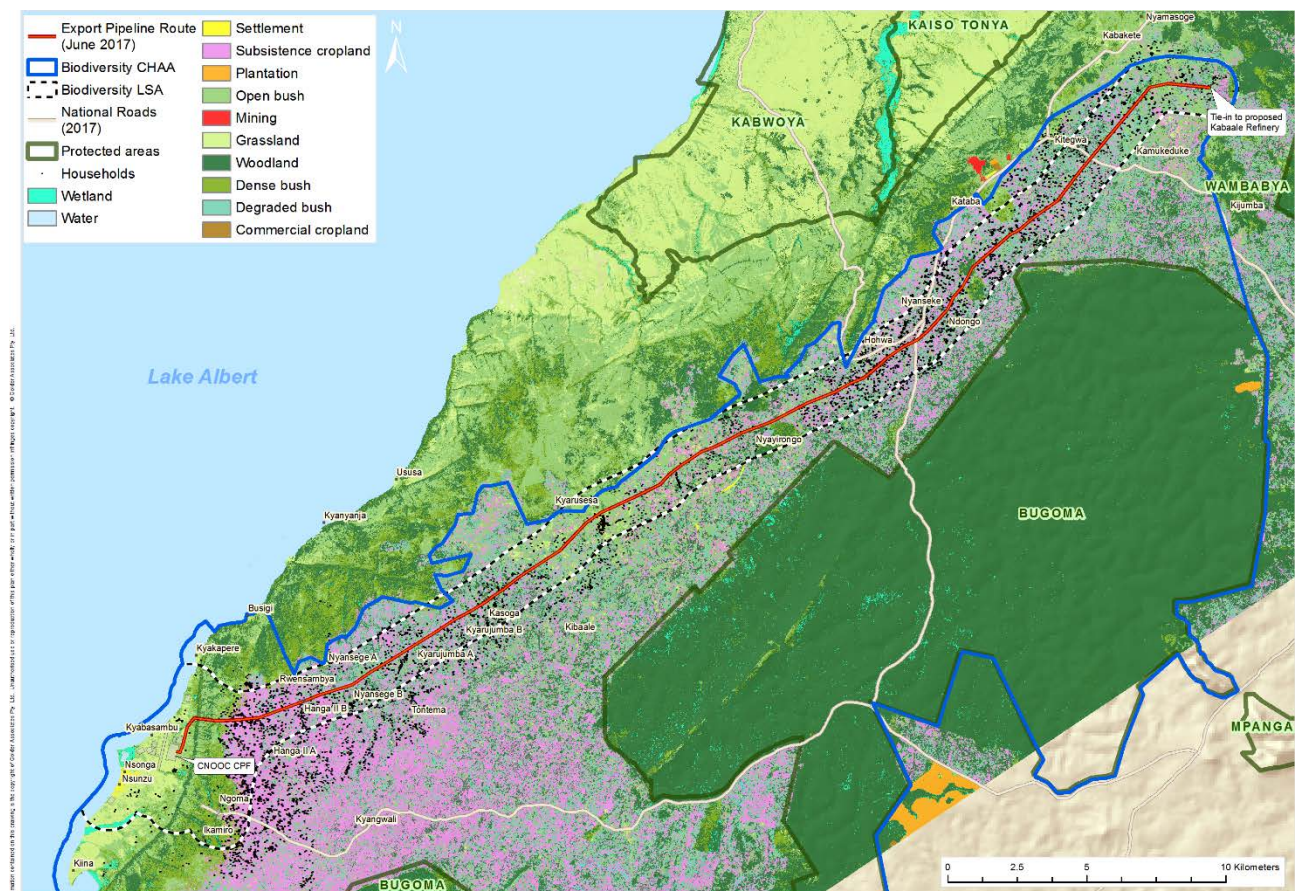
Figure 6: Land cover in the Project Area of Influence

The area of each land cover category within the Local Study Area in relation to estimated land take from Project components (that is, footprint, escarpment road and pipeline) are shown on Table 7 and Table 8.

Land cover is treated separately for the Kingfisher Development Area of the Local Study Area (the Project footprint the escarpment road, and the pipeline servitude from the Buhuka Flats to the top of the escarpment)

and the pipeline route above the escarpment, as the dominant land cover types in these two areas are quite different.

Table 7: Land cover in the Buhuka Flats and proportion lost as a result of existing permitted, and proposed land take

Kingfisher Development Area		Existing permitted land-take (Ha)	Proposed additional land-take (Ha)	% loss
Land cover Class	**Total Area (Ha)**			
Bare	5.0	1.9	0.3	44%
Dense Bush	53.3	0.0	0.6	1%
Grassland	773.8	34.5	57.5	12%
Open Bush	27.5	0.1	0.2	1%
Settlement	142.2	0.3	2.8	2%
Water	21.2	0.0	0.0	0%
Wetland	184.0	0.8	2.9	2%
Woodland	109.5	0.0	0.0	0%
Total:	1316.5	37.6	64.3	8%

Excluding bare ground, grassland on the Buhuka Flats and open bush of the escarpment will suffer proportionately the greatest loss to the Project (Table 7); while subsistence cropland will be the most affected land cover type by the pipeline route servitude, beyond the escarpment (Table 8).

Table 8: Land cover in the Export Pipeline area of influence and proportion lost as a result of proposed land take

Pipeline Route LSA (1km buffer)		Estimated land take by 30 m pipeline servitude	
Land cover Class	**Area (Ha)**	**Area (Ha)**	**% of total**
Bare	3.05	0.00	0%
Degraded Bush	2459.23	36.98	2%
Dense Bush	246.45	0.82	0%
Grassland	408.98	4.93	1%
Open Bush	2467.99	39.35	2%
Settlement	6.62	0.00	0%
Subsistence cropland	2562.94	39.93	2%
Water	44.55	0.00	0%
Wetland	12.29	0.36	3%
Woodland	1270.69	15.57	1%
Total:	**9482.78**	**137.94**	**1%**

5.1.1   Land cover condition

The ecosystem condition of the various land cover types within the Local Study Area was estimated. Table 9 shows each of the affected mapped land cover categories as they relate to habitat types recorded within the

Project Area of Influence, and their condition. This allowed a judgement on the condition of the land cover types to be made (and, therefore, their potential capacity to supply ecosystem services), based on the reported baseline condition of the habitat types supported therein.

Table 9: Land cover classes, associated ecosystems, habitat types and condition

Land cover class	Ecosystems	Dominant Habitat types	Estimated condition
Dense Bush Open Bush Grassland	Escarpment vegetation corridors	Open wooded grassland Dense wooded grassland Dense bushland Riverine bushland	Slightly degraded to moderately degraded
Degraded Bush Settlement Subsistence cropland	Settlement and cultivation areas	Open bushland and shrubland Grassland with thicket Open grassland	Heavily degraded
Wetlands	Wetlands	Permanent wetlands, seasonally flooded grassland	Slightly degraded to moderately degraded
Woodland	Bugoma Central Forest Reserve	Woodlands, Wooded bushlands	Slightly degraded to moderately degraded
Water	Near-shore habitats of Lake Albert	Shallow river-associated waters, open sandy shores, lagoons, large bays, rocky escarpments, open-water habitats	Near-Pristine

6.0 REVIEW OF BASELINE BIODIVERSITY, SOCIOECONOMIC AND BIOPHYSICAL ENVIRONMENT OF THE LOCAL STUDY AREA

The Project will be located on the south-eastern flank of the Lake Albert Basin, which is part of the western arm of the East African Rift System. This area is commonly known as the Buhuka Flats, situated in the administrative boundary of Kyangwali Sub-County in Hoima District (Figure 2). The Project also includes the pipeline route to Kabaale (Figure 3).

This section presents a description of the existing environment within the Local Study Area, in relation to the supply of, and demand for, ecosystem services. In particular, it presents a summary of the relevant information distilled from the biodiversity and surface water baseline reports, in order to put the proposed Project area's provisioning, supporting and regulating ecosystem services supply capability in context. Terrestrial and aquatic biodiversity is discussed in terms of vegetation communities and habitats and their condition, which directly relates to the results of the land cover condition assessment discussed in Section 5.0 above. This section also addresses drivers of ecosystem change that already exist within the Study Area, in the absence of the Project.

6.1 Terrestrial and Aquatic Biodiversity

Surveys of flora and fauna were conducted in the Project footprint and along the pipeline route, for the baseline biodiversity assessment (Eco & Partners, 2014). The data gathered on vegetation communities and fauna is presented in the following sections in the context of ecosystem service provision within the Local Study Area.

6.1.1 Vegetation Communities Providing Ecosystem Services

Buhuka Flats

The vegetation communities that dominate the Buhuka Flats include thicket-grassland mosaic, open grassland, wooded bushland and wetlands (Figure 7, Figure 9). These areas are a source of fodder for grazing cattle, and are over-exploited for grazing in many parts. The wetlands are a source of thatching material, wattle and mud 'daub' for traditionally built houses (Golder Associates, 2014) (Figure 8). Papyrus culms are also harvested from wetlands and used as a construction material for houses (NEMA, 2002).

Thicket-grassland

Open grassland

Woodland (riparian areas)

Seasonally-flooded wetlands on shore of Lake Albert

Figure 7: Vegetation communities of the Buhuka Flats

Figure 8: Traditionally built house in process of being thatched
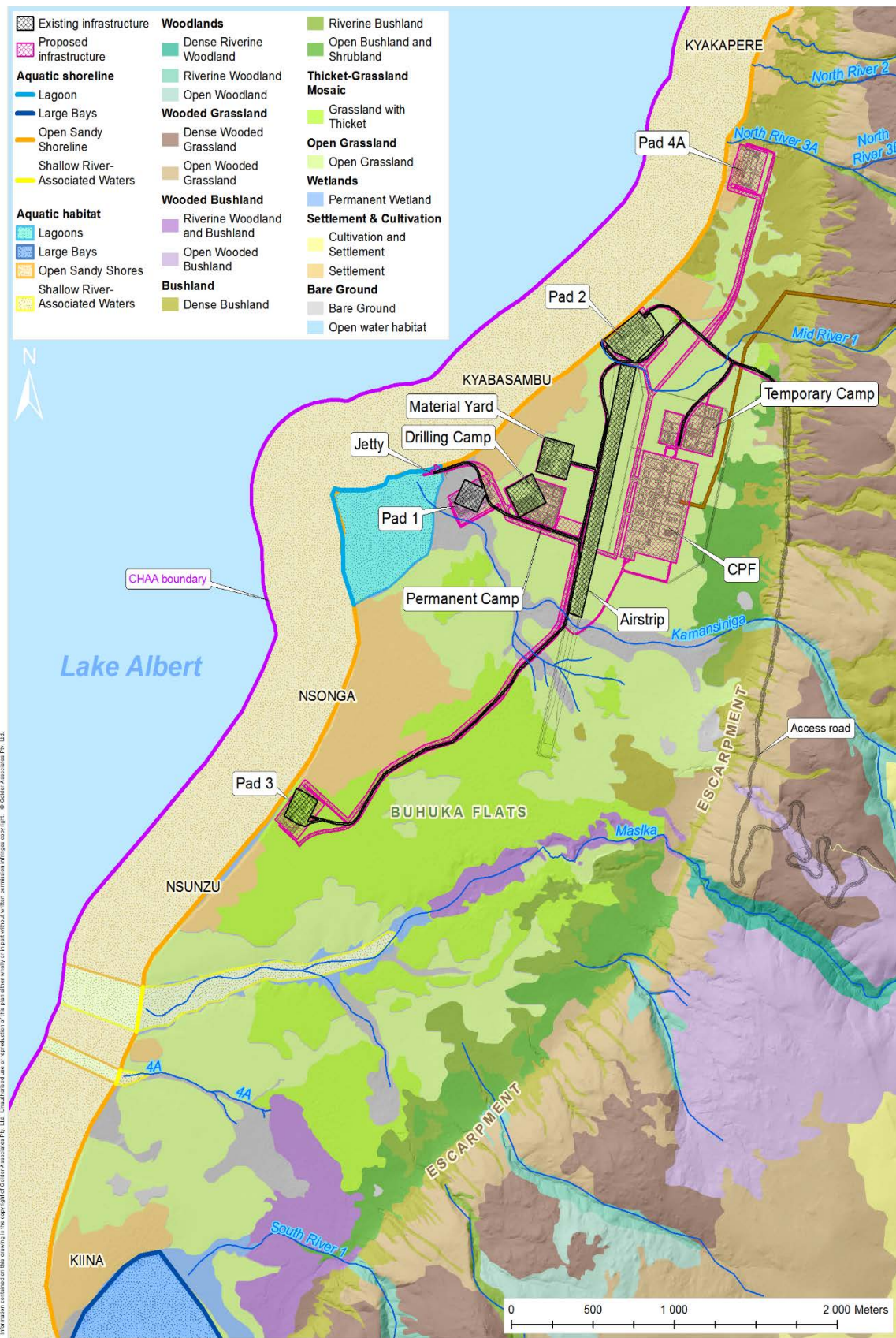
Figure 9: Focus on vegetation communities and aquatic habitats of the Buhuka Flats
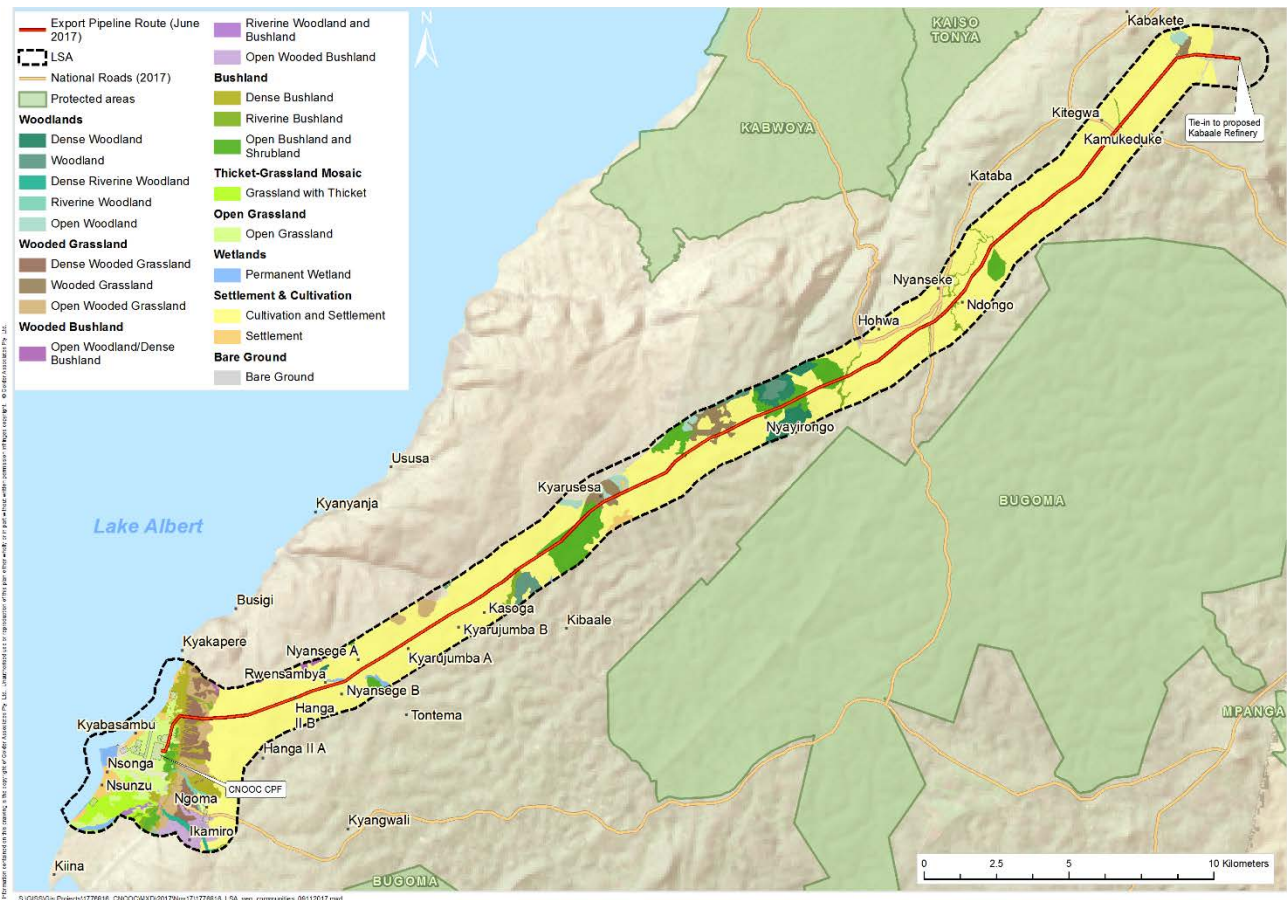
Figure 10: Vegetation communities of the Local Study Area

Escarpment

The slopes of the Escarpment are characterised by wooded grassland, bushed grassland and bush-land and shrub-land (Figure 11). These vegetation types lend themselves to ecosystem services provision including wood for charcoal production, and subsistence hunting (Golder Associates, 2014).

Tamarind (*Tamarindus indica*) is fairly common on the escarpment in woodland and wooded grassland; this species is commercially used for food in parts of northern Uganda (Katende, et al., 1995) though it is unclear whether it is used for this purpose in the Local Study Area. Due to its heavy exploitation, it is of conservation concern in Uganda and is on the Uganda Reserved Tree Species List of the National Forest Authority (Eco & Partners, 2014).

The total length of the escarpment road is approximately 7 km and 9 metres wide, including shoulders. The construction of the road is likely to influence the supply and demand of ecosystem services. The loss of the wooded grassland and woodland will reduce the supply of ES such as availability of wood for charcoal production; the presence of the road will enhance access to wooded areas and this may increase demand for ES supplied by woodlands in these areas.

Pipeline route

The pipeline route to the refinery area and Kabale is approximately 46 km in length. The majority of this part of the Local Study Area has been subjected to high intensity, subsistence agriculture, which has altered much of the original natural landscape (Forest Department, 2002); the dominant vegetation type along the pipeline route is cultivated land associated with settlement .

Widespread cattle grazing and charcoal manufacture have put significant pressure on the few natural vegetation communities in the vicinity of the pipeline route, which consist of fairly degraded seasonal wetlands, riverine bushland along Hohwa River and pockets of natural woodlands. The effects of large-scale conversion of natural habitats to subsistence agricultural fields are particularly noticeable between the escarpment proper and Bugoma Central Forest Reserve.

6.1.1.1   *Invasive plant species*

A number of invasive plant species are present throughout the Local Study Area. *Mimosa pigra* (Giant Sensitive Tree), *Lantana camara* (Lantana), and *Eichhornia crassipes* (Water Hyacinth) were the commonest species recorded, predominantly on the Buhuka Flats and the shore of Lake Albert ,which are recognised as some of most noxious weeds in the world (Lowe, et al., 2000).

Several of the invasive species recorded in the Local Study Area provide ecosystem services to local communities and are planted specifically for this purpose, including Castor oil (*Ricinus communis*), Neem (*Azadirachta indica*), Jatropha (*Jatropha curcas*), and Parkinsonia (*Parkinsonia* sp.):

- **Castor oil**: planted and used for medicinal purposes in the LSA (Golder Associates, 2014).

- **Jatropha**: its non-edible seeds are harvested for biodiesel production; it is also planted on graves in the LSA (Golder Associates, 2014).

- **Neem**: used in East Africa for various medicinal purposes including the treatment of scabies and head lice, and its hard wood is harvested for use in construction (BioNET-EAFRINET, 2011).

- **Parkinsonia**: may be used for firewood, charcoal production, medicine, fodder, shade, mulch, as a 'live' fence, and as a windbreak for soil stabilisation (BioNET-EAFRINET, 2011).

Wooded Grassland

Bushland and shrubland

Bushed grassland

Wetlands associated with Escarpment ravines

Figure 11: Vegetation communities of the Escarpment

6.1.2   Faunal Communities Providing Ecosystem Services

6.1.2.1   Freshwater Fish Communities of Lake Albert

Nile Perch (*Lates niloticus*), *Ragoge* (*Brycinus nurse*), *Ngassa* (*Hydrocynus forskahlii*), Shield-head Catfish (*Synodontis schall*), Black Nile Catfish (*Bagrus bajad*), *Muziri* (*Neobola bredoi)* and *Angara* (*A. baremoze*) made up the majority of the wet and dry season baseline fish survey catch , and are some of the most commercially important species in Lake Albert (Taabu-Munyaho, et al., 2012).

In 2014, the fish community in the near-shore zone of the LSA was composed of a fairly uniform, multispecies mix of various ages in good condition. The diversity, age classes and condition of the species assessed was a reflection of adequate food and a healthy environment.

The near-shore artisanal fishery is dominated by gillnets, and is mostly focused on Nile Perch, *Ragoge*, *Ngassa*, and *Angara*; whilst *Muziri* features strongly in the seine net fishery. The condition of the near-shore aquatic habitats that support the fishery was considered Near-Pristine (ref. Section 5.1.1); therefore, the capacity of this ecosystem to continue to supply this ecosystem service is high. Further information on the fisheries value of the Lake Albert fish community to beneficiaries is provided in Section 6.4.1.

6.1.2.2   Terrestrial Fauna Hunted for Bush Meat

A study of bush meat consumption in Uganda found that bush pig (*Potamochoerus larvatus*), cane rat (*Thryonomys* sp.), guinea fowl (*Numida meleagris*) and kob (*Kobus kob*) were the main sources of bush meat in the Murchison Falls area (Olupot, et al., 2009), which is the nearest (approx. 150 km northeast) studied area to the ecosystem services Local Study Area. Other species taken for bushmeat in Uganda include bushbuck (*Tragelaphus scriptus*), duikers (*Cephalophinae*), oribi (*Ourebia ourebi*), buffalo (*Syncerus caffer*), hippopotamus (*Hippopotamus amphibius*), redtail monkey (*Cercopithecus ascanius*) and black-and-white colobus monkey (*Colobus* sp.). However, Olupot et al. (2009) reported that bush meat was eaten by a comparatively low number of respondents (5-32%) when compared to the (reported) consumption of livestock meat and fish (94-100%).

Due to the heavily human-impacted nature of the Local Study Area, vegetation cover is compromised and the potential of the area to support terrestrial mammal species is considered limited (Eco & Partners, 2014); however, a few medium sized mammals were recorded during the biodiversity baseline studies. These tended to be thicket and dense bushland specialists, such as bushbuck and duiker . The low populations and diversity of these species could also be a reflection of increased pressure for bush meat from the local human population, which has increased markedly over the last ten years (AECOM, 2012).

The socio-economic baseline report makes reference to hunting occurring in several villages, and hunting of 'rats' as an alternative livelihood in the village of Kamukeduke ; these, together with mammal species that were

reported (during interviews with locals, and trapping and observation of track/sign during field work) in the biodiversity baseline study of the LSA, that are known bush meat sources in the area, are outlined in Table 10.

Table 10: Mammals recorded in the Kingfisher LSA that are bush meat sources[2]

Common name	Species
Hippopotamus	*Hippopotamus amphibius*
Bush Duiker	*Sylvicapra grimmia*
Lesser Cane-rat	*Thryonomys gregorianus*
Northern savanna multimammate rat	*Mastomys hildebrandti*
Black rat	*Rattus rattus*

The biodiversity baseline report identifies bush meat hunting as a driver of change in the Local Study Area, particularly in Bugoma Central Forest Reserve (NEMA 2010, Plumptre et al. 2010). Between 2011 and 2012, increased immigration into the areas surrounding the forest resulted in increased deforestation, with an estimated 5,000 ha of the forest subject to encroachment by about 1,000 families and pit-sawyers (AECOM, 2013). In Bugoma CFR, trapping of large mammals now appears to have declined, which is attributed in part to the decline in large mammals to such an extent that hunting is not very productive any more (Plumptre et al., 2010).

A study of nearby Budongo Central Forest Reserve (Zommers & MacDonald, 2012), identified that of the local communities that hunted bush meat in the forest, nearly 73% were immigrants to the area; and furthermore, that the households of immigrants were also more likely to be involved with deforestation.

Overall, the indication is that bush meat is a resource utilised by beneficiaries within the Local Study Area, and may be of greater importance to immigrant populations than residents who have established subsistence crops or livestock grazing areas. Pressure on faunal species that are hunted for bush meat is thus expected to increase as a result of population influx associated with development of the Project.

6.2   Surface Water Systems

Lakes and rivers provide provisioning services in the form of water supply, food (fish), and vital regulating services such as groundwater recharge, water storage, flood control and water purification/waste assimilation (IPIECA, 2011).

The information presented in the following sections contextualises the baseline information presented in the Surface Water baseline report in terms of supply of fresh water to the Project and to beneficiaries, and regulating ecosystem service provision within the Local Study Area.

6.2.1   Surface Water Resources in Local Study Area

The location of the proposed Project in relation to regional surface water features and topography is shown in Figure 12 and Figure 13 respectively. The local surface water features in relation to the Project are illustrated in Figure 14.

Hydrologically, the Project is located within the Lake Albert catchment, which drains westwards from the escarpment into the south-eastern shores of Lake Albert. Lake Albert's catchment is strongly associated with the adjacent escarpment, draining into the lake via several streams flowing westwards. Surface water bodies within the Project's Area of Influence include the Kamansinig and Masika Rivers. Various other streams also flow off the escarpment and either join the main rivers mentioned above (such as Masika) or gradually and independently feed Lake Albert. The area below the escarpment is approximately 13 km^2 and, besides the rivers mentioned, is characterised by relatively scattered wetlands at an elevation level associated with most Project infrastructure (Figure 13).

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[2] Based on WCS study (Olupot, et al., 2009) and (Golder Associates Africa , 2014 (a))

The escarpment catchment generates runoff during the rainy season that discharges onto the Buhuka flats via ravines. High energy ravine flows are quickly dissipated as the slope meets the flats and the bushy vegetation at the bottom of the escarpment further slows the flow of water. Streams that are large enough slowly make their way through densely vegetated wetlands to Lake Albert. Some of the smaller streams disappear from the surface a few hundred metres away from the bottom of the escarpment; this shows that the zone at the bottom of the escarpment is an important zone of recharge of water into the soil.

Water quality results for the baseline assessment were compared with the local Ugandan Acceptable Standards for drinking standards (NEMA, 1996), and the World Health Organisation (WHO) for Drinking Water (WHO, 2011). Overall, the water quality in the Buhuka Flats area during the dry season is generally good; during the wet season there is potential for humic acids (from surrounding land areas such as wetland systems) to increase pH levels and introduce metals into Lake Albert.

6.2.2   Ecosystem Services Provided by Surface Water Systems in Local Study Area

The zone at the bottom of the escarpment is an important zone of recharge of water into the soil; therefore, this area has a role in provision of regulating services in the Buhuka Flats area, including groundwater recharge, water storage and flood control. Scattered wetland areas in the Buhuka Flats consist of riparian floodplains, and permanent wetlands at the Lake's edge. These wetland areas also provide regulating ecosystem services including flood attenuation and sediment retention.

Main water sources within the villages along the pipeline route include springs, streams and boreholes, which are used for drinking and domestic purposes as well as animal watering. These water sources provide typically poor-quality drinking water, which commonly causes various illnesses in the local communities .

The communities of the Buhuka Flats region source drinking and bathing water from either Lake Albert or from the gravity flow scheme (which is contaminated with human waste). These households also dispose of solid waste and waste water into the Lake ; therefore, the lake has importance both as a source of drinking water, and for provision of some waste assimilation services.

The construction and operation of the Project has potential to influence or change the processes that drive these systems and thus their capacity to supply ecosystem services. For example, the road leading from the foot of the escarpment and the borrow pit has noticeably influenced the flow regimes and drainage patterns of the seasonally flooded grasslands associated with the Kamansinig River, resulting in the alteration of the wetland on the western side of the road and associated loss of function. Construction of the pipeline route is expected to intercept several permanent wetland systems which may alter flow regimes and ultimately affect the capability of the wetlands to provide services such as flood attenuation or nutrient (waste) assimilation.

6.2.3   Project Water Demand

During the operational phase, the Project will require a maximum of 9360 m^3/day, which equates to a maximum of 3.416 Ml/year. This equates to between 0.00000857% of the average inflow into Lake Albert (39750 Million Ml/a). This is much less than the monthly variations observed naturally at Lake Albert. Therefore, the supply of fresh water provided by the Lake is not expected to be significantly affected by the water required for Project operation.
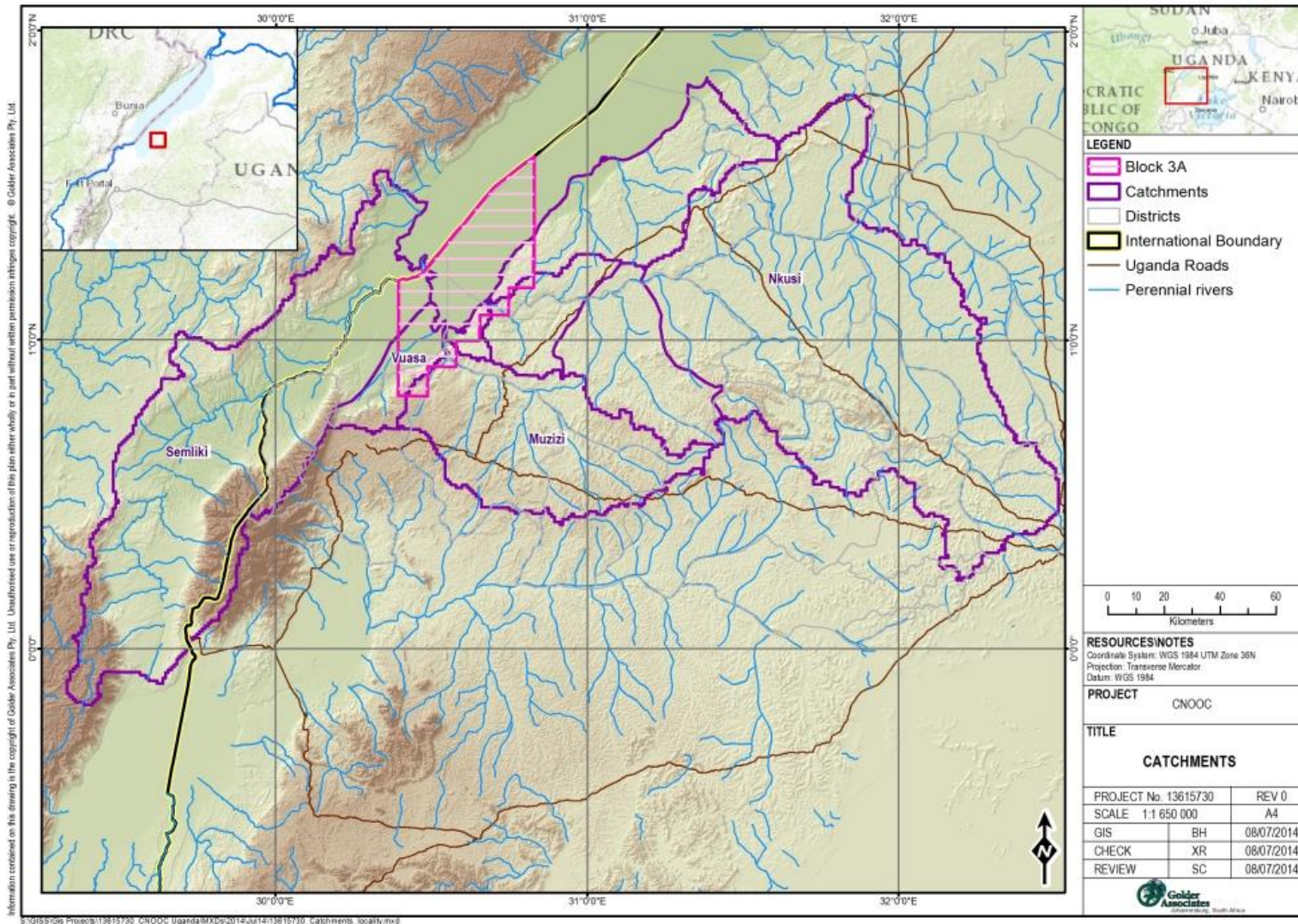
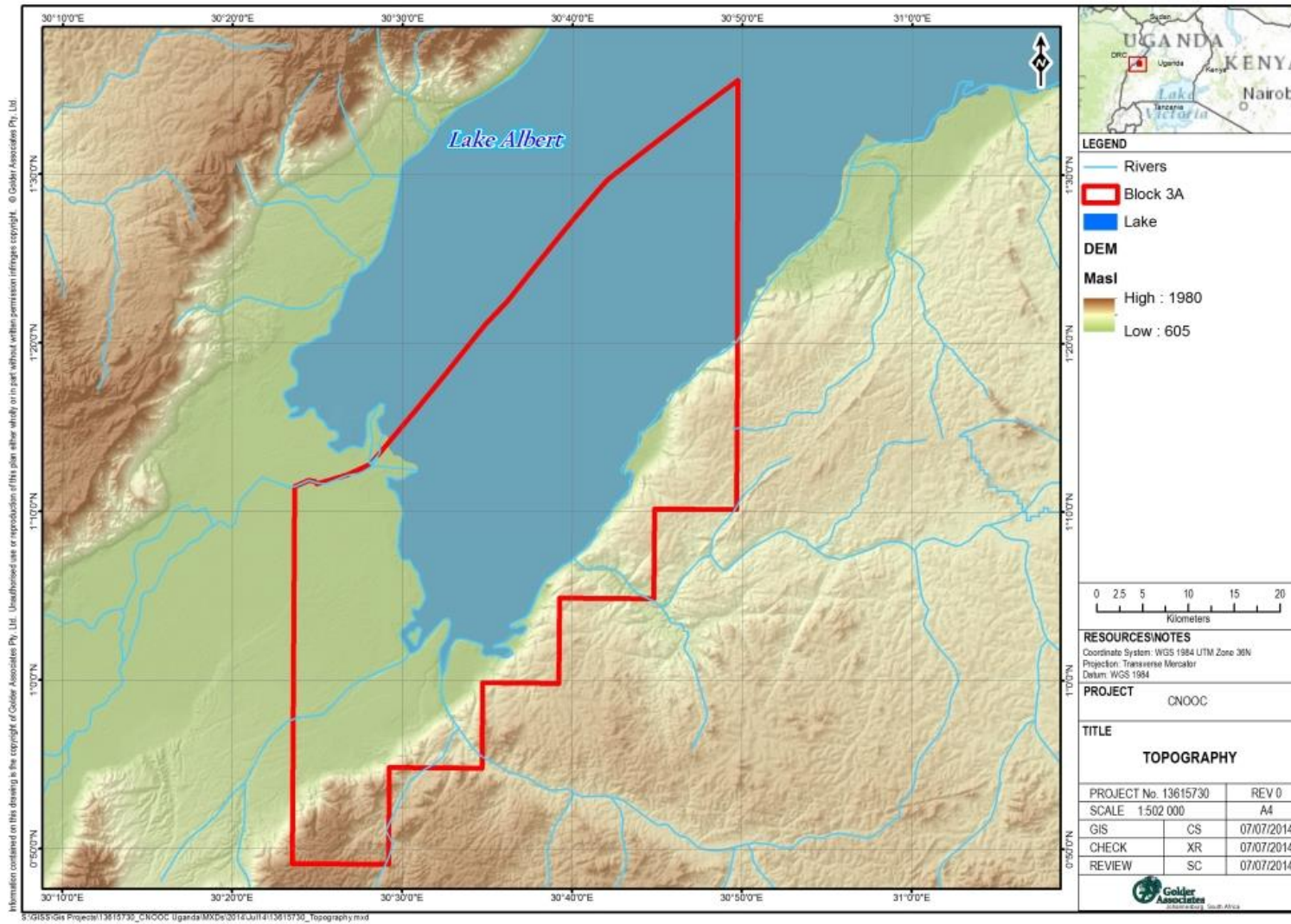*Figure 12: Regional location of the Project in relation to surface water features*

Figure 13: Regional Topography

Figure 14: Local context of the Project in relation to surface water features and floodlines

6.3   Land Use, Land Capability and Soils

Land uses in the Local Study Area were assessed as part of the baseline study for the ESIA. Land capability was determined based on the types of soil present in the areas investigated.

In the Buhuka Flats, 'natural grassland' consisting of thicket-grassland mosaic, open grassland, and seasonally flooded grassland vegetation categories, is the dominant existing land use (Table 11). This area is currently used for grazing cattle. The land potential of this area is appropriate for arable crop production . Wetlands (approx. 19%) and settlements (approx. 16%) account for the majority of the remainder of land use in the Buhuka Flats area.

Land use along the pipeline route is dominated by 'cultivated land' (Table 11). Patches of permanent wetland, seasonally flooded grassland, and open bushland and shrubland occur along the pipeline route, these are classified as 'natural grassland' in terms of land use category. The land potential of the areas classified as 'natural grassland' is also considered suitable for arable crop production.

Table 11: Land use within the Local Study Area

Area	Land Use	Surface Area (ha)	% of Total
Buhuka Flats	Existing CNOOC Base & Airstrip	24	3.16
	Natural Grassland	468	61.57
	Cultivated Land	5	0.66
	Villages and immediate surrounds	120	15.79
	Wetlands	143	18.82
Pipeline Route	Natural Grassland	396	17
	Cultivated Land	1,923	83

Examination of the land use categories in the Local Study Area, shows that livestock grazing opportunities provided by natural grassland and wetland categories accounts for approx. 80% of the land use of the Buhuka Flats area. This highlights the importance of this area for provision of grazing ecosystem services. Almost no crop cultivation occurs in this area.

Land use along the pipeline route is dominated by cultivated lands (83%). These areas are used for subsistence farming and small-scale commercial farming, which are the main economic activities along the pipeline route . Production is carried out on small farm holdings less than 1 acre in size (Figure 15), and crops are mostly used for household consumption or sale in community markets.

Figure 15: Backyard farming in Nsonga, Buhuka Flats

6.4   Baseline Socio-economic Setting

The information in the following sections is largely derived from the interviews done as part of the socio-economic baseline study. Other relevant information sources are referenced as appropriate throughout the text.

The Local Study Area is starkly different from the general district and national trends in terms of primary economic activity. While agriculture is a major economic activity in the district, the Local Study Area is mostly characterised by fishing and livestock (mainly cattle) keeping as economic activities. The villages in the Buhuka Flats have traditionally predominantly engaged in fishing and cattle farming as a livelihood, whilst villages on top of the escarpment engage in agricultural crop farming activities as a main livelihood activity. A substantial amount of processing and trade across Lake Albert occurs with the fish produce. The Buhuka area in general is experiencing rapid economic development since the opening of the escarpment road into the Flats, where two large markets have developed, selling various goods and services which attract an extensive daily clientele. This has resulted in induced and indirect employment opportunities being created. More details regarding economic activities are provided in the following sections.

Household size on the Buhuka Flats ranged between 1 and 11 persons, with an average of 8 members per household. This figure is substantially higher than the average district household size of 4.9 persons and the national average of 4.7 persons.. There has been a substantial increase in the growth of villages on the Flats over the past 10 years, with figures for the period 2003-2013 indicating that the rate of growth in the number of structures in villages ranged between 96%-175%, with the exception of Kacunde village which experienced a 439% increase in the number of structures in the village over the same period (59 to 256) (see Volume 4, Specialist Study 10, Social Impact Assessment). This increase is thought to be driven by a multitude of factors including regional instability, attractive livelihood opportunities to engage in fishing on Lake Albert interest in capitalising from opportunities related to oil and gas developments, and more recently, the opening of the escarpment road.

6.4.1   Fisheries

At least 75% of the households in Buhuka Parish villages directly depend on subsistence fishing activities as a source of food, livelihoods and a cash income. The fish caught in the district is spread over 68 landing sites in the district which are distributed quite evenly along the shoreline. Drying and salting of fish along the lake shore (Figure 16) is undertaken before selling the fish at markets in Hoima. According to focus group discussions held in 2014, relatively little of the fish catch went up the escarpment for trade (about 25%), with village residents from the top of the escarpment being more likely to travel to the lake to catch their own fish for household consumption and transport it back to their houses than to purchase fish from the markets. Since then, the opening of the escarpment road has spurred significant change in the way that the traditional Buhuka Flats fisheries trade was conducted. Migration onto the Buhuka Flats has already been significant as a result of the access created by the escarpment road. The continued influx of migrants as well as opportunistic and uncontrolled fishing practiced by local villagers and people from outside of the Buhuka Parish, including commercial fisherman from Hoima and even Kampala, has resulted in overfishing, negatively affecting the livelihoods of local households. Fish trade appears to be conducted across the lake into the Democratic Republic of Congo (DRC) (e.g. at Panyimur, Bwera and Ntoroko), while vast quantities of silver fish of fingerling size are harvested and sold (primarily as poultry feed) within Uganda as well as in Kenya. The fishing trade (including both fishermen and traders) forms part of the informal economic sector, and therefore earnings are largely undocumented. What is clear, is that earnings are unpredictable in size and occurrence. Fishing has greatly influenced social and economic development in the sub-county of Kyangwali where the Project will be located.

There are numerous reports of declining fish numbers, driven by unsustainable fishing practises and an increasing population engaging in fishing activities. The fishing sector is also being threatened by declining catches, mainly due to the use of destructive and illegal fishing methods, fishing in breeding areas, non-compliance with regulations and inadequate control of catches. Poor fishing gear and techniques result in taking of immature fish before they have the chance to reproduce and maintain the fish population. Other factors that affect fishing activity on the lake shore include restrictions on illegal fishing methods and poaching put in place by **Beach Management Units** (BMUs); however, limited funds and inadequate coordination

between BMUs and fisheries authorities limits the conservation capacity of these organisations (Uganda Nile Discourse Forum, 2013), and the BMUs are currently (2018) largely defunct. Most fisheries are formally open-access with no legal controls in place to prevent entry to fisheries (Scullion, 2007). The direct impact of oil exploration activities on fishing is thought to be the least detrimental impact on current amounts of fish caught. Indirect effects of oil exploration activity, such as population influx, is likely to increase in the number of people involved in fishing, putting fish stocks under increasing pressure which is expected to result in swifter fish stock decline. These indirect effects have been underlined since the opening of the escarpment road, which has facilitated easy vehicular access to the lake shore. The results of fieldwork conducted during November 2017 to update the social baseline suggest that fishing pressure on the Buhuka Flats has increased significantly to fuel the demand that has been generated by the new access to the shore, with trucks arriving daily from as far as Kampala to buy the catch.

Figure 16: Drying Nile perch at the shore of Lake Albert (2014)

6.4.2 Agriculture

Subsistence farming and small-scale commercial farming are the main economic activities in the Hoima District. The majority of people along the pipeline route are dependent on agriculture, with crop production as a major economic activity, followed by poultry and livestock. However, the Buhuka Flats is notably different, with households being heavily dependent on fisheries rather than agriculture. Where subsistence farming is engaged in, the dominant activity in this area is livestock keeping, rather than the growing of crops.

6.4.2.1 Buhuka Flats

Very few households grow agricultural produce in the Buhuka Flats, and instead purchase this from sources on top of the escarpment, and at the daily markets that have become established on the Flats since the opening of the escarpment road.

Households in the Buhuka Flats that do grow crops, do so on small backyard plots. Crops typically consist of cassava, maize, beans, sweet potatoes, tomatoes and *matooke* (bananas). Some of the food crops are sometimes sold in order to raise money needed for other household needs. Besides cultivating on open spaces in the backyard of their homesteads, approx. 33% of Buhuka Flats respondents reported that they also had access to arable land away from their homesteads, the majority of which (approx. 70%) is located on top of the escarpment and the rest comprising plots of land in the Buhuka Flats. The average size of land currently being cultivated according to the respondents is 3 acres and the most common size is 1 acre.

On the Buhuka Flats, livestock keeping is undertaken by a large percentage of households (approx. 80%). Livestock numbers are large. Carrying capacity calculations suggest that there is a high degree of overgrazing (approx. double the carrying capacity) already in both the Buhuka Flats and neighbouring areas into which cattle herders range to find alternative grassland sources .

In 2014, an influx of cattle keepers from as far as Tanzania and Kasese areas lead to a tremendous increase of cattle in the Kyangwali sub-county, including the Buhuka Flats. In Buhuka, the cattle keepers were attracted mainly by the abundance of water from the lake and the open grasslands that are conducive for grazing animals . Since the opening of the escarpment road, cattle grazing in the Buhuka Flats appears to have further intensified, with erosion and degradation of riparian habitats due to excessive cattle trampling being observed during the fieldwork conducted as part of the social baseline update in November 2017.

Figure 17: Cattle trampling around water source on Buhuka Flats, Nov 2017. Escarpment road in background.

6.4.2.2   Pipeline Route

Most of the pipeline route is covered by cultivated areas (Figure 6). The most common subsistence crops include bananas (for food), bananas (for beer), cassava, sweet potatoes, Irish potatoes, cotton, soybeans,

groundnuts, pigeon peas, beans, sorghum and maize, whilst perennial crops including coffee, banana and sugar cane plantations and tree plantations (pine wood, eucalyptus), which are typically commercial crops. Beekeeping for honey production is practised in a number of villages along the pipeline route (.

Both the crop farming and livestock sectors in the Kyangwali sub-county are faced with a number of challenges and these include: unpredictable weather changes, vermin attacks, crop diseases, poor farming practices which is leading to shortages of land for cultivation, and environmental degradation/deforestation because of the increase in clearing of land for farming practices.

6.4.3   Freshwater

On the Buhuka Flats, the main source of water for household consumption is piped water from the gravity flow scheme. The water is sourced from open water sources at the top of the escarpment and is then piped down to the Buhuka Flats area. Approx. 79% of the Buhuka population buy their water from taps and 15% draw their water from the lake (Environmental Assessment Consult (U) Ltd., 2013). Poor quality drinking water is a challenge for most villages in the Local Study Area, (for example, in Kyakapere village, tap water is reportedly polluted so water is drawn from the lake and boiled) and water-borne diseases are prevalent.

In the vicinity of the pipeline route, villages obtain water from sources including boreholes, wells, water holes, streams/rivers and swamps. In many cases, animals/livestock use the same sources for drinking water, and the bad quality of drinking water contributes to the spread of various illnesses. These water sources are considered sensitive where construction of the pipeline will take place.

6.4.4   Land tenure and use

The Hoima district covers a total land area of 3,612.17 km^2. Out of this, 2,853.48 km^2 (79.1%) is under agriculture, settlement and other miscellaneous land uses. The remaining 758 km^2 (20.9%) is under protected areas, including forest reserves and wildlife conservation areas. Protected areas are classified as Public Land and include forest reserves, wetlands and any other land outside customary, free-hold or lease-held land.

On private land, customary land tenure (both individual and communal) is the most widely practiced system. The lack of a uniform land tenure system, presents management challenges particularly with regard to land speculation that has been exacerbated by the discovery of oil in the district. This could cause land use conflicts and result in landless households and communities in the district, as land purchases and delineation of previously communally owned land continue to take place. Such conflicts have the potential to affect the Project's social license to operate.

6.4.5   Human health risk

Most urban populations in Uganda lack water-borne sewage systems, and domestic wastes often flow directly into swamps and wetlands, which provide important water purification services (NEMA, 2002).

No formal waste disposal services or facilities exist in the Hoima District, and, therefore, by implication, the Local Study Area. This lack of sanitation and refuse disposal systems has implications for health conditions of communities. It also increases the importance of the role played by swamps and wetland in absorption of nutrients and waste assimilation, in the absence of formal municipal treatment schemes.

6.4.6   Recreation and Tourism

Ecosystems and biodiversity play an important role for many kinds of tourism, which in turn provides considerable economic benefits and can be a vital source of income for many countries (TEEB, 2010). Tourism is typically based on the use of both natural and cultural ecosystem services (PANParks, unknown). In addition, people derive recreational pleasure from natural or cultivated ecosystems (Landsberg, et al., 2013)). In Uganda, tourism is focused in the approximately 21,000 km^2 of gazetted wildlife protected areas (NEMA, 2002), where tourists pay to view wildlife in remote and pristine natural settings. The aesthetic value of the Lake Albert landscape offers cultural ecosystem services to tourists, in the form of inspirational experiences.

The development of accommodation establishments around Lake Albert (for example, Lake Albert Safari Lodge and Lake Albert Guest House) has been attributed to the developing oil industry, the employees of which are thought to be boosting tourism in the area (Solomon & George, 2012). Although Lake Albert has

potential for community tourism, with activities such as sport fishing and canoeing/kayaking considered feasible; most landing sites on the lake shore have not been developed for tourism and lack the necessary facilities and amenities (Solomon & George, 2012). However, oil industry-related activities may negatively impact tourism potential through land take and associated impacts on flora and fauna, potential pollution and primarily, visual intrusion. In order to assess the impacts of oil activities on tourism; number of species, number of tourists, tourism revenue, visual impact and habitat quality would need to be monitored .

6.5 Cultural Heritage Context

Due to the confidential nature of some of the cultural sites (for example, secret sites) their exact locations were not given in the baseline report. An overview of cultural sites present within the Project Area of Influence is provided in Figure 18. Further detail is provided in .

6.5.1 Spiritual Values

People attach spiritual, religious, aesthetic values to ecosystems, landscapes and species (Landsberg, et al., 2013), which are non-material contributions of ecosystems to human well-being. The ecosystems, sites and landscapes that contribute to this ecosystem service in the Local Study Area are discussed in the following sections.

6.5.1.1 Sacred Sites

Sacred sites within the Project Area of Influence fell into four broad categories:

- Ritual Sites

- Sacred Rivers

- Sacred Trees and/or Cultural Trees

- Ritual Objects.

Ritual Sites

- 'Luzira' is a lagoon close to the Project footprint. It is an active place of worship and the historic centre of cultural activity, where, traditionally, pilgrims would travel some distances to stay within the swamp for nine consecutive days, to make offerings and conduct ritual activities.

- Kasonga beach, near the village of Nsonga, is used for ritual ceremonies specifically related to fish catches – when lake stocks appear low or when fishermen have troubles.

- A secret sacred pool is located on the River Masika. It is well known by elders and taboo for younger members of the community. The site is utilised for rituals during cholera outbreaks in particular, and a specific ceremony for sick babies is also conducted there.

Sacred River

- The River Masika in itself is considered sacred. Areas on the river bank are used for ceremonies to improve fish catches and occasionally to cure sick children.

Sacred, Cultural and Barkcloth Tree

- A secret tree (species unidentified) at one of the lakeshore villages has a number of taboos associated with it. Another such tree is present near the escarpment road.

- A Barkcloth Tree (*Ficus natalensis*) near the pipeline route at Kaseeta – barkcloth making is an ancient craft listed on UNESCO's intangible world heritage list.

- A tree in Nsonga village is the village assembly tree.

Ritual Objects

- These were recorded at three locations - a village in Buhuka Flats, escarpment road and along the pipeline route. They consisted of stones used for feet washing, rituals and worship.

6.5.1.2   *Cultural landscapes*

Both Lake Albert and the escarpment are iconic features of the natural landscape, defining the local (communal) sense of place and apparent (traditional) cultural associations of the natural features (rivers, lakes, trees). Both sites provide a strong historic and religious focus for the lakeside communities in particular, evident within the oral traditions and the sacred places associated with both locations (Box 1).

> *"There is a tradition that (as a sign of respecting the fish and ensuring their continued supply from the lake) if a woman comes from the escarpment top with cassava flour, it's up to her husband to prepare it to accompany a fish. When the woman leaves the lake shore to return she is then given a fish to take back up the escarpment top"*
>
> (Golder Associates, 2014(e))

Box 1: Example of Oral Tradition associated with Escarpment

6.5.2   Inspirational Values associated with Lake Albert

People in the Local Study Area have derived various elements of information from the ecosystems surrounding them in Lake Albert, and used this information for aspects of culture, traditions, art and story-telling. These practices that are intrinsic to Lake Albert contribute to the local people's sense of place.

Local legends and revered animals

Throughout the lakeside villages consulted during the community survey, some common beliefs and practices were identified. Some traditional practices call on a giant snake (seen to bring good fortune) or a giant crocodile (can bring or take away fish shoals).

Beliefs associated with Lake Albert

A number of taboos and beliefs are specifically associated with Lake Albert, such as ceremonies to cure sick children and bless new boats and nets, beliefs that evil spirits roam the area at night time, and conducting of certain activities during the night is a sign of disrespect to the ancestors, and taboos relating to women bathing in the Lake, amongst others.

Oral history and village naming

The names of many of the lakeshore villages are directly derived from natural features (e.g. Nsunzu is the name of the type of grass that is good for feeding cattle).

Medicinal plants

About 80% of the population in Uganda depend on traditional plant medicines derived from >300 plant species (CRA, 2006). Medicinal/traditionally used plant species observed by the cultural heritage field team are summarised in Table 12; specific knowledge on the exact identification (taxonomy) of these plants was not gathered. 'Secret plants' were also mentioned to be used by women in labour, specifically to address complications with the afterbirth.

Table 12: Traditional Plant names and uses

Local Plant name	Medicinal Use
Omwoyante	Malaria (boiled leaves)
Kyangwe	Used for sponges; leaves for ringworm
Tengo	Backache; bilharzia; teeth: use the roots; remove poison: fruits; eibisebe: flowers
Omulisana	Ringworms, hook worms

Local Plant name	Medicinal Use
Omukoma	Constipation; allergy: the stem
Ekiryabiruku	Cough
Kibeere	Cough, making the placenta stable
Omususa	Allergy, syphilis
Omupeera (guava)	Cough (leaves), asthma (roots)
Omusheshe	Allergy (leaves and roots), syphilis (stem),
Omukwatange	Fibroids (stems and roots)
Akagando	Wounds locally called ebironda (leaves), asthma (roots), Allergies, Teeth
Omululuza	Worms, malaria, wounds, and burns. Note: it has to be picked early in the morning when the chlorophyll is in the leaves but if the roots are to be used it is advisable to pick them in the evening.
Omushebashebe	Pancreas (stem to be drunk).

6.5.3   Intangible cultural heritage

A number of intangible heritage practices were identified during interviews with the local community within the Local Study Area that can be associated with certain ecosystem services.

Hand-crafted ghee storage gourds

Ghee-making is traditionally practised by the Balalo pastoralist community ('cattle keepers') who were interviewed near the Project during the cultural heritage field work. The hand-crafted ghee storage gourds also traditionally made by this group were displayed by the community members to the cultural heritage field team. The use of biological raw materials for fashioning ornamental/functional items, such as a ghee storage gourd, is a recognised ecosystem service (Landsberg, et al., 2013)

Making bark-cloth

Bark-cloth making is an ancient craft performed by the Baganda people from the Buganda kingdom in south Uganda (UNESCO, 2005). Although no direct evidence of bark-cloth making within the Local Study Area was gathered, a tree that can be used for bark-cloth making (*Ficus natalensis*) was identified in proximity to the pipeline route; however, there was no evidence of use for this purpose on that individual.

Traditionally built houses

Hand built shelters for ducks and chickens were observed within the villages surveyed by the field team . Traditionally built houses, without any manmade materials, were also prevalent amongst the isolated communities on the Buhuka Flats. The practice of constructing a house is done by men only, with women only allowed to smear the house to finish off the building. Materials used in construction of these shelters and houses are mud (daub) and 'wattle', which is wood harvested from trees. It is unclear exactly which tree species are harvested to provide the timber for the wattle. One estimate for Uganda suggests that if the stock of wattle and daub housing in Uganda was to be maintained, 136,000 trees per year would be needed to supply enough wood (European Commission, 2001). Grasses and reeds are used to thatch the roof (Figure 8).
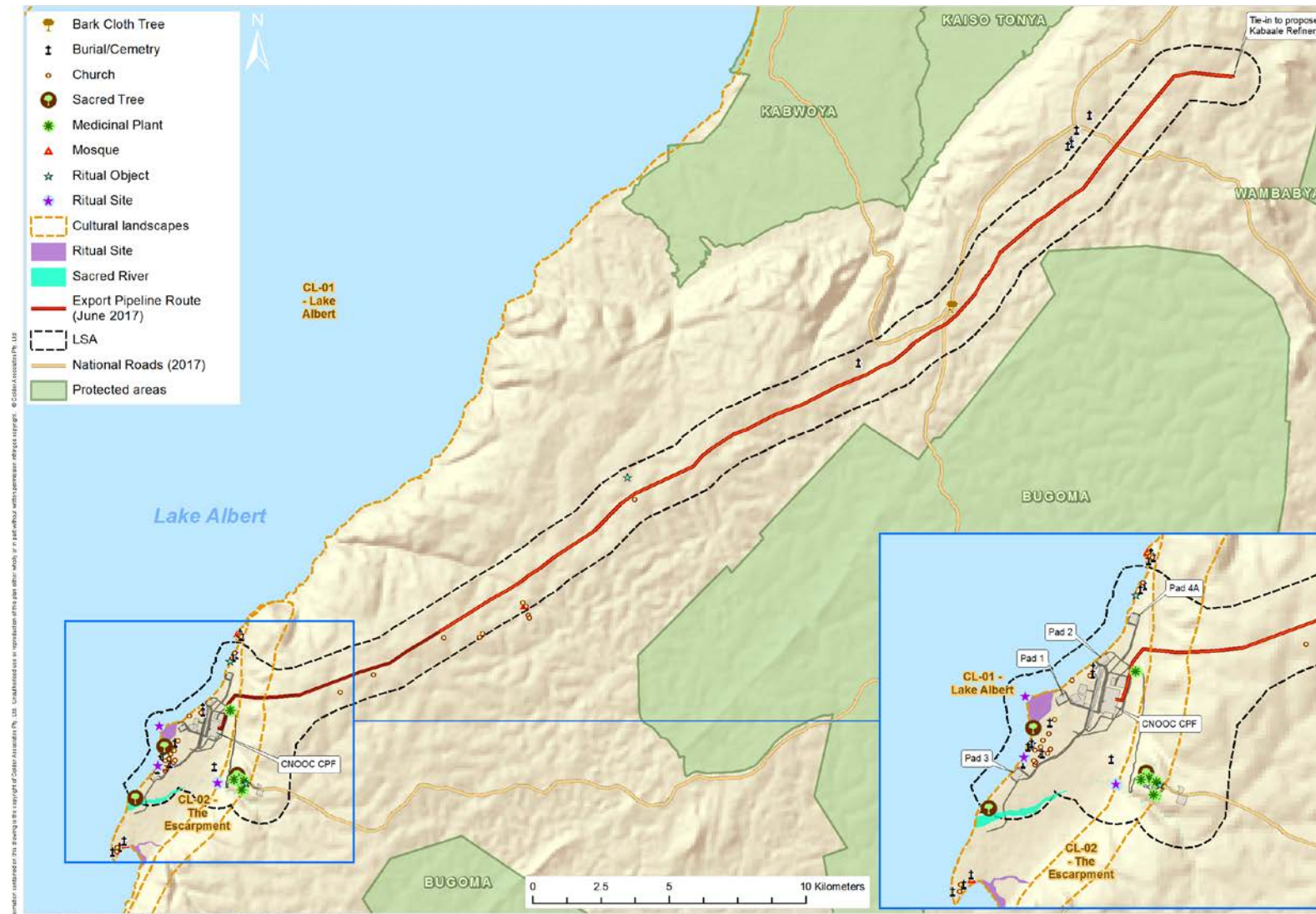
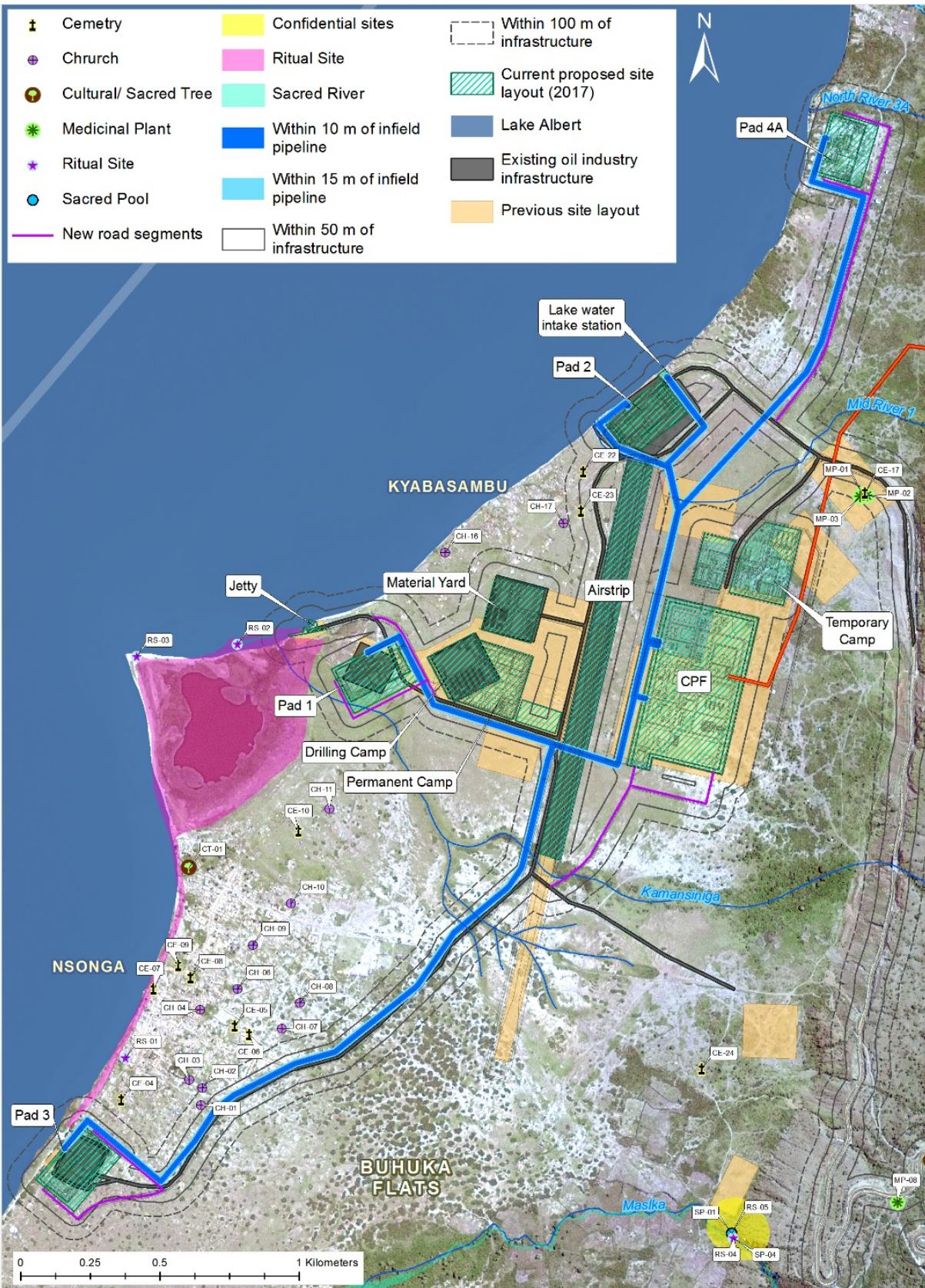*Figure 18: Overview of cultural sites and objects identified in the wider Local Study Area*

Figure 19: Cultural sites and objects identified on the Buhuka Flats

6.6 Existing Drivers of Ecosystem Change

Ecosystems are directly affected in two ways; by natural processes (for example, desertification) that cause continual change in species composition and habitat structure across regions; and by human activities and increased human population pressure. Five direct drivers of ecosystem change directly attributable to human activity have been identified (Landsberg, et al., 2013); changes in local land use and land cover, harvest and resource consumption, pollution, introduction of invasive species, and climate change. These are considered to have the greatest effects on ecosystem health and condition, and therefore the supply of ecosystem services. In summary, the existing land cover within the Local Study Area is already modified by the five main drivers of ecosystem change, which are directly attributable to human activity and behaviour.

6.6.1 Changes in local land use and land cover

The natural vegetation of the Buhuka Flats region has been substantially modified, largely due to over-grazing and uncontrolled harvesting of trees for wood and charcoal production, and house construction (Golder Associates, 2014).

Along the pipeline route, the natural vegetation has been replaced by a mosaic of commercial crop production, subsistence farming, with remaining non-cultivated areas consisting of heavily-modified grassland, wetland and woodland habitats. The occurrence of frequent fires was also evident on the escarpment. Over-frequent fire is known to detrimentally affect the functioning and processes of savanna ecosystems (Smith, et al., 2013), thus may be a driver of change in land cover condition, and, therefore, ecosystem condition and ecosystem service delivery in this part of the Local Study Area.

As mentioned in the next section, population influx has increased demand for ecosystem services such as grazing for cattle; livestock grazing has now been extended into areas that might not previously have been typically grazed, such as dense reed stands in wetlands and difficult-to-access open bushland areas of the escarpment. Such changes in land use and land cover are likely to affect spiritual sites, as these sites have typically been selected due to their remoteness, natural setting, and difficulty to access. Further changes in land use and land cover in the LSA as a result of the Project are anticipated.

6.6.2 Harvest and resource consumption

Fishing activities based out of both the fishing villages in the Buhuka Flats and villages further up the escarpment, puts pressure on the local fish populations. Apart from the published accounts of the decrease in commercial fish stocks (Wandera, 2000), (Wandera & Balirwa, 2010); Taabu-Munyahu et al. 2012), anecdotal accounts from the local fishermen also identify noticeable decreases in catches of fish per unit effort over the years. The main drivers of change influencing the vegetation communities along the escarpment are from livestock grazing, fuel wood harvesting, charcoal manufacture and the conversion of natural vegetation for subsistence agriculture. This is particularly noticeable along the pipeline route.

The keeping of livestock forms a substantial component of the local socio-economic structures in the Local Study Area, and particularly on the Buhuka Flats. Livestock numbers are large and there is strong evidence for overgrazing on the Buhuka Flats extending up onto the escarpment.

Large trees on the escarpment are becoming rarer as these individuals are selectively harvested for the manufacture of charcoal, which is typically then sold. Smaller woody species are regularly harvested for fuel wood used directly in the fishing villages. The harvest of fibre and other house construction materials is common on the escarpment. For example, thatching grass is regularly harvested on the escarpment and transported to the local fishing villages of the Buhuka Flats (Figure 20).

There has been a substantial increase in the local population over the past 10 years, driven by factors such as regional instability, livestock grazing opportunities, attractive livelihood opportunities to engage in fishing on Lake Albert, and more recently, the opening of the escarpment road, as well as interest in capitalising from opportunities related to oil and gas developments . This population influx is expected to exacerbate demand for numerous ecosystem services already used by the local population, including fisheries, fuel and construction wood, and bush meat, which will have knock-on effects on the extent and condition of the ecosystems that supply them.

Figure 20: "Chutes" used for the transport of thatching grass harvested from the escarpment, 2014

6.6.3 Pollution

Despite the human impacts evident throughout the Project Area of Influence, industrial/commercial facilities and/or concrete hard-standing typically associated with pollution potential are generally absent. Pollution of surface water and groundwater resources and air pollution has not been highlighted as a major issue in the baseline biophysical reports; however, Wandera (2000) and Wandera and Balirwa (2010) have identified that agricultural run-off is having real effects on increasing the nutrient levels of Lake Albert, contributing to eutrophication of the lake's waters. In addition, the presence of approximately 22,000 people on the Buhuka Flats and other nearby villages who do not have access to running water and sanitation , will put large pressures on the nutrient loading of the inflowing waters of Lake Albert.

Many ecosystem services are reduced when inland waters become eutrophic; water from lakes that experience algal blooms is more expensive to purify for drinking or industrial uses, fish populations can be reduced or eliminated, and many of the cultural services provided by lakes can be lost, for example, odours of rotting algae, slimes, and toxic chemicals produced by some blue-green algae during blooms keep people from swimming, boating, and otherwise enjoying the aesthetic value of lakes (Nelson, 2005).

6.6.4 Introduction of invasive species

A number of invasive plant species have been observed throughout the Local Study Area, including lantana, castor oil, neem, jatropha and Parkinsonia (Golder Associates, 2014). Some species, e.g., castor oil, are proliferating in uncultivated areas of the escarpment. Invasive aquatic plants including water lettuce (*Pisitia stratiotes*) and water hyacinth (*Eichhornia crassipes*) have been recorded on the shores of Lake Albert itself (Figure 21).

Many invasive plant species do have the capacity to change vegetation community composition and the ecosystem services provided by those vegetation communities. This is particularly the case for water hyacinth, which can reduce biological diversity through reduction of water oxygen levels (e.g., oxygen-sensitive fish species may be affected), blocking sunlight to native plants, and blocking access to water to some animal communities (Center for Aquatic and Invasive Plants, University of Florida, 2014). Water hyacinth has already become dominant of the marginal ecotones of Lakes Kyoga and Victoria, which has resulted in negative impacts on aquatic biodiversity and fishing activity in marginal habitats (Twongo, 1996). Spread of water hyacinth in Lake Albert could therefore become a major driver of change in the near-shore aquatic habitats of the Lake in the future.

Invasive castor oil plant on escarpment   *Invasive Pistia stratiotes on shore of Lake Albert*

Figure 21: Examples of invasive species in the Project Area of Influence

6.6.5   Climate change

Observed changes in climate, especially warmer regional temperatures, has already effected changes in species distributions, population sizes, and the timing of reproduction or migration events, as well as an increase in the frequency of pest and disease outbreaks, especially in forested systems (Nelson, 2005).

Uganda is expected to experience more extreme periods of intense rainfall, and erratic onset and cessation of the rainy seasons and more frequent episodes of drought due to future climate change (Global Climate Change Alliance, 2012). Recent increases in the range of water level fluctuations in Lake Albert have been attributed to climate change (International Lake Envrionment Committee Foundation, 1999). For example, flooding on the Buhuka Flats in 2012 - which could be attributable to climate change - caused the death of 10 people, the loss of 70 homes and other household losses (Golder Associates, 2014).

7.0   ECOSYSTEM SERVICE REVIEW FOR IMPACT ASSESSMENT

7.1   Step 1: Identification of Relevant Ecosystem Services

The Project's area of influence hosts numerous ecosystem services. The following sections characterise the supply of ecosystem services within the Project's area of influence, their quality, and their level of use or value to beneficiaries.

Beneficiaries considered most likely to be affected by the Project are the inhabitants and herders of the Buhuka Flats, and subsistence farmers whose plots lie within the servitude of the proposed pipeline route.

7.1.1   Land Cover Types / Ecosystems which could be impacted by the Project

Given the limited amount of non-degraded natural habitat types within the Project footprint, the extent (Table 7, Table 8) and ecosystem condition (Table 9) of the various land cover types within the Project footprint was estimated. The ecosystems that could be impacted by the Project are discussed according to the relevant area of the Local Study Area.

Buhuka Flats and Escarpment

■ The dominant land cover classes in the Buhuka Flats (grassland) and the Escarpment (open bush and dense bush) will have the greatest proportionate loss to the Project footprint.

■ The condition of the escarpment vegetation corridors is slightly to moderately degraded, therefore, its capacity to supply provisioning ecosystem services such as fuel wood, construction wood and inspirational services such as spiritual sites is considered to be moderate to high.

■ The Buhuka Flats have extensive settlement areas, which have resulted in over-exploitation of livestock grazing resources available in the open grasslands, grasslands with thickets and open bushland and shrublands that dominate the land cover of the Buhuka Flats. As a result, the condition of these ecosystems is considered heavily degraded, largely due to overgrazing. In addition, carrying capacity calculations indicated that these areas were being grazed by more than twice the amount of cattle than they were capable of.

■ However, as stated previously (Section 4.3.1.1), not all ecosystem services supply dynamics are affected to the same degree by the condition of the land cover type. In this case, the capacity of degraded grasslands to supply livestock grazing ecosystem services is still considered high; however, ongoing poor grazing management practises are likely to result in ploughing of the ground by cattle's hooves in wet conditions, and overgrazing in dry conditions, ultimately leading to soil erosion, bush encroachment and exotic species invasion. The Project and associated population influx will likely create additional pressure on these grazing resources. These expected changes in land cover will reduce the capacity of these ecosystems in the Buhuka Flats to supply ecosystem services (including grazing for livestock) in the future.

Pipeline

■ The dominant land cover classes are subsistence farmland and degraded bush; accordingly, these will have the greatest proportionate loss to the pipeline servitude footprint.

■ Although the 'ecological' condition of subsistence cropland land cover class is considered poor due to the negative ecological impacts of cultivation, its functionality/ability to supply ES is an effect of its cultivation; therefore, its capacity to supply ecosystem services is considered high as it supports crop production.

■ The condition of degraded bushland is heavily-degraded, largely as an effect of clearance of bush for cultivation, and probably over-grazing by browsing livestock. Its ability to supply its associated ecosystem services (Table 13) is thus considered Low.

7.1.2 Which Ecosystem Services could the Project impact?

The ecosystem services supplied within the Local Study Area are listed according to land cover type in Table 13. These ecosystem services are supplied by ecosystems that will have a loss in extent, condition or ease of access as a result of the Project, and thus could potentially be impacted by the Project.

Table 13: ES supplied within the Project Area of Influence

Ecosystem Service	Land Cover Type	Definition of Service
Provisioning		
Food	Subsistence cropland	**Crops:** Subsistence crops associated with individual households Small-scale commercial plantation crops along pipeline route
	Grassland Open bush	Grazing for livestock Cattle and goat herders in the Buhuka Flats are reliant on the availability of grazing resources

Ecosystem Service	Land Cover Type	Definition of Service
	Water (Lake Albert)	**Capture Fisheries:** Fish is the main source of nutrition for the people in Buhuka Parish
	Degraded bush Open bush Dense bush	**Wild foods:** Subsistence hunting for bush meat was reported for several villages, mostly along the pipeline route. No reports of wild food (fruits, roots) use were recorded during baseline. One study of wild food use in Uganda reported stigma attached to use of wild foods (indicative of poverty and laziness) (Agea, et al., 2011); therefore, actual levels of use of wild foods may have been under-reported.
Biological raw materials	Wetland Woodland Grassland	Reeds and grasses are harvested from wetlands and escarpment grasslands for use as thatching material. Papyrus culms may be harvested from wetlands for construction of traditionally-built houses. Timber is harvested from trees for use as 'wattle' in construction of mud and wattle houses.
	All categories	Extraction of local natural materials (e.g. aggregates) for Project road and camp construction etc.
Biomass Fuel	Degraded bush Open bush Dense bush Woodland	Wood is harvested for firewood and charcoal production.
Freshwater	Water Wetland	Freshwater for consumption and irrigation is taken from Lake Albert, boreholes, wells, rivers, streams and swamps throughout the area.
Medicinal plants	Degraded bush Open bush Dense bush Woodland Grassland	Numerous medicinal plants are harvested for various purposes within the local study area.
Regulating		
Regulating air quality	Water Wetland	Baseline air quality is generally considered good but may deteriorate periodically as a result of biomass burning – Lake Albert and its associated sedimentary flats and wetlands would have a role as a 'sink' for any atmospheric pollutants.
Regulating climate	Woodland	The topography of the escarpment plays a role in the local climate, particularly in rainfall patterns in the Buhuka Flats, which are lower than those on the top of the escarpment.
Regulating water flows and timing	Grassland Open bush Wetland	Approximately half (56%) of the soils within the Kingfisher Development Area footprint are readily permeable, facilitating aquifer recharge. Wetlands in the Buhuka flats retain water and contribute to reduced flooding frequency.
Control of erosion	Grassland Open bush Wetland	Vegetation cover within the footprint reduces soil loss and prevents erosion. In areas where storm water infrastructure has been improperly installed, severe erosion was observed.

Ecosystem Service	Land Cover Type	Definition of Service
Water purification and waste treatment	Wetland	In the absence of municipal water treatment schemes, wetlands within the Project Area of Influence likely have an important role in partial water purification.
Pollination	Subsistence cropland Degraded bush	Beekeeping is practised in several villages along the pipeline route. Subsistence agriculture reliant on pollination by bees for fruit and vegetable growth.
Cultural		
Recreation and ecotourism	Water (Lake Albert)	Some holiday lodge facilities have been constructed in the vicinity of Lake Albert to cater for tourism thought to be largely driven by staff of the local oil industry.
Ethical and spiritual values	Water (Lake Albert, rivers) Wetland Woodland (escarpment)	Local communities of the Buhuka Flats have strong spiritual ties with the lands. The Buhuka Flats area has numerous sacred sites, and has a rich, intangible cultural heritage that includes folklore and taboos related to the Lake, traditional crafts (e.g. making ghee, making bark-cloth), and oral histories.
Educational and inspirational	Water Wetland Grassland Open bush Dense bush Woodland	The communities of the Buhuka Flats area have stories and taboos relating to, and inspired by, the landscapes of the Lake and the escarpment.
Supporting		
Habitat	Wetland Water Woodland	Wetland areas are nurseries for juvenile fish. Lake Albert provides habitat for fish and waterfowl. Wooded areas on the escarpment support terrestrial fauna Forested areas contribute to landscape connectivity for terrestrial fauna through their role as wildlife corridors (Akwetaireho, et al., 2011).
Nutrient cycling	Subsistence cropland	The majority of the pipeline route is considered to have agricultural potential as arable land, due to the productive nature of the soils.
Primary production	Grassland Wetland	The Buhuka Flats is an important grazing area as a result of the combination of water availability and productive soils which promote the development of grasslands and wetland vegetation.
Water cycling	Grassland Wetland	The Buhuka Flats' hydrological system is different to that beyond the escarpment and plays a role in aquifer recharge. Wetland systems in the Buhuka Flats and on top of the escarpment have importance for water storage and flood attenuation.

7.1.3 Which Beneficiaries are potentially affected?

The beneficiaries who use those services supplied by the ecosystems that could be affected by the Project (Section 7.1.2) were identified, and fall into two categories:

- The local community – the people that benefit from ecosystem services (Type I) supplied by the land cover types of the area that will be affected by the Project. This consists largely of the rural subsistence population, including subsistence farmers, pastoralists, fishermen, and the unemployed.

- The Project (Type II):

  - the Project is dependent on the abstraction of appropriate quantities of fresh water from Lake Albert for make-up water as part of its operation;

  - the Project is dependent on the regulation of water quality of Lake Albert; if water quality decreases then treatment costs may be prohibitive;

  - the Project is dependent on flood attenuation in the Buhuka Flats due to aquifer recharge and wetland water storage;

  - the Project is dependent on a **social licence to operate.**

The demand for services by beneficiaries varies between the different Project-affected areas, largely depending on the dominant land cover type in that area.

Buhuka Flats

In the Buhuka Flats, demand for services (Type I) arises principally from the following beneficiaries:

- The communities of the lakeshore villages that depend on the Lake Albert fisheries as a primary source of livelihood, income and nutrition.

- The communities of the lakeshore villages that depend on obtaining thatching material from wetland areas on the Buhuka Flats and grassland areas on the escarpment; and construction material for building mud and wattle houses from trees in woodland and bushland both on the escarpment and above it.

- Subsistence farmers resident in the lakeshore villages that use the Buhuka Flats for grazing livestock.

- Migratory herders that bring their cattle to the Buhuka Flats to avail of grazing opportunities there.

- The communities of the lakeshore villages that have strong spiritual attachment to the Lake, the river Malika and the Escarpment.

In addition, ecosystem services are demanded by the Project itself (Type II) - clean fresh water in the necessary quantities and of appropriate quality, which will be abstracted from Lake Albert and used in the oil extraction process during Project operations; as well as the social licence to operate from local communities, who may see their sense of place change as a result of the Project.

Pipeline Route

Beyond the escarpment, demand for services arises principally from the communities of the villages along the pipeline route who depend on:

- Cultivation of subsistence and small-scale commercial crops as a primary source of livelihood, income and nutrition.

- Raising livestock as a primary source of meat and dairy products.

- Obtaining freshwater from rivers, streams, swamps, wells and boreholes.

- Harvest of timber for wood fuel for cooking, charcoal production and use in home construction.

- Harvest of grass for use in thatching traditionally built homes.

- Hunting of bush meat as a dietary supplement in times of hardship.

7.2 Step 2: Ecosystem Service Prioritisation

Priority ecosystem services related to the Project were identified following an ecosystem service review (Landsberg, et al., 2013). The services were prioritised in two phases, and were aligned with the two types of Priority ecosystem services defined by IFC PS 6.

As *Supporting* ecosystem services have no specific/direct beneficiaries, and impacts to these are captured within the *Provisioning, Regulating* and *Cultural* categories for this project, they are not included in the prioritisation exercise.

7.2.1 Type I Ecosystem Services: Priority Ecosystem Services according to Project Impact

Ecosystem services were prioritised according to project impact, by answering three key questions (Landsberg, et al., 2013):

1)   Could the Project affect the ability of others to benefit from this ecosystem service?

2)   Is the ecosystem service important to beneficiaries' livelihoods, health, safety or culture?

3)   Do beneficiaries have viable alternatives to this ecosystem service?

The results of the prioritisation exercise for Type I ecosystem services are detailed in Appendix B. All Type I ecosystem services and the reasoning behind their determination as Priority ecosystem services (or not) are discussed in the following sections.

7.2.1.1 Provisioning

Food – Subsistence Crops

The majority of land cover along the pipeline route consists of subsistence cropland, which is a primary source of livelihood, income and nutrition for the beneficiaries in this part of the Local Study Area. Approximately 1.3% of this land cover will be temporarily lost to the footprint of the pipeline and its 30 m servitude during construction (Table 8), with cultivation of maize and other grain crops expected to resume once the pipeline has been buried and the soils reinstated. The average size of farm currently being cultivated according to the respondents is 3 acres (1.2 ha) and the most common size is 1 acre (0.4 ha. Therefore, average maximum land loss to the pipeline servitude is expected to range from 0.18 ha or 46% of the most common sized farms, to 0.33 ha or 27% of average farms.

Although this may temporarily impact the ability of farmers whose land is intercepted by the pipeline and servitude to benefit from this ecosystem service, alternatives may be provided to affected beneficiaries; if this is not possible, then fair and adequate compensation should be offered . The compensation should be in line with IFC Performance Standard 5 and will be addressed in an appropriate Resettlement Action Plan (RAP).

Food from subsistence crops is therefore classed as a non-priority ecosystem service for the purposes of this assessment.

Food – Grazing for livestock

Some residents of the Buhuka Flats raise cattle for subsistence purposes, so access to **grazing** areas is considered a priority ecosystem service. The availability of alternative locations to those that may be lost to the Project footprint is uncertain, as at baseline, the carrying capacity for grazing animals in the Buhuka Flats area was already being exceeded by approximately double the amount of livestock present. In addition, land tenure in the area is uncertain.

Both residents of the Buhuka Flats and the villages near the pipeline route, and migratory pastoralists, raise **livestock** for subsistence purposes. The extent to which these beneficiaries rely on the grazing opportunities provided by the grasslands in the Project Area of Influence is likely of high importance to their livelihoods and wellbeing. As the availability of alternative sources of grazing is likely to be limited, given the current rates of overstocking, this is considered a **Priority ES**.

Food – Capture fisheries

Although **capture fisheries** are not anticipated to be directly negatively affected by the Project, there is a perception amongst residents of the Buhuka Flats that the Project will affect fish stocks and catch success. Additionally, the development of the escarpment road for vehicular access to the Production Facility on the Buhuka Flats has driven increased demand for fish from areas above the escarpment and beyond, which is now having repercussions on the supply of fish (both quantity and quality) from the lake shore fisheries for local beneficiaries. Capture fisheries are therefore included as a **Priority ES** for which potential impacts must be assessed.

Food – Wild foods

Bush meat hunting and beekeeping were recorded in communities along the pipeline route. The importance of these ES for beneficiaries is uncertain, and the availability of viable alternatives to these ES is unclear, so **wild foods** are included as **Priority ES** based on the precautionary principle.

Biological Raw Materials – Construction Products

The majority of houses in the communities of both the Buhuka Flats and the pipeline route are traditionally built, using grasses from on top of the escarpment as thatching material, mud daub on walls and wood or papyrus culms as construction material for walls. Grasslands, wetlands, woodlands are the primary source of these materials, small areas of which will be lost to the Project footprint in the context of the LSA.

Given the proportionately small amount of expected loss of this land cover type in the context of the Project Area of Influence, there should be viable alternative sources of these raw materials in other unaffected locations. However, the level of increased demand for these materials as a consequence of population influx is unknown. In addition, Project-associated population influx effects on wetland functioning beyond the footprint are uncertain. Supply of biological raw materials is therefore considered a **Priority ecosystem service**.

Biomass Fuel

The majority (approximately 98.9%) of the population in Hoima District use **wood fuel** as the dominant source of energy. In some villages along the pipeline route, a mixture of firewood, banana leaves and grass are used as a source of fuel for cooking. However, firewood has become scarce and many people have resorted to using charcoal which is expensive, and therefore is not considered a viable (affordable) alternative for beneficiaries. Biomass fuel is therefore considered a **Priority ecosystem service**.

Freshwater

The provision of **freshwater** is considered to be a **Priority ES**, due to its importance for beneficiaries throughout the Project Area of Influence, stakeholder perception that the Project may impact the availability and/or quality of freshwater supply, and the lack of viable alternatives to this ES.

Medicinal Plants

Given the proportionately small areas of land take by the Project relative to the available areas within the Local Study Area, it is expected that alternative areas that support medicinal plant species are readily available to beneficiaries. This ES is therefore not considered as priority.

7.2.1.2 Regulating

Regulating Air Quality

Woodland and bushland vegetation of the escarpment may contribute to extraction of atmospheric chemicals (e.g., near roadways), and Lake Albert plays a role as a sink for air emissions of compounds from the burning of fires.

The Project is unlikely to push the regulation of air quality across a sustainability or regulatory threshold, and emissions are expected to be within the standards required by the IFC. This ecosystem service is not considered to be in short supply relative to demand in the Local Study Area, given the baseline of very little industrial or commercial enterprises in the area. Regulation of air quality is therefore not considered to be a priority ecosystem service in terms of Project impact for this assessment.

Regulating Climate

Escarpment vegetation, wetlands of the Buhuka Flats and sediments of Lake Albert within the Local Study Area may contribute to climate regulation through their role as a carbon sink. The loss of the relatively small areas of escarpment vegetation and wetlands to the project footprint, in the context of total available alternative areas in the Project Area of Influence is minimal. However, the effect of increased pressure on these systems, due to greater demand for services by the increased population, is uncertain. Given the current uncertainty in relation to climate change and possible scenarios, as well as increasing human pressures, how important these habitats will become in the future in terms of climate regulation is uncertain. Indications are that they will increase in importance (Ayebare, et al., 2013), provided human pressures do not overwhelm them. Overall predictions of Project impacts on the ecosystems involved in regulation of climate range from moderate on escarpment vegetation and wetlands ; to no impacts on Lake Albert deep water areas.

The Project is unlikely, however, to push the regulation of climate across a sustainability or regulatory threshold; neither is this service in short supply relative to demand in the LSA, given the minor loss of the ecosystems that supply this ES to the expected Project impacts. Regulation of climate is therefore not considered to be a priority ecosystem service for this assessment.

Regulating Water flows and timing

The Buhuka Flats has a unique hydrological system which is not fully understood (for example, water supply to 'Luzira' lagoon, aquifer recharge in the Flats from escarpment streams, and wetland water storage capacity). The potential Project impacts on the hydrological system (crossing of drainage lines) are considered to still have a moderately severe impact post-mitigation. Therefore, the Project could affect the ability of others to benefit from this important ecosystem service in the Buhuka Flats area. Viable alternatives to this hydrological system are not evident; therefore, regulating water flows and timing is a **Priority ecosystem service**.

Regulating Soil Stability and Erosion Control

Potential Project impacts on the regulation of soil stability and associated erosion control are considered likely, because clearance of vegetation for construction works in the Buhuka Flats, the escarpment road, and along the pipeline route will increase the vulnerability of soils in these areas to erosion by wind and water. The greatest impacts to soils typically occur during the construction phase. However, erosion-related mitigation measures and construction management controls are expected to be adhered to during construction of the Project infrastructure, therefore the Project is not expected to impact on this ecosystem service in such a way that the ability of others to benefit from this service would be affected. Therefore, this ecosystem service is not considered a priority for this assessment.

Water Purification and Waste Treatment

Kyangwali sub-county, within which the Project Area of Influence is located, has low safe water coverage (approx. 47%); and many beneficiaries obtain their water supply directly from rivers, streams and swamps. This heightens the importance of the role that wetlands play in the removal of harmful pollutants such as metals and organic materials from surface water systems; this is thus considered a **Priority ecosystem service.**

7.2.1.3   Cultural

Recreation and ecotourism

This ES is not of importance to local beneficiaries, as tourism facilities are non-existent at Lake Albert within the Local Study Area. Although some tourism accommodation facilities (safari lodges) have been developed in the Hoima District to accommodate low-level tourism by oil workers, there is no evidence that the local communities of the Buhuka Flats or the pipeline route benefit in terms of livelihoods. This ES is thus not considered a priority ES.

Ethical and spiritual values

Sacred sites and intangible cultural heritage, evident throughout the Project Area of Influence, are intrinsically linked with natural ecosystems such as wetlands, rivers, lakes and forests. Changes in natural ecosystems arising from Project land take, and changes in the appearance of the landscape due to the visual presence of the Project are likely to affect the ability of local communities to benefit from this ES. This ES is important to

beneficiaries as it substantially contributes to their sense of identity. It has thus been identified as a **Priority ecosystem service**.

Educational and inspirational values

The Lake Albert and Escarpment landscapes inspire folklore, myths and taboos, thereby contributing to beneficiaries' sense of heritage and identity. Changes in appearance of the landscape are likely to affect the ability of beneficiaries to retain the benefit of this service that is considered important in terms of cultural heritage and identity; in addition, access to these areas may be increased (thus impacting the remote quality of the landscape) or restricted as a result of the Project (e.g., the lagoon near the Kingfisher Development Area) therefore this ecosystem service is considered a **Priority ecosystem service** for this assessment.

7.2.2 Type II Ecosystem Services – Priority Ecosystem Services according to the Extent of Project Dependence

The outcomes of the prioritisation exercise for Type II ES are detailed in Appendix C. The Type II ecosystems and reasoning behind classification as priority/non-priority ecosystem services are discussed in the following sections.

7.2.2.1 Provisioning Services

Freshwater

The Project will depend on the abstraction of fresh water from Lake Albert for successful performance (oil extraction), and there are no viable alternatives to water abstraction. There is concern amongst beneficiaries that the Project may impact the quality of water; in addition, the quality of water in Lake Albert is already being pressured by elevated nutrient inputs and associated eutrophication. The Project is reliant on the quality of freshwater resources remaining constant throughout its lifetime, both in order to maintain its social license to operate and in order for operation to remain cost-effective - treatment of eutrophic waters to an acceptable standard for processing use may be cost-prohibitive for the Project.

Although the amount of water required by the Project is considered minimal in the context of the currently available resource (see Section 6.2.3), the ecosystem service could potentially change in ways that affect operational performance (e.g. water quality deterioration from eutrophication throughout the lifetime of the Project may affect water intake infrastructure, or require additional treatment). The Project has no viable alternative water source other than abstraction from Lake Albert. Therefore, freshwater provision is considered a Type II **Priority ecosystem service**.

Aggregates for construction

The Project depends on the extraction of locally-sourced aggregates for construction of facilities, such as camps and access roads, in order to reduce resource costs by using locally available materials, and reduce carbon emissions.

Existing demand for locally-extracted aggregate by other beneficiaries is unclear. Local beneficiaries in the Local Study Area currently mostly live in wattle and mud houses but it is unknown how construction practises may change in the future, if economic standards were to improve. The Project has no viable alternative to this ecosystem service; therefore, it is considered a **Priority ecosystem service** in terms of Project dependence.

7.2.2.2 Regulating Services

Regulating air quality

Air emissions from oil and gas development activities include combustion sources from power and heat generation and use of engines, emissions resulting from flaring and venting of hydrocarbons and fugitive emissions. Stakeholders in the Project Area of Influence perceive that the Project may impact the air quality; therefore, the Project is reliant on the quality of air remaining constant throughout its lifetime in order to maintain the social license to operate.

Although emissions from the Project are expected to be in compliance with the specified standards, and the service is not considered to be in short supply relative to demand in the Local Study Area, given the baseline

of very little industrial or commercial enterprises in the area, public perception is that the Project will impact air quality within the Local Study Area. Therefore, this is a **Priority ecosystem service** in terms of Project dependence on maintenance of a social license to operate.

Regulating climate

Flooding of the shores of Lake Albert in 2012 resulted in damage and destruction of homes, and some loss of life. The predicted changes in climatic conditions over the lifetime of the Project could lead to a rise in Lake Albert's water level, which would result in flooding of the flats, which could affect operational performance.

To counter this risk, the Project infrastructure will be designed to stand at a raised elevation from the actual ground level to avoid potential impacts of flooding over the Buhuka Flats, and will also include additional designed and engineered controls.

These engineering design measures can be considered to be viable alternatives to the climate regulation service provided by ecosystems within the local study area, therefore regulating climate is a non-priority ecosystem service in terms of Project dependence.

Regulation of water timing and flows

The Buhuka Flats is a zone of aquifer recharge from escarpment streams, and the wetlands in the Buhuka Flats area play a role in water storage. The potential Project impacts on the hydrological system (crossing of drainage lines) are considered to have a moderately severe impact post-mitigation for the construction and operation phases, and this together with ecosystem changes external to the Project (such as increased flooding due to climate change) could potentially change this ecosystem service in a way that would prevent the Project from achieving operational performance.

However, the Project design takes into account such potential impacts, and will put in place appropriate stormwater and flood management engineered measures to prevent the predicted potential impacts taking place. These engineering design measures are viable alternatives to the ecosystem service.

Therefore, regulating water flows and timing is a non-priority ecosystem service in terms of Project dependence.

Regulating soil stability and erosion control

The predicted rise in the level of Lake Albert over the Project lifetime could lead to an increase in erosion of the shoreline, thereby reducing the width of the Flats and increasing flood likelihood; therefore, the Project depends upon continued supply of this ES for its operational performance.

Engineered measures for the control of erosion arising from vegetation removal are considered sufficient to minimise the impacts of vegetation clearance. The Project, in compliance with the requirements of IFC Performance Standards 1 and 3, has undertaken predictive modelling to ensure that the Project's operational performance will not be put at risk by rises in Lake Albert's level. Therefore, regulating soil stability and erosion control is not considered to be a Priority ecosystem service according to operational risk to Project Performance.

Water Purification and Waste Treatment

The Project is reliant on the availability of fresh water of a certain quality standard from Lake Albert, both for use as drinking water for Project staff, and for Project oil and gas activities and processes. The role that wetland systems and the lake itself play in water purification through nutrient assimilation may change over the lifetime of the Project, both in terms of wetland and lake ecosystem extent and condition which could potentially decrease in this time, due to existing drivers of change.

However, the Project incorporates a waste water treatment facility, which could be a viable alternative for this ecosystem service, should abstracted fresh water need to be treated to achieve appropriate standards prior to use. In addition, the Project's water management specification commits the Project to discharge waters that are treated to acceptable environmental standards. Water purification and waste treatment is thus not considered a priority ecosystem service in terms of Project dependence.

7.2.2.3   Cultural

Ethical and spiritual values

The Project may depend on the availability of this ES remaining constant throughout its lifetime, in order to maintain its social license to operate. However, the presence of the Project in the landscape may affect beneficiaries' affinity to sacred sites for example, which are most frequently associated with areas of natural beauty, and that also have less obvious qualities, such as being remote or isolated or quiet. Maintenance of such features and their associated ecosystem services is considered significant in order to maintain the Project's social license to operate, so these are classified as Type II **Priority ecosystem service**.

Educational and inspirational

As with the provision of ethical and spiritual values, the Project may depend on the availability of this ecosystem service remaining constant throughout its lifetime, in order to maintain its social license to operate. Similarly, the actual physical presence of the Project may reduce the inspirational value of the Lake Albert and Escarpment landscapes; and Project provision of an alternative inspirational resource would likely prove impossible. This is therefore considered a **Priority ecosystem service**.

8.0   PROJECT AREA OF INFLUENCE FOR PRIORITY ECOSYSTEM SERVICES

The Project Area of Influence for Priority Ecosystem Services was set by mapping the land cover types that supply Priority Ecosystem Services against the Local Study Area, within which the beneficiaries of those ecosystem services are encompassed. The Project Area of Influence for Priority Ecosystem Services is illustrated in Figure 22. It is in this context that impacts on priority ecosystem services are assessed.
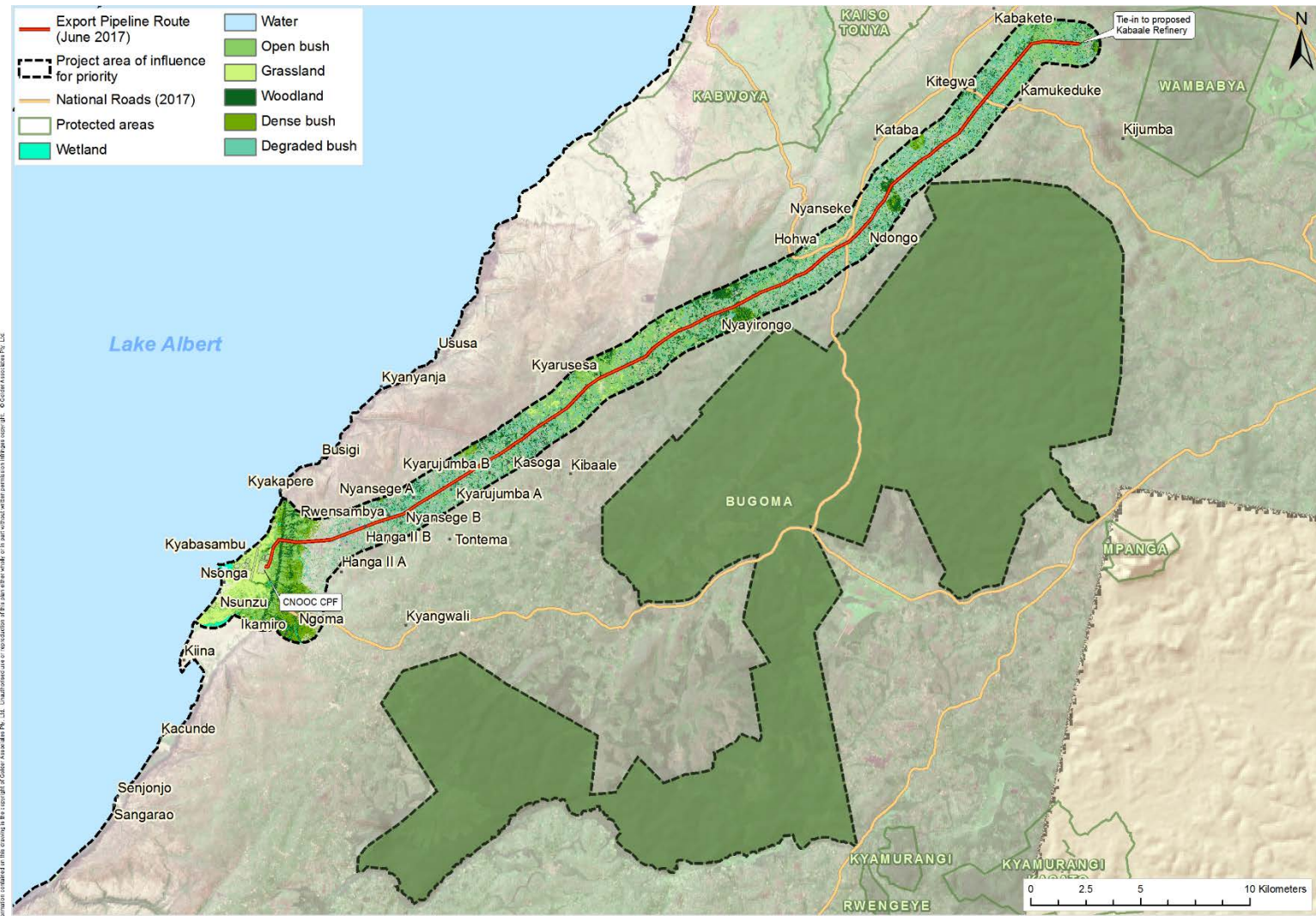
Figure 22: Project Area of Influence for Priority Ecosystem Services (includes Lake Albert)

9.0 ASSESSMENT OF PROJECT IMPACT ON PRIORITY ECOSYSTEM SERVICES

The following sections summarise expected impacts on Priority ecosystem services. Three of the four identified Type II ecosystem services overlap with Type I ecosystem services; in these cases, they are discussed under the same heading.

The impact assessment is not separated into construction/operation/decommissioning phases, as the ecosystem services are generally tied to land cover types and associated loss to the Project footprint (especially provisioning and regulating ecosystem services), or the presence of the Project in the landscape (cultural ecosystem services), which will be in effect for the lifetime of the Project. However, where potential impacts on ecosystem services are considered specific to a particular Project phase (for example, regulation of air quality is more likely to be affected during the operational phase of the Project), this is stated at the outset.

The impact significance ratings presented in Table 14, Table 15 and Table 16 are based on the anticipated impacts on ecosystem services, before and after specific mitigation measures have been applied. Specific mitigation measures relating to ecosystem services set out by relevant specialist studies are discussed in Section 10.0. In cases where the specialist studies do not address mitigation of impacts on ecosystem services (that is, food and biofuel provisioning ecosystem services), or where residual impacts on ecosystem services remain following application of specialist recommendations, additional mitigation measures to address such impacts are also provided in Section 10.0 Mitigation Measures.

9.1 Food Provisioning

The potential impacts on food provisioning within the Project Area of Influence will extend throughout the construction, operation and decommissioning phases in the Project, due to the presence of the Project and associated loss of land cover to its footprint, and the increased demand on food supply that is expected to occur in tandem with population influx, once the Project commences construction and operation. The potential impacts will be limited to the construction phase for the Pipeline route, because the Pipeline will be buried and the servitude will be rehabilitated to its former land use following completion of the construction phase.

The impacts on all Provisioning ecosystem services are discussed in the following Sections and summarised in Table 14.

9.1.1 Grazing for livestock

Potential Project impacts on this ecosystem service are related to the loss of available area for subsistence farming, and increased loss of cropland associated with increased risk of soil erosion in areas cleared (particularly along the pipeline servitude) grazing livestock. Grassland areas that are currently used for grazing livestock will be reduced in extent as a result of land-take for the Project footprint in the Buhuka Flats, and will be further pressured by population influx to the Buhuka Flats and concomitant increased demand for livestock grazing resources.

The loss and reduction in quality of this land constitutes a more significant impact in comparison to the loss of cropped land, because grazing pressure in the Buhuka Flats is severe and the loss of areas of grassland will place more pressure on the remaining grazing lands. Pastoralists travel to the Buhuka Flats specifically to graze their livestock, indicating a paucity of alternative grazing lands in the region. Population influx once the Project commences construction, and during operation may further contribute to increased grazing pressure in the Buhuka Flats. In addition, land tenure in the Project Area of Influence is not always well defined, which may affect the success of compensation schemes for beneficiaries.

The magnitude of potential Project impacts on supply of grazing for livestock was considered to be **high**, due to the current level of overgrazing in the Buhuka Flats, and its potential compoundment by loss of grazing lands to the Project footprint, and the Project population influx, which is expected to increase pressure on the availability of grazing for livestock. The geographic extent of the impact may reach to beneficiaries beyond the footprint, such as pastoralist herders who travel to the Flats specifically to access grazing lands.

The sensitivity of this ecosystem service is considered **high**, due to the apparent lack of alternative grazing resources elsewhere in the region. As with subsistence cropping, land tenure in the area is not always clear, and there are beneficiaries (for example, the Balalo pastoralist communities) grazing livestock in the Buhuka Flats that do not have the right land tenure, and therefore may be difficult to compensate for their loss.

The potential impact significance on this ecosystem service is thus considered **high.** With the application of the recommended mitigation measures, the magnitude of impact on this ecosystem service will be reduced; with appropriate resettlement, compensation and community development planning the sensitivity of the ecosystem service to impact can also be reduced, resulting in an impact of **moderate** significance, post-mitigation.

9.1.2   Capture Fisheries

The majority of beneficiaries in the Buhuka Flats rely on Lake Albert fishery as a sole source of livelihood, income and food, and there is concern amongst beneficiaries that the Project may impact fish stocks or the size of the fish catch. However, the Project itself, in terms of its footprint and operations, is expected to have minor impacts on the near-shore habitats of Lake Albert post-mitigation. The near-shore aquatic habitat is an important fish breeding area. Although it can be projected that construction of the Project and its operation will have minor impacts on the Lake Albert fishery, the predicted population influx associated with the Project and increased easy access to the lakeshore via the proposed escarpment road will place additional strain on the supply of natural resources and may contribute to over-fishing in the locality, as well as degradation of the near-shore habitats supporting important fish breeding zones.

Taking into account the construction impacts and the more intense potential effects of population influx, the magnitude of potential Project impacts on this ecosystem service is considered **high,** largely due to population influx. Population influx is expected to contribute to a negative feedback loop that will contribute to overfishing - as the villages on top of the escarpment become more accessible to fish sellers as a result of improved access via the escarpment road, more favourable conditions for trading fish on the escarpment (instead of at boat-accessible locations) are expected to develop, resulting in stimulation of economic growth in the Project Area of Influence – which in turn is expected to attract more people to the Project Area of influence – which may ultimately have dire consequences on the long-term viability of the Lake Albert fishery. These positive and negative socio-economic impacts will be addressed by the livelihood management plan. The effect of population influx would likely occur from construction through to the medium-term, that is, the lifetime of the project operations (25 years).

The sensitivity of the ES is **high**, as it is not substitutable or replaceable – beneficiaries are heavily dependent on this ES, and have no obvious alternate livelihoods, incomes or even food sources. The significance of the potential Project impact on the supply of this ES is thus considered **Major**. Following the application of the recommended mitigation measures, including influx management planning and provision of mess facilities, the magnitude of impacts is reduced to Low, leaving an impact of **moderate** significance, post-mitigation.

9.1.3   Wild foods

Bush meat hunting (specifically hunting for rats) was recorded in several villages near the pipeline routes. Bush meat hunting is a known pressure in Bugoma Central Forest Reserve in the Project Area of influence. The value of this ecosystem service to beneficiaries within the Project Area of Influence is unclear from the baseline data, however, the literature suggests that bush meat hunting may form an important 'bridge' or 'safety-net' resource for beneficiaries, particularly during times when food is scarce e.g. during times of unemployment, crop failure or drought (Akwetaireho, et al., 2011), (CRA, 2006).

Reductions in land cover types (woodland, dense and open bush) that support the supply of this ecosystem service due to Project impact will negatively affect the supply. In addition, the construction of the escarpment road and upgrade of the Hoima-to-Ikamiro Road will increase and enhance ease of access to the escarpment vegetation and Bugoma Central Forest Reserve, which, together with the expected population influx to the area, is expected to significantly increase demand for these ecosystem services. This could therefore likely affect the condition of the ecosystems and their capacity to supply ecosystem services. However, the demand for bush meat within the Project Area of Influence is uncertain. Bush meat is not thought to be a major source

of food within the Project Area of Influence. A **medium**-magnitude Project impact on this ecosystem service is expected for beneficiaries of this ES within the Project Area of Influence.

The sensitivity of this ES is ranked as medium – the supply of bush meat that would be affected by Project land take and population influx may not be easily substitutable. As mentioned earlier declines in poaching in Bugoma Forest Reserve were attributed to the lack of animals left to hunt, rather than changes in hunters' attitudes.

The significance of potential Project impacts on the supply of this ES is thus considered **moderate**. These impacts will still be of moderate significance following mitigation measures, but are predicted to occur at a lower magnitude as a result of promotion of sustainable farming and other activities that provide alternative food sources, and community education programmes.

9.2 Biological Raw Materials

Construction materials for traditionally built houses

Almost all beneficiaries in the Local Study Area (approx. 98%) live in houses constructed with mud-and-wattle walls with earth floors; a very small percentage live in houses built with fired bricks. The majority have thatched roofs (approx. 76%), with the remainder having iron sheet roofs . As a sub-set of the Local Study Area, this pattern is also expected in the Project Area of Influence.

Thatching materials are sourced from grasslands on the escarpment (being traditionally transported to the flats via chutes Figure 20), and wattle is timber harvested from trees in woodland and bushland areas. Increases in the population in the Project Area of Influence is expected to increase demand for these raw construction materials, which could affect their supply; both in terms of immediate availability, and in the long-term, degradation of the ecosystems that supply these ecosystem services may also contribute to reduced supply capacity. At present however, there is no baseline evidence that suggests that availability of these resources is under pressure. The magnitude of potential Project effects on the supply of raw materials for traditional house construction is thus considered **medium.**

Alternative housing materials (fired bricks and iron roof sheeting) are available for purchase in the Project Area of Influence; however, purchase of these materials is probably not a viable alternative to harvesting grass and wattle timber, which is free. Therefore, the sensitivity of the ecosystem service is **high**.

The significance of potential Project impacts on the supply of this ecosystem service is considered **major**. Provision of housing for workers employed by the Project during construction and operation may alleviate the demand for these materials in the Project Area of Influence, which would reduce the magnitude of the impact, however the sensitivity of the ecosystem service remains unchanged as population influx will also include people who do not work at the Project, for whom the ecosystem service will not be substitutable. Post-mitigation impacts are thus expected to be of **moderate** significance.

Natural aggregates for Project facility construction

The scale of extraction of aggregates for Project facility construction is unclear. It is not expected that the Project will affect the ability of other beneficiaries to benefit from this ecosystem service, as other beneficiaries within the Project Area of Influence do not typically rely on aggregate extraction as a priority/non-priority ecosystem service; however, construction practises may change over the lifetime of the Project, and local beneficiaries may come to depend on this ecosystem service. Based on current evidence, the magnitude of potential Project effects on the availability of natural aggregates is considered **medium**.

The Project is reliant on the availability of locally-sourced aggregates to maximise cost efficiency and carbon footprint reduction; however, alternatives in the form of imported resources are expected to be available to the Project. The sensitivity of the ecosystem service is thus considered **medium**.

The significance of potential Project impacts on the supply of this ecosystem service is considered **moderate**. Avoiding extraction of aggregate in areas important for ecosystem service supply, especially sites of cultural heritage importance, and Project development of a procurement strategy for using locally-sourced aggregates,

reduces the magnitude of impact and sensitivity of receptors, reducing the significance of potential impacts on this ecosystem service to **minor**.

9.3   Biomass Fuel

The majority of the population in the Hoima district and thus the Project Area of Influence use wood fuel as their main source of energy. However, firewood has become scarce and many beneficiaries have resorted to using charcoal, which is expensive. In addition, charcoal is derived from timber that is also harvested from woodland and bush areas.

Reductions in land cover types (woodland, degraded bush, open bush, dense bush) that supply this ecosystem services due to Project impact may negatively affect the supply of this ecosystem services. In addition, population influx to the area associated with the Project is expected to significantly increase demand for firewood and charcoal, which will have a direct impact on the condition of the woodlands and bush, and thus their capacity to continue to supply timber for use as fuel. The magnitude of potential Project effects on the supply of biomass fuel is thus considered **high**, as the ecosystems and their capacity to supply firewood may be altered to the extent that supply will temporarily or permanently cease.

The sensitivity of the ecosystem service is **high**, because there are almost no viable alternatives to the use of firewood and charcoal by beneficiaries, it is not easily replaceable – although non-wood products, such as banana leaves and grass, are used in some parts as a source of fuel for cooking to supplement firewood, such fuels could not replace firewood in terms of burning time and heat generation.

The significance of potential Project impacts on the supply of this ecosystem service is considered **major**. If the recommended mitigation measure of CNOOC, that is, investigating the feasibility of provision of cheap gas to local communities is enacted, the impact would be reduced in magnitude and the ecosystem service sensitivity would be lowered due to the availability of an affordable substitute to charcoal, resulting in **minor** impacts, post-mitigation.

9.4   Freshwater

Freshwater falls under both Type I and Type II priority ES – the Project may impact the supply of this ES and the Project is also dependent on both the quantity and the quality of supply of this ES.

9.4.1   Freshwater as a Type I Priority ES

The Project footprint may impact the supply of Freshwater for beneficiaries, particularly in the vicinity of areas where the infrastructure will intercept drainage lines, streams, rivers and/or swamps. Pressure from increased populations in the Project Area of Influence may contribute to increased nutrient load and eutrophication of the lake, with concomitant effects on water quality. Although unlikely, an accidental spill of oil or process water in Lake Albert cannot be discounted as a potential impact on the quality of the freshwater supply. Impacts on the quality and quantity of water supply may ensue.

The magnitude or magnitude of potential effects could extend throughout the Project Area of Influence and beyond, but would most likely be short-term in duration. Potential impacts on water quality would most likely occur during the construction phase due to potential sediment release during earthworks activities, and may also occur during the medium-term operational life of the Project, in the event that inflow of untreated human waste and agricultural runoff continues and will increase due to population influx. Impacts on quantity of freshwater supply are considered unlikely, given the amount of water being abstracted from Lake Albert for the Project operations in the context of the available surface water resource. Nonetheless, should water quality be impacted negatively, for example, by eutrophication or an industrial accidental leakage, the magnitude of impacts could be **high**.

The sensitivity of the ecosystem service is **high**, as freshwater supply in the necessary quantities and to the required quality standards is not easily substitutable. In addition, impacts on Lake Albert water quality from potential eutrophication would also directly affect the fish population and thus the capacity to support capture fisheries, which is also a highly sensitive ecosystem service. The significance of potential Project Impacts on the supply of this ecosystem service is thus considered **major**. The magnitude of impacts can be reduced by

appropriate water management and monitoring mechanisms and influx management planning, reducing the predicted impacts post-mitigation to **moderate** significance.

9.4.2   Freshwater as a Type II Priority ES

The Project is dependent on the supply of Freshwater from Lake Albert for operational performance, as water use is a necessary part of the oil extraction process; however, the Project requirement is miniscule in the context of the available resource. No significant impacts on the quantity of this ES over the lifetime of the Project are envisaged, either as a result of changing water levels in Lake Albert or the cumulative effects of other oil development areas also abstracting (similarly negligible amounts) water from Lake Albert for the same purpose. Water quality deterioration may occur in Lake Albert as a result of eutrophication from nutrient loading of streams and rivers flowing into the lake. The Project is dependent on the lake's capacity to assimilate this waste loading, to avoid the financial implications of having to provide additional treatment to bring intake water to an appropriate standard for use in operations, other than that already planned[3].

The magnitude of potential Project effects on this ecosystem service is considered **negligible**. The amount of water demanded by the Project in terms of the available water resource is negligible, and will be even more so if as predicted the water level in Lake Albert rises due to predicted effects of climate change. Although ongoing nutrient-loading to the lake is likely to result in water quality deterioration, treatment of the abstracted water prior to use is already planned as part of the Project.

The sensitivity of the ES is **low**, as during operation the majority of Project water requirements will be achieved through re-use of produced water, rather than abstraction of make-up water from the Lake, and thus is considered largely substitutable. The significance of potential impacts on this ES in terms of Project demand is thus considered **minor**.   Participation in water catchment management activities in the Lake Albert basin can further reduce the Project impact magnitude to negligible, with overall impacts on this ecosystem service post-mitigation remaining **minor**.

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[3] Hypochlorite (NAOCl), together with a flocculent, will be injected close to the intake water pump station in order to minimise the risk of build-up of Sulphate Reducing Bacteria (SRB) in the pipeline to the CPF

Table 14: Impacts on Provisioning ecosystem services within the Project Area of Influence

Ecosystem Service	Potential Impacts	Pre-mitigation			Post-mitigation		
		Magnitude	Sensitivity	Significance	Magnitude	Sensitivity	Significance
Grazing for Livestock	■ Loss of grassland to Kingfisher Development area ■ Increased erosion potential of grassland adjacent to cleared areas ■ Population influx-associated pressures on already over-utilised resource ■ Land tenure not clearly defined – there are pastoralist herders present on the Buhuka Flats who do not have land tenure and thus would not be compensated for loss	High - 4	High - 4	Major - 16	Medium – 3	Medium – 3	Moderate – 9
Capture Fisheries	■ Perception amongst beneficiaries that Project may impact fish stocks/fish catch ■ Minor impacts on near-shore aquatic environment expected, which may affect fish breeding ■ Population influx will increase demand on Lake Albert fisheries	High - 4	High - 4	Major - 16	Low – 2	High – 4	Moderate – 8
Wild Foods	■ Bush meat hunting takes place in some villages along the pipeline route and in Bugoma Central Forest Reserve; ■ Woodland and bush that supports hunted species will be reduced in area by pipeline servitude land-take, and will be made more accessible to hunters by upgrade of road and clearance of pipeline servitude ■ Population influx will increase demand for bush meat	Medium - 3	Medium - 3	Moderate - 9	Low – 2	Medium - 3	Moderate – 6
Construction materials for traditionally-built houses	■ Reductions in land cover types (grassland, wetland, woodland and bushland) that supply this ES due to Project land-take ■ Population influx may increase demand for housing construction materials	Medium – 3	High – 4	Major - 12	Low – 2	Medium – 3	Moderate – 6
Natural aggregates for Project facility construction	■ Reductions in land cover types that supply this and other ES due to extraction of aggregates ■ Local shortages in aggregates could lead to higher costs for other beneficiaries if importation becomes necessary	Medium – 3	Medium – 3	Moderate - 9	Negligible – 1	Low – 2	Minor – 2
Biomass Fuel	■ Reductions in land cover types that supply this ES due to Project land-take, particularly along pipeline route and escarpment road ■ Population influx expected to increase demand for firewood and charcoal	High - 4	High - 4	Major - 16	Low – 2	Low – 2	Minor – 4
Fresh Water (Type I)	■ Impacts on quantity and quality of water supply where Project infrastructure intercepts drainage lines, streams, rivers and/or swamps ■ Impacts on water quality of Lake Albert should an accidental spill occur ■ Impact on water quality due to increased nutrient loading from population influx	High – 4	High – 4	Major - 16	Low – 2	High – 4	Moderate – 6

Fresh Water (Type II)	■ Quantity of fresh water supply to the Project may be affected by climate change and change in Lake Albert levels ■ Cumulative effect of other oil development areas also abstracting water from Lake Albert ■ Water quality deterioration may necessitate treatment of water being used in Project activities, increasing Project operation costs and affecting operational performance	Low - 2	Low – 2	Minor – 4	Negligible – 1	Low – 2	Minor – 2

9.5 Regulating Air Quality

This is a Type II priority ecosystem service – the Project is also dependent on the supply of this ES in order to maintain its social licence to operate, and maintain operational performance by not triggering regulatory responses, for example, by exceeding emission guidelines.

Regulation of Air quality as a Type II Priority Ecosystem Service

The Project depends on the ongoing provision of this ecosystem service, as although Project emissions will be within the recommended limits set out in the relevant guidelines, there will still be some level of emissions by the Project to the air. Stakeholders perceive that the Project may affect air quality, so any changes in air quality (though not necessarily caused by the Project itself) might be attributed by beneficiaries to the Project, thereby affecting its social license to operate.

The principle ecosystem delivering air quality regulation services within the Project Area of Influence is Lake Albert's sediments and its associated flats and wetlands, which would have a role as a 'sink' for any atmospheric pollutants, as well as carbon sequestration. The escarpment vegetation and forest areas, particularly Bugoma CFR, grasslands and bushlands are also expected contribute to air quality regulation.

The significance of Project impacts to the Lake Albert and wetland ecosystems providing this service is expected to be minor following mitigation; however moderate-major effects remain on the escarpment vegetation and Bugoma CFR respectively, after mitigation . The magnitude of potential Project impact on the provision of this ecosystem service is considered to be **low**, given the limited amount of loss of escarpment vegetation and woodland area, and the minor effects anticipated on Lake Albert and wetlands post-mitigation.

The sensitivity of the ecosystem service is **high**, as although measures can be enacted to mitigate direct Project impact on this ecosystem service, the perceptions of local stakeholders may be difficult to change. The significance of potential future impacts on the Project is **moderate,** as a result of its dependence on this ES for operational performance and maintenance of its social license to operate.

Following the application of recommended mitigation measures, particularly community education programmes and corporate social responsibility initiatives, the negative public perception of potential Project impacts on air quality and thus the sensitivity rating for this ecosystem service can be reduced to low; and magnitude to negligible, resulting in a residual impact of minor significance.

9.6 Regulating Water Flows and Timing

The effects of placing Project infrastructure within and intercepting wetlands, rivers, streams and drainage lines will both reduce the surface area of these land cover types, reducing their ability to regulate water flows, and alter their hydrological properties (e.g., subsurface flow through soils) and ecological integrity, which may affect their capacity to regulate water flows.

The magnitude of potential Project construction impacts on wetlands and drainage lines that supply this ecosystem service in the Project Area of Influence is expected to be **medium**, as although the wetlands will be altered, natural processes are expected to continue in impacted wetlands, albeit in a modified way.

The sensitivity of the ecosystem service is considered **medium**, as the proposed mitigation measures for wetlands that are directly affected by the Project should ensure that the provision of the ecosystem service will be maintained over the lifetime of the Project. A potential Project impact of **moderate** significance on the supply of this ecosystem service is predicted.

The application of the recommended mitigation measures, particularly the incorporation of engineered design features to ensure that water flows in impacted wetland systems and sub-surface flows are maintained, will reduce the extent of any potential impacts and limit their duration, however the sensitivity of the ecosystem service will remain medium; a potential Project impact of **moderate** significance is predicted for this ecosystem service, post-mitigation.

9.7 Water Purification and Waste Treatment

Many beneficiaries within the Project Area of Influence obtain their drinking water directly from sources including Lake Albert, rivers, streams, wetlands and swamps. The role that ecosystems such as wetlands play in the removal of harmful pollutants such as metals and organic materials from surface water systems is important in the context of the lack of formal water treatment systems. Lake Albert also plays a role in the assimilation of nutrients in surface water systems associated with the lack of human sanitation facilities in the region.

The amount of wetland cover being directly lost to the footprint is minimal in the context of the available resource in the Project Area of Influence. However, where wetlands are being intersected by linear infrastructure such as roads and the pipeline route, there is a potential for the downstream wetland habitat to be affected if proper management controls are not implemented, particularly during construction. Even with appropriate measures in place, erosion of wetlands is expected to take place downstream of pipeline and road crossings, and flooding upstream of crossings. Indirect Project impacts may put pressure on Lake Albert's capacity to deliver this ecosystem service, namely the presence of approximately 22,000 people on the Buhuka Flats and other nearby villages who do not currently have access to running water and sanitation. The effect of which is currently unknown but may extend regionally, should the water quality of Lake Albert and its capacity to supply water purification services be impacted. The overall potential Project impact magnitude on this ecosystem service is thus expected to be **high**.

The sensitivity of the ecosystem service to Project impact is **medium**, as although additional pressures on the nutrient loading of Lake Albert from the expected population influx cannot be readily predicted; the ecosystem service is substitutable with the development of appropriate water treatment and sanitation facilities, which will be addressed by the Influx Management Plan for the Project . The overall significance of potential Project impacts on this ecosystem service is thus considered **high**.

The incorporation of appropriate wastewater treatment and suitable sanitation facilities at the Project, as well as the Influx management plan will reduce the magnitude of Project impact on this ecosystem service where it is provided by Lake Albert. Appropriate mitigation to maintain wetland functioning in areas that will be intersected by the pipeline will also contribute to reduced impact magnitude. However, the sensitivity of the ecosystem service remains the same, therefore a post-mitigation impact of **moderate** significance is predicted.

Table 15: Impacts on Regulating ecosystem services

Ecosystem Service	Potential Project Impacts	Pre-mitigation			Post-mitigation		
		Magnitude	Sensitivity	Significance	Magnitude	Sensitivity	Significance
Regulating Air Quality (Type II)	Loss and degradation impacts on wetlands and vegetation of escarpment and Bugoma Central Forest reserve may reduce the capacity of these ecosystems to supply this ES Reduction in supply of this ES may reduce social license to operate due to beneficiary perception that the Project is the cause, despite application of mitigation measures	Low - 2	High - 4	Moderate - 8	Negligible - 1	Low - 2	Minor - 2
Regulating Water Flows and Timing	Placing Project infrastructure within and intercepting wetlands, rivers, streams and drainage lines will both reduce the surface area of these land cover types, reducing their ability to regulate water flows	Medium - 3	Medium - 3	Moderate – 9	Low - 2	Medium - 3	Moderate - 6
Water Purification and Waste Treatment	The role that wetlands play in water purification and waste treatment, in the context of limited formal water treatment systems is likely significant Amount of wetland land cover being directly lost to the footprint is minimal in the context of the available resource in the Project Area of Influence, however indirect impacts on wetland functioning that may occur Indirect Project impacts on Lake Albert nutrient assimilation capacity due to population influx and lack of sanitation facilities	High - 4	Medium - 3	Major - 12	Moderate - 2	Medium - 3	Moderate - 6

9.8 Ethical and Spiritual Values; Educational and Inspirational Values

These ES are considered together given that they are rooted in the same cultural landscapes and are potentially affected and demanded by the Project in the same ways. These ecosystem services may be impacted by the Project, and the Project also relies on the maintenance of the supply of these ecosystem services in order to prevent potential impacts on its social licence to operate.

Ethical and Spiritual Values, and Inspirational Values as a Type I Priority ES

Sacred sites and intangible cultural heritage are inextricably linked with the landscapes and natural ecosystems of Lake Albert and the escarpment, and are important in terms of beneficiaries' sense of identity and heritage. The Project will impact these ecosystem services due to changes as a result of loss of areas of natural ecosystems, and the visual presence of the Project itself in these landscapes; both of which are expected to limit the beneficiaries' capability to benefit from this ecosystem services.

The potential Project impact on the supply of these ecosystem services will have a **medium** magnitude, as the effect will likely extend to beneficiaries in the Project Area of Influence, and will last for at least the duration of the Project and probably longer than that – it is probable that even if the Project footprint is rehabilitated post-decommissioning, the escarpment road will remain, and the landscape of Lake Albert and the escarpment will have changed irreversibly, and associated intangible cultural heritage such as oral histories of places though expected to continue, will become modified in future generations.

The sensitivity of these ecosystem services is **high** as they are irreplaceable, based as they are on the Lake Albert and escarpment landscapes as they stand and have stood for generations. The overall significance of the potential Project impact on these ecosystem services is thus considered **major**.

The application of mitigation measures can reduce the magnitude of Project impacts. However, the sensitivity of the ecosystem service remains high as it is essentially irreplaceable. A post-mitigation impact of **moderate** significance is predicted.

Ethical and Spiritual Values, and Inspirational Values as a Type II Priority ES

The Project relies on the continued supply of these ecosystem services to maintain its social licence to operate, granted by the local community who gains most from these ecosystem services.

The magnitude of potential effects on the Project due to its reliance on the continued supply of this ES to maintain its social license to operate are **medium** – the Project's operational performance could be moderately affected if beneficiary disaffection and social unrest due to loss of integrity of sacred sites begins to impact the Project's social licence to operate.

The sensitivity of the Project to changes in this ES is **high**, as the supply of this ES by the culturally significant landscapes of Lake Albert and the escarpment are not substitutable. The overall significance of potential impacts on the Project due to its dependence on this ES is therefore **major**.

The application of mitigation measures can reduce the magnitude of Project impacts. However, the sensitivity of the ecosystem service remains high as it is essentially irreplaceable. A post-mitigation impact of **moderate** significance is predicted.

Table 16: Impacts on Cultural ecosystem services

Ethical and spiritual values, and Inspirational values	Potential Impacts	Pre-mitigation			Post-mitigation		
		Magnitude	Sensitivity	Significance	Magnitude	Sensitivity	Significance
Type I	The Project will impact these ES due to changes as a result of loss of areas of natural ecosystems, and the visual presence of the Project itself in these landscapes	Medium - 3	High - 4	Major - 12	Low -2	High - 4	Moderate - 8
Type II	Potential reduction in the value of this ES for beneficiaries may adversely affect the Project's social license to operate	Medium - 3	High - 4	Major - 12	Low -2	High - 4	Moderate - 8

10.0   RECOMMENDED MITIGATION AND MONITORING MEASURES

Mitigation measures provided in the following sections include those from specialist studies that are specific to potential impacts on the supply of ecosystem services, and suggested additional mitigation measures based on the guidance provided by IPIECA/OGP for oil and gas project impacts and dependencies on ES (IPIECA, 2011). The recommended mitigation measures are presented in Table 17.

Table 17: Mitigation measures for impacts on Priority Ecosystem Services

Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Responsible Entity	Training Necessary
■ *Food Provision – Grazing for Livestock*				
Economic displacement experienced by impacted herding communities has been addressed in terms of the IFC Performance Standard 5 through development of an appropriate Resettlement Action Plan (RAP). The RAP includes provision in the entitlement matrix to compensate people with customary rights for loss of grazing The RAP may require a specialist livestock assessment and management component to address impacts to livestock.	■ As stipulated in RAP	-	CNOOC	-
A livelihood restoration plan or similar should be developed to specifically formulate mitigation strategies for the loss of grazing land	■ Livelihood Restoration Plan to be commissioned		CNOOC	-
Support of sub-county administration strategies to solve regional farming difficulties such as crop failure due to disease and drought (e.g. introduction of modern farming methods, training farmers in post-harvest techniques, and sensitising farmers about land degradation) as part of the Community Development Plan/Corporate Social Responsibility initiatives	■ Community development plan to be commissioned.	-	CNOOC	-

Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Responsible Entity	Training Necessary
The Project could support the local economy by sourcing food locally, where feasible	■ Community development plan to be commissioned.	-	CNOOC	-

■ *Food Provision – Capture Fisheries*

Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Responsible Entity	Training Necessary
An influx management plan will be developed to address appropriate measures to mitigate the expected Project-associated in-migration effects on capture fisheries	■ Monitoring measures described in the plan	As required	CNOOC	-
Enforcement of a complete ban on wildlife harvesting (hunting/ trapping/ fishing) for all Project personnel	■ No personnel and/or contractors allowed beyond footprint of Project	As required	CNOOC and Contractors	Inductions for all staff
Inclusion of a construction camp with mess facilities for locally-hired staff	■ -	-	CNOOC	-

■ *Food Provision – Wild Foods*

Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Responsible Entity	Training Necessary
Supporting local communities in developing sustainable farming, ecotourism or other activities that provide alternative food sources and income	■ Livelihood Restoration Plan to be commissioned	-	CNOOC	-
Support scientific studies and monitoring programs aimed at assessing the sustainability of using local resources, as part of Corporate Social Responsibility initiatives	■ -	-	CNOOC	-
Enforcement of a complete ban on wildlife harvesting (hunting/ trapping/ fishing) for all project personnel	■ No personnel and/or contractors allowed beyond footprint of Project	-	CNOOC and Contractors	■ Inductions for all staff

Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Responsible Entity	Training Necessary
Worker and community education programme focussing on the impacts and risks of bush meat hunting (e.g. disease) to be incorporated into the Community Development Plan	■ Community development plan to be commissioned	-	CNOOC	-
Inclusion of a construction camp with mess facilities for workers	■ -	-	CNOOC	-
■ *Biological Raw Materials – construction material for traditional houses*				
Inclusion of a construction camp with accommodation facilities for workers in Project plan	■ -	-	CNOOC	-
Support scientific studies and monitoring programs aimed at assessing the sustainability of using local resources for home construction	■ -	-	CNOOC	-
■ *Biological Raw Materials – aggregates for construction of Project facilities*				
Avoid aggregate extraction in areas of natural habitat or in the vicinity of sites of cultural heritage importance; target aggregate extraction for areas already in degraded state such as subsistence cropland within the Project footprint	■ -	-	CNOOC	-
Develop a procurement strategy that encourages use of locally-source aggregates, but that involves mechanisms for assessing or maintaining the sustainability of the supply.	■ -	-	CNOOC and Contractors	-
■ *Biomass Fuel – fire wood and charcoal*				
Supply of cheap alternatives (e.g. gas) to local markets by CNOOC to be investigated	■ -	-	CNOOC	-

Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Responsible Entity	Training Necessary
Support scientific studies and monitoring programs aimed at assessing the sustainability of using commercially-planted forms of biomass fuel, such as Jatropha	■ Livelihood Restoration Plan to be commissioned	-	CNOOC	-
Enforcement of a complete ban on harvesting of fire wood at for all project personnel	■ No personnel and/or contractors allowed beyond footprint of Project	-	CNOOC and Contractors	Inductions for all staff
■ *Fresh Water (Type I)*				
Implement appropriate water pollution control measures such as oil interceptors, treatment of sewerage and hydrotest discharge	■ As per Surface Water report	-		-
Assessment of the natural capacity of Lake Albert to provide waste assimilation services, and insurance through monitoring and analysis that these are not exceeded	■ Monitoring of lake water quality once assimilation capacity has been calculated	■ As required	CNOOC	-
The development of an Influx Management Plan will identify appropriate measures to mitigate the expected increased waste-loading to surface water systems as a result of in-migration due to the presence of the project.	■ Monitoring measures described in the plan	■ Monitoring frequency described in the plan	CNOOC	-
■ *Fresh Water (Type II)*				
Contribute to water catchment management in association with other Projects in neighbouring exploration blocks to promote equitable sharing of fresh water resources of Lake Albert	-	-	CNOOC	-

Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Responsible Entity	Training Necessary
■ _Regulating Air Quality_				
Loss of vegetation and wetland ecosystems to the Project footprint and associated indirect effects to be addressed by the mitigation measures recommended in the Biodiversity Impact Assessment and the Surface Water Impact Assessment	■ As per Surface Water and Biodiversity Impact Assessments	As required	CNOOC	-
Dedicate a portion of the land used for the project for native forest, and/ or invest in replacing or protecting CO2 sequestration/storage services in the immediate area, as part of Corporate Social Responsibility initiatives	-	-	CNOOC	-
Assess the relative importance of natural air quality regulatory services within the Project Area of Influence, and design infrastructure to accommodate and enhance such services where feasible.	-	-	CNOOC	-
Community education programmes on pollution prevention and monitoring schemes. Promotion of CNOOC corporate social responsibility initiatives	-	-	CNOOC	-
■ _Regulating Water Flows and Timing_				
Where possible, avoid or enhance natural barriers such as wetlands before investing in man-made replacements.	■ As per Surface Water and Biodiversity Impact Assessments	As required	CNOOC	-

Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Responsible Entity	Training Necessary
Mitigation measures outlined in the Surface Water Impact Assessment and Biodiversity Impact Assessment report include the incorporation of engineered design features to ensure that water flows in impacted wetland systems are maintained. Mitigation measures should be applied as recommended.	■ As per Surface Water and Biodiversity Impact Assessments	As required	CNOOC	-

■ *Water Purification and Waste Treatment*

Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Responsible Entity	Training Necessary
Minimising the amount of wetland being directly lost to the Project footprint will contribute to reduction of potential impacts on the supply of this ES. Appropriate engineered mitigation measures at wetland and riparian crossings along the pipeline route, which maintain surface and subsurface flows and subsequently the integrity of these systems will also contribute to minimisation of potential impacts	■ As per Biodiversity Impact Assessment	■ As required	CNOOC	-
Assessment of the natural capacity of Lake Albert and Project-affected wetlands to provide water filtration and waste assimilation services, and insurance through monitoring and analysis that these are not exceeded	■ Monitoring of lake water quality once assimilation capacity has been calculated	■ As required	CNOOC	-
Appropriate sewerage facilities and wastewater treatment systems to be put in place at construction camp and at long-term operational Project facilities	■ Monitoring of quality of wastewater discharge	■ As required	CNOOC	-
The development of an Influx Management Plan will identify appropriate measures to mitigate the expected increased waste-loading to surface water systems as a result of in-migration due to the presence of the project.	■ Monitoring measures described in the plan	■ Monitoring frequency described in the plan	CNOOC	-

■ *Cultural Heritage Ecosystem Services*

Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Responsible Entity	Training Necessary
In accordance with IFC PS8 (Cultural Heritage), where the Project may significantly impact on **critical cultural heritage** that is essential to the identity and/or cultural, ceremonial, or spiritual aspects of beneficiaries' lives, priority will be given to the avoidance of such impacts.	■ Avoid development in areas identified as spiritual or sacred sites	-	CNOOC	-
Where significant project impacts on **critical cultural heritage** are unavoidable, the client will obtain the free, prior and informed consent (FPIC) of the Affected Communities, as per IFC PS8 and PS1 requirements	■ Undertake a process of Informed Consultation and Participation of the affected communities	-	CNOOC	-
Protection of the environmental setting for sacred sites close to construction / operation areas	■ No personnel and/or contractors allowed beyond footprint of Project ■ Designated no-go areas, e.g., sacred sites, ritual sites ■ Screening planting around Project facilities to protect views	■ As required	CNOOC and Contractors	■ Inductions for all staff
Maintaining community access to sacred sites and facilitating respect for local intangible cultural heritage, tradition and taboo will ensure that the negative socio-cultural effects are effectively managed – regular platforms for community liaison are recommended and provisions for such should be made in the Cultural Heritage Management Plan (CHMP)	■ As per CHMP	■ As required	CNOOC	■ Inductions for all staff

Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Responsible Entity	Training Necessary
Cultural sensitivity training to be provided to Project staff and incorporated into the site induction process	■ As per CHMP	■ As required	CNOOC and Contractors	■ Inductions for all staff

11.0 CONCLUSION

The Project will affect beneficiaries of priority ecosystem services in two main ways; the physical presence of the Project infrastructure, and population influx associated with the construction and operation of the Project.

The presence of the Project infrastructure will cause land cover changes and associated loss of supply of ecosystem services; it will also change the physical landscape of the area which lends itself to the cultural heritage value of Lake Albert and the escarpment to local communities. Population influx of job-seekers, and people seeking to provide commercial services to the increasing population, will increase demand for ecosystem services, and therefore increase pressure on the ecosystems that supply these services.

Other than the actual direct and indirect effects of Project activities, maintenance of the Project's social licence to operate from affected beneficiaries is critical. Local people perceive that oil exploration projects have affected fish stocks in Lake Albert and that air quality has deteriorated as a result of oil-related commercial activity in the area. It is therefore crucial that the mitigation hierarchy is followed and all efforts to avoid impacts on Lake Albert water quality, air quality and sites of cultural heritage value are made.

Where avoidance of impacts is impossible, application of the recommended mitigation measures is crucial. In particular, worker and community education programmes are key in both maintaining CNOOC's social licence to operate in the area, and educating beneficiaries to promote sustainable use of the ecosystem services that they rely on. Appropriate resettlement action plans, livelihood restoration plans and influx management plans are key mitigation measures to ensure that the beneficiaries that are most reliant on priority ecosystem services within the Project Area of Influence are suitably accommodated.

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APPENDIX A

Prioritisation of ES according to Project Impact

PRIORITISATION OF ES ACCORDING TO PROJECT IMPACT

Priority ecosystem services are those services for which the answers to questions 1 and 2 are "Yes" or "Unknown", **and** "No" or "Unknown" to question 3.

Impact prioritisation spreadsheet

Ecosystem Service	Potentially affected beneficiaries	Potentially affected benefits	1. Could the project affect the ability of others to benefit from this ES? (Y/N/?)	2. Is this ES important to beneficiaries' livelihoods, health, safety or culture? (Y/N/?)	3. Do beneficiaries have viable alternative to this ES? (Y/N/?)	Priority ES 1 = Priority 0 = Non-priority
Provisioning						
Food – Subsistence crops	Pipeline route community	Income, livelihoods, food intake	Y	Y	?	1
Food - Grazing for Livestock	Buhuka Flats community	Reduced grazing area due to Project land-take and increased pressure from population influx will reduce grazing availability, which may limit the ability of people to raise livestock for subsistence and livelihood purposes	?	Y	N	1
	Migratory herders	As above	?	Y	N	1
Food – Capture fisheries	Buhuka Flats community	Income, livelihoods, food intake	Y – stakeholder perception that the Project will affect fish stocks, increased demand from population influx	Y	N	1
Food – wild foods	Pipeline route community	Reduced bush meat availability due to reductions in woodland/bush land cover that supports hunted species Reduced vegetation cover may limit bee's ability to produce honey and honey production	?	Y	?	1
Biological raw materials – construction of traditional houses	Buhuka Flats and Pipeline route communities	Ability to construct homes and animal shelters	?	Y	Y	0

Ecosystem Service	Potentially affected beneficiaries	Potentially affected benefits	1. Could the project affect the ability of others to benefit from this ES? (Y/N/?)	2. Is this ES important to beneficiaries' livelihoods, health, safety or culture? (Y/N/?)	3. Do beneficiaries have viable alternative to this ES? (Y/N/?)	Priority ES 1 = Priority 0 = Non-priority
Biological raw materials – extraction of aggregates for Project Construction	The Project Buhuka Flats and Pipeline route communities	Landscape value and spiritual and inspirational values Impacts via land take of ecosystems that may provide priority ecosystem services	?	Y	N	1
Biomass fuel – wood and charcoal	Buhuka Flats and Pipeline route communities	Energy sources for cooking, fish processing, brick making	Y	Y	Y – most fuel sources in Project area of influence have been exhausted and charcoal and fire wood are purchased	1
Fresh water	Buhuka Flats and Pipeline route communities	Availability and quality of fresh water for drinking may be compromised by abstraction from Lake Albert and interception of sources by the pipeline	Y – stakeholder perception that the Project will affect water quality	Y	N	1
Medicinal plants	Buhuka Flats and Pipeline route communities	Availability of traditional medicines	N – areas of forest and grassland loss to footprint in context are minimal	n/a	n/a	0
Regulating						
Air quality	Buhuka Flats and Pipeline route communities	Project effects on ecosystems that provide this ecosystem service are negligible in the context of available unaffected areas in LSA	N	n/a	n/a	0
Water flows and timing	Buhuka Flats community	Wetlands and the unique hydrological system of the Buhuka Flats may be disturbed/interrupted	Y	Y	N	1
Soil stability & erosion control	Buhuka Flats community	Vegetation clearance for construction may reduce the ability of the surrounding soils to withstand erosive forces of wind and floods	N	n/a	n/a	0

Ecosystem Service	Potentially affected beneficiaries	Potentially affected benefits	1. Could the project affect the ability of others to benefit from this ES? (Y/N/?)	2. Is this ES important to beneficiaries' livelihoods, health, safety or culture? (Y/N/?)	3. Do beneficiaries have viable alternative to this ES? (Y/N/?)	Priority ES 1 = Priority 0 = Non-priority
Water purification and waste treatment	Buhuka Flats and Pipeline route communities	Disturbance of wetlands by proposed infrastructure may impact the integrity of wetlands and their ability to provide ES Population influx may increase nutrient loading and pressurise assimilative capacity of Lake Albert	Y	Y	N	1
Cultural						
Recreation and ecotourism	Buhuka Flats community	Tourism associated with oil company staff is currently developing – development may ultimately be restricted by Project presence and visual impact effects	Y	N	n/a	0
Ethical and spiritual values	Buhuka Flats community	Sacred sites and intangible cultural heritage are intrinsically linked with natural ecosystems such as wetlands, rivers, lake and forests and substantially contribute to beneficiaries' sense of identity	Y	Y	N	1
Educational and inspirational	Buhuka Flats community	the Lake Albert and Escarpment landscapes inspire folklore and contribute to beneficiaries' sense of heritage and identity	Y	Y	N	1

APPENDIX B

Prioritisation of ES according to Project Demand

PRIORITISATION OF ES ACCORDING TO PROJECT DEPENDENCE

Priority ES are those services for which the answers to question 1 is "Yes" or "Unknown", **and** "No" or "Unknown" to question 2. If the answer to question 1 is no, it is automatically a non-priority ecosystem services. Changes in an ecosystem services can be driven both by causes of ecosystem change external to the Project and by the Project's own impacts.

Priority ecosystem services according to the extent of Project Demand

Ecosystem Service	1. Could this ES change in ways that will affect operational performance (Y/N/?)	2. Does the Project have viable alternatives to this ES (Y/N/?)	Priority ES 1 = Priority 0 = Non-priority
Provisioning			
Food – Subsistence crops	N	n/a	0
Food - Grazing for Livestock	N	n/a	0
Food – Capture fisheries	N	N	0
Food – wild foods	N	n/a	0
Biological raw materials – aggregate extraction for Project facility construction	?	N	1
Biomass fuel – wood and charcoal	N	n/a	0
Fresh water	Y – stakeholders perceive that the Project may impact the quality of water, therefore the Project is reliant on the quality and quantity of freshwater remaining constant throughout its lifetime in order to maintain its social license to operate. Cumulative impact of abstraction by other projects unknown	N	1
Medicinal plants	N	n/a	0
Regulating			
Air quality	? – stakeholders perceive that the Project may impact the air quality, therefore the Project is reliant on the quality of air remaining constant throughout its lifetime in order to maintain the social license to operate	N	1

ECOSYSTEM SERVICES ASSESSMENT

Ecosystem Service	1. Could this ES change in ways that will affect operational performance (Y/N/?)	2. Does the Project have viable alternatives to this ES (Y/N/?)	Priority ES 1 = Priority 0 = Non-priority
Climate regulation	Y – the expected changes in climatic conditions over the lifetime of the Project could lead to a rise in Lake Albert's water level, which would result in flooding of the flats, which could affect operational performance	Y – design and engineering mitigation measures take into account flood and climate modelling predictions	0
Water flows and timing	Y – Soils, wetlands and drainage lines influence the timing and magnitude of water runoff, flooding and aquifer recharge. The Project will affect wetlands and drainage lines which may cause flooding on the Buhuka Flats, which could affect operational performance	Y – engineering mitigation measures to manage surface and sub-surface flows in the construction and operation phases of the Project are considered sufficient to reduce potential impacts to neglible significance	0
Soil stability & erosion control	Y – predicted rise in the level of Lake Albert over the Project lifetime could lead to an increase in erosion of the shoreline, thereby reducing the width of the Flats and increasing flood likelihood. Vegetation removal for site clearance could also contribute	N – Engineered measures for the control of erosion arising from vegetation removal are considered sufficient to minimise the impacts of vegetation clearance. The Project, in compliance with the requirements of IFC Performance Standards 1 and 3, has undertaken predictive modelling to ensure that the Project's operational performance will not be put at risk by rises in Lake Albert's level	0
Water purification and waste treatment	Y - Nutrient assimilative capacity of the lake may reach thresholds, resulting in eutrophication	Y – Project incorporates a water treatment system which can be used as necessary	0
Cultural			
Recreation and ecotourism	N	n/a	0
Ethical and spiritual values	Y – the Project is reliant on the availability of this ES remaining constant throughout its lifetime in order to maintain its social license to operate	N – there are no alternatives to the presence of the Project in the landscape	1
Educational and inspirational	? – the Project could be reliant on the availability of this ES remaining constant throughout its lifetime in order to maintain its social license to operate	N – there are no alternatives to the presence of the Project in the landscape	1