Assessment summaries and management plans

Proposed new plantings by Ramu Agri Industries in Zifasing and Tararan, Morobe Province, Papua New Guinea

First submission: 21 August 2018
Second Resubmission: 5 October 2018
Third Resubmission: 18 October 2018

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Acronyms

ADB	Asian Development Bank
ALS	Assessor Licensing Scheme
ANZ	Australia and New Zealand Banking Corporation
AOI	Area of Interest
BSP	Bank of South Pacific
CG	HCV Resource Network Common Guidance
CHS	Community High School
CPO	Crude Palm Oil
DEM	Digital Elevation Model
DFAT	Department of Foreign Affairs and Trade (Australian Government)
ECE	Early Childhood Education
EFB	Empty Fruit Bunch
EIS	Environmental Impact Statement
FFB	Fresh Fruit Bunch
FGD	Focus Groups Discussion
FPIC	Free, Prior and Informed Consent
FSC	Forest Stewardship Council
GIS	Geographical Information Systems
Ha	Hectare
HCS	High Carbon Stock
HCV	High Conservation Value
HCVA	High Conservation Value Area
HCVMA	HCV Management Area
IAIA	International Association for Impact Assessment
IUCN	International Union for Conservation of Nature
MOU	Memorandum of Understanding
MP	Member of Parliament
NBPOL	New Britain Palm Oil Limited
PKE	Palm Kernel Expeller
PKO	Palm Kernel Oil
POIG	Palm Oil Innovation Group
RAI	Ramu Agri Industries
RSPO	Roundtable on Sustainable Palm Oil
RSPO	Roundtable on Sustainable Palm Oil
RTE	Rare, Threatened or Endangered
SDA	Seventh Day Adventist
SIA	Social Impact Assessment
SOP	Standard Operating Procedures

TOR	Terms of Reference
UNICEF	United Nations Children's Fund
WWF	World Wide Fund for Nature

1. Overview and background

A new development is proposed by Ramu Agri Industries (RAI). RAI is an agricultural company with oil palm, sugar cane and beef cattle estates. RAI is owned by New Britain Palm Oil Limited which is wholly owned by Sime Darby Plantation. RAI's oil palm plantations are located in Madang and Morobe Province, Papua New Guinea. The proposed development is within Morobe Province and will potentially augment the existing plantations by **5998.77 ha** of oil palm plantations and **409.12** ha of HCV/HCS management area, a total potential development and conservation area of **6407.89 ha.**

1.1 Overall location

The project located in the Wampar Rural Local Level Government (LLG) area of Huon Gulf District (HGD), which is one of the nine districts that make up Morobe Province. It is bound within following top left and bottom right coordinates, 146.468° E/6.504 ° S and 146.657° E/6.652 ° S.

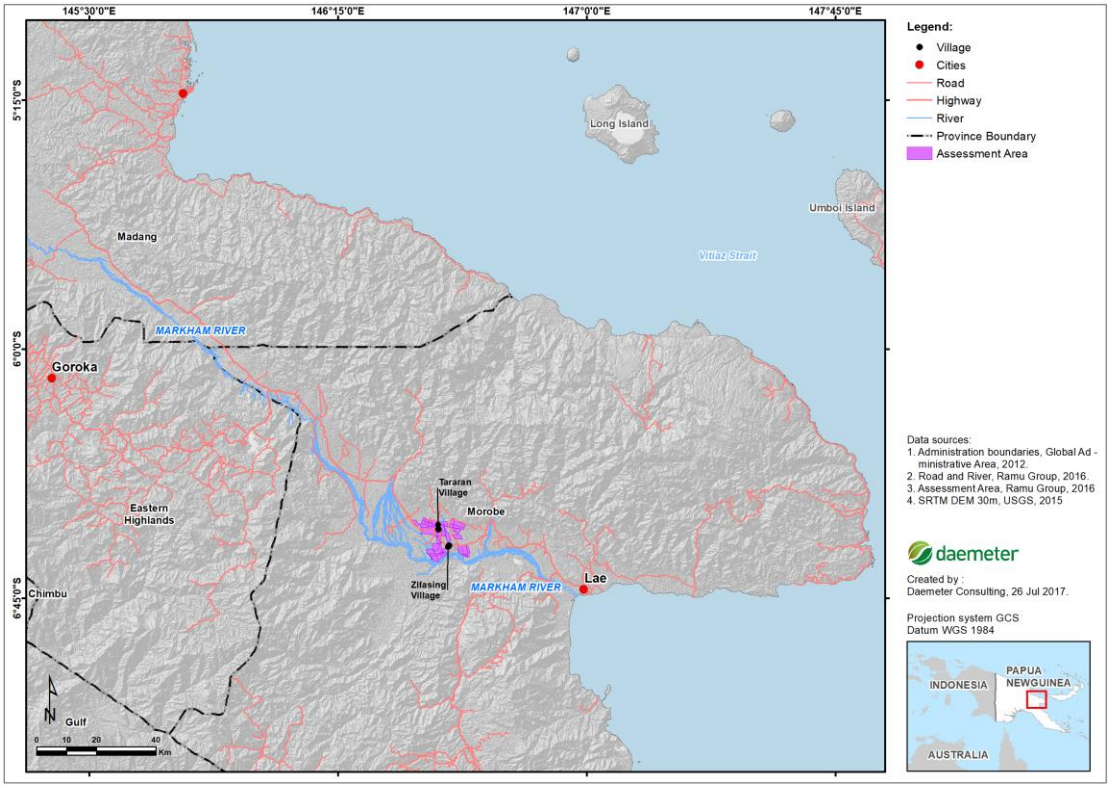


Figure 1 Overall assessment areas

1.2 General physical description land scape

The Markham valley overlays the Ramu-Markham fault which extends eastward and merges with the submarine New Britain trench. The towering still growing Finisterre Range to the North and the vast ranges of the Eastern Highlands have produced the alluvium which covers

the Ramu and Markham Valley floor. Although the rate and intensity of these geomorphological processes have subsided, tectonic activity and high rainfall in the ranges can still cause massive erosion, flooding and deposition of material in the valley. Planning for human habitation and land use such as agriculture in the valley must account for these incessant natural processes.

1.3 Description of proposed areas

There are 6 separate areas that are currently being proposed for new development. The areas were chosen because the land owners approached NBPOL to express their interest in a joint venture to develop their land and the current land cover allows for a land use conversion that is consistent with the NBPOL Forest Policy, committing to no deforestation through the High Carbon Stock Approach. The landscape here is mostly grassland or vegetated by Rain Trees (*Samanea saman*) a tree species introduced as part of the cattle industry which dominated this region in the 1970s.

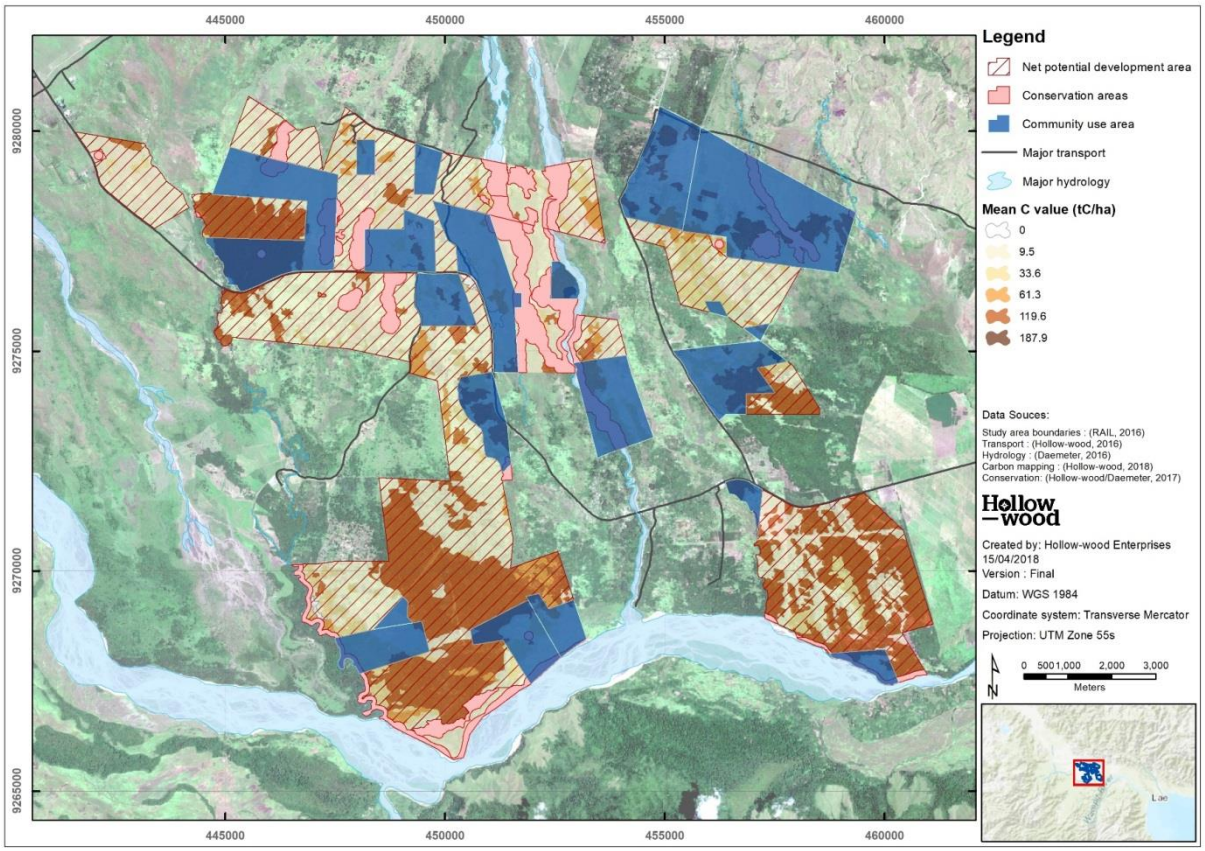


Figure 2 Gross assessment areas and net potential development areas

Note that the overall areas assessed are greater than the areas proposed for development. This is due to the iterative FPIC process utilized and the results of the feedback from the landowners resulting in the specific areas of their land they want to convert into oil palm plantations. Because the landowners participated in all the baselines studies: SEIA, HCV, HCS they were informed of the outcomes of this and the implications for land use potential that the safeguards represents. The safeguards include areas not available for conversion because of their High Conservation or High Carbon Stock values and “community use” areas that the land owners wanted to keep available for food production and housing. The resulting areas

reported on in this New Planting submission are those that landowners have offered for development. They represent their Free and Prior Informed decision on what areas they would like NBPOL develop in a joint venture with them.

The assessed area was detected to contain swamps, small secondary forest patches and rivers that run through and adjacent area assessed. Rivers are also source of water and fish for the community needs. Additionally, there were a number of old villages, cemeteries and sacred places (ples masalei) within the development area.

2. Assessment process and methods

2.1 Process overview

As explained, the process applied in this NPP varies from the New Planting Procedure as the final areas proposed for development is a subset of the total areas assessed. This approach is required due to the land tenure and resulting land acquisition process in Papua New Guinea. In Papua New Guinea concessions are not granted, instead legal permission to develop the land is granted by the Government and land user rights are authorized by the recognized indigenous landowners. The first and last decision on land use is made by the indigenous land owners. As such when they gave their first expression of interest it was only an indication of the potential area for development. Once the entire FPIC process was conducted, a process that took over two years to complete, the landowners had a better understanding of the social and environmental safeguards that NBPOL respects. As a result of this process, they made an informed decision on the lands they wanted to include in this submission.

In order to clarify that the current approach is the best option for the land tenure in Papua New Guinea, a brief clarification follows. The baseline studies, SEIA, HCV, HCS, LUCA and Soil Suitability studies cover a larger area than currently proposed. They have all been conducted to the highest standard and in compliance with the current New Planting Procedure. This approach allowed landowners to fully appreciate the advantages and disadvantages of following this best practice approach and make an informed decision on those areas they would like to lease to NBPOL for management as oil palm plantations and conservation. Part of this process included setting aside “community use” areas which landowners delineated in order to allow for their traditional production of food and residential expansion. Note that these areas exceed the minimum of 0.5ha per person over the lease period as per the High Carbon Stock Approach requirement. In addition, the some of the conservation areas as identified in the previously mentioned assessments are included in the areas leased for management by NBPOL. The Management Plans and Carbon Stock/Emission statements are restricted to these areas as these are the areas they will transfer land rights and management control over.

2.2 Scope

As mentioned above, the scope of the current submission is a subset of the entire area which was covered in the original baseline biophysical and social impact studies as required under the current New Planting Procedure[1]. This approach is utilized because in Papua New Guinea and much of the rest of Melanesia, concessions are not granted by the government and authorization to develop land must come from the indigenous landowners. In Papua New Guinea indigenous traditional land rights are recognized in the Constitution. As such the first and last authorization of the process of conducting a feasibility study to transferring temporary land user rights for an oil palm development lies entirely with the traditional

[1] As approved by the RSPO Board of Governance November 2015

landowners and is guided by their traditions. The FPIC process allowed them to understand the full implications of the development and the current submission is an expression of their desired development option. Note that NBPOL maintains a strict policy of not soliciting their interest in developing land and investigates potential development only after an expression of interest has been placed by verified landowners. In recognition of this the current NPP covers only a subset of the entire study area of the original biophysical and social impact studies that were carried out as per the current New Planting Procedure. The following table summarises the areas included in the original studies and the current submission:

Table 1 Scope of baselines assessments and current submission

Sum of Area_ha	Land Use			
Conserv_Type	Conserve	Develop	Enclave	Grand Total
HCSAF	46.96	0.00	58.38	105.34
HCVMA	646.56	0.00	340.68	987.24
HCVMA & HCSAF	45.28	0.00	29.87	75.15
n/a	21.63	5998.77	3464.69	9485.09
Grand Total	760.43	5998.77	3893.62	10652.82

Table 2 Areas made available by landowners for development (conversion) and conservation

Sum of Area_ha	LandUse		
Conserv_Type	Conserve	Develop	Grand Total
HCSAF	46.96	0.00	46.96
HCVMA	316.88	0.00	316.88
HCVMA & HCSAF	45.28	0.00	45.28
n/a	0.00	5998.77	5998.77
Grand Total	409.12	5998.77	6407.89

Note that the areas in Table 2 will be leased to NBPOL and all the management control handed over to NBPOL. Therefore the Management and Monitoring Plans in this document are restricted to those areas. The High Conservation Management Areas (HCVMA) and the High Carbon Stock Areas (HCSAF) outside of the lease areas will remain under management control of the landowners o and thus are not included in the Management and Monitoring Plans within this NPP.

Forecast of Planting Schedule (updated18 Oct 2018):

No	Land	Area (ha)	Year
1	Ngarugayan	114.87	2019
2	Momem	980.24	2019
3	Orogawi	125.26	2019
4	Yasinaron	232.40	2019
5	Ngaruburub	96.69	2020
6	Ngaromugish	42.34	2020
7	Bampu	52.14	2020
8	Ampamoachech	88.20	2020
9	Ngarobasab	262.31	2020

10	Moto	260.38	2020
11	Mpisugwarup	139.40	2020
12	Gor	567.29	2020
13	Soror 1	234.26	2021
14	Soror 2	621.84	2021
15	Gamegamen	171.69	2021
16	Ngarowafes	476.15	2021
17	Waifampes	253.89	2022
18	Yadzu	103.96	2022
19	Bampurompun	909.96	2022
20	Waiyo	265.50	2022
	Sum	**5998.77**	

2.3 Dates assessments were conducted

The main assessments (SEIA, HCV, and HCS) were conducted between November 2016 -May 2017 with report writing and peer reviewing finalized in May 2018. While the bulk of the field work and data collection was completed by May 2017 there was a required follow up period for the HCV peer review process which took until May 2018 to complete. The HCS/GHG work under the High Carbon Stock Approach requires a completed HCV assessment as such this was only completed once the HCV study was available. An important input to the HCS process was the participative mapping of "community use areas" to be enclaved from the analysis. With this the HCV was completed in January 2017. All of the supporting studies, Soil Suitability Study and Land Use Change Assessment were completed within this same time period. The Green House Gas assessment, which complements the HCS was finalized last, so as to reflect just the areas being proposed for development in the current submission.

2.4 Assessors and FPIC experts and their credentials

2.4.1 HCV Team **(updated 5 Oct 2018)**

Julian Crawshaw is the report writer on the Daemeter team. He is the Senior Forestry and System Manager at Daemeter. He worked as a private consultant in forestry since 2010, conducting various work such as REDD project and other sustainability projects in forestry. He has a Master Degree in Business Systems from Monash University and a Bachelor of Forestry Science from University of Canterbury. He has been working in forestry since 1987.

Jules is an ALS fully licensed HCV assessor (ALS14006JC) and has conducted field work and written reports for in excess of 30 HCV studies throughout Indonesia, Malaysia, Myanmar, PNG and Solomon Is. In all assessments he has either led or taken part in both the biodiversity and social assessments. He was also responsible for Reporting, Mapping & Project Coordination. He has worked on the HCVRN Quality Panel as an auditor.

From 2008 to 2010 he worked for APRIL Group as Strategic Planning Manager in Riau Andalan Pulp & Paper. Jules Crawshaw received 1st place in the NSW Premiers Award for Business Management and Financial Performance in 2005 and also received FNSW CEO Commendation for Management of the Carbon Project in 2006.

Kenn Mondiai assisted this project as a social expert. Kenn is and has been the Executive Director & Technical Community Forestry Specialist at Partners With Melanesians Inc. for the past 15 years. Before that he was a Forestry Officer at WWF, using his experience in the logging industry and forestry education from Unitech to help improve forest management in PNG. Kenn has extensive experience in community land use planning and conservation at both the grass roots, national and international level.

Jeffery Lawrence assisted this project as a vegetation expert. He is the resource manager with Yumicom Ltd. After graduating from the PNG University of Technology with a BSc Degree in Forestry in 2004 Jeffery has 11 years' experience in working in the fields of forestry, the forest industry and conservation in PNG, namely Western Province, Madang, Milne Bay, Central Province, and Popondetta. His work included surveying 10% & 100% ID of trees species, supervising harvesting, leading work place safety in which Jeffery is a certified safety officer and has level 1, 2 & 3. Jeffery was involved in Forestry High Carbon Stock Inventory Survey contracted under NBPOL. Jeffery has also been involved in HCVF within some of the provinces he has worked in. Jeffery has had exposure in all forms of forest related operations which include forest industries and forest conservation, and working with recognised NGO's. He has been involved in inputting information with a forest logging company undergoing accreditation under the Forest Stewardship Council. Jeffery's involvement and experience in forestry is vast and wide.

Clement Bailey assisted this project as a vegetation expert. Heis a freelance forester and environmental professional in Papua New Guinea. Clement graduated from PNG University of Technology in Lae, Morobe Province, Papua New Guinea with a BSc (Hons) Forestry in 2003. Clement has 11 years' experience in working in the fields of forestry, conservation and natural resource management in PNG, including preparation of Project Management Plans and project proposals for Provincial Governments, community and private organizations, and feasibility/design proposals including their implementation. Clement has also attained an Advanced Certificate in Project Management at the University of Queensland in 2011 and has been involved in many project management operations in West New Britain. Since 2009, Clement has assisted on HCV assessments with Tom Vigus for potential oil palm developments in PNG on an occasional basis for RSPO certified oil palm companies in PNG. Clement also has vast experience in Forest Certification Audit, Assessment and Implementation for Forest Stewardship Council (FSC) Certified Projects in PNG. He is currently providing advisory and consultancies in the management of public utilities programs for the West New Britain Provincial Government, specific to water supply and water resource management.

Indrawan Suryadi is the GIS and Remote Sensing Manager at Daemeter Consulting, with more than a decade of experience in spatial analysis, geo-information management and remote sensing application and applied his experience in this project.

He graduated from the Faculty of Forestry at the Bogor Agricultural University in 2002 and secured a scholarship from the Dutch Government to attend the Professional Course on Geo-information Management in International Institute for Geo-information Science and Earth Observation (ITC) in Enschede, the Netherlands, in 2005.

Indra has previously worked on spatial analysis using GIS as well as geo-database management in various organisations, including the Center for International Forestry Research (CIFOR), the Nature Conservancy (TNC) in Kalimantan and Sulawesi, Tropenbos International, and Daemeter. Indra's last positions were with UNDP-REDD+ Task Force and FAO-UNREDD

programme as an REL/MRV consultant, working on issues including spatial analysis related to land cover monitoring, carbon accounting, and the development of reference emission levels.

Michael Hansby assisted as a vegetation expert in this project. He is a forester by profession and owns a small consultancy specialising in forest inventory and remote sensing. Michael has a Bachelors degree in Forest Science from the Australian National University and a Post Graduate Diploma in Bushfire Management from the University of Melbourne. Michael has over 10 years experience in vegetation assessment in a range of forested ecosystems, including the temperate wet forests of Victoria and NSW and the tropical forests of the Solomon Islands, Papua New Guinea and Cambodia.

Michael has worked in Australian native forestry (specialising in native forest silviculture), fire management planning and more recently has conducted High Carbon Stock Approach (HCSA) assessments in Papua New Guinea and the Solomon Islands.

Aji Sartono is a GIS technician at Daemeter Consulting, with almost a decade of experience working in a number of consulting firms and research organisations in Indonesia. He has extensive knowledge on mapping across the archipelago as well as in geo-database development and maintenance.

Aji holds a degree and a diploma from the Forestry Faculties at the Winayamukti University in Bandung and Bogor Agricultural University (IPB), respectively. He developed a case study in Tegal, Central Java, and conducted spatial analysis of urban forest as the thesis for his bachelor degree

Mellie Musonera assisted as a birds and mammals expert in this project. He is a Conservation Biologist from Papua New Guinea (PNG). He has been working as a freelance consultant since 2013. He has a Masters Degree in Conservation Biology from the University of Kent, an Honours Degree (First Class) and a Bachelor of Science in Biology from the University of Papua New Guinea. He has been working as a Conservation Biologist since 2005.

Mellie has worked on four HCV assessments so far and has conducted rapid assessments on birds, mammals, amphibians and reptiles.

From 2009 to 2011 he worked as a staff Conservation Biologist with the Wildlife Conservation Society - PNG Program. He covered projects including REDD, biodiversity assessments and research into the endemic Admiralty cuscus in Manus Province, PNG.

Mellie was awarded a Chevening Scholarship to study for a Masters Degree in the United Kingdom in 2008.

Sander van den Ende assisted in this project as conservation planning for NBPOL. He is a forester by training who has worked in conservation, forestry and oil palm for over 15 years. Sander received a BSc in Plant Ecology from the San Francisco State University in Californian and subsequently a Masters in Tropical Forestry from the Wageningen Agricutural University. He has worked to improve the environmental performance of the forestry and agriculture industry in African Latin America, SE Asia and Papua New Guinea/Solomon Islands through conservation science and implementing best practices within the industry through credible certification standards like the FSC and RSPO.

Arison Arihafa is a staff of NBPOL and assisted the project as an vegetation expert, social mapping and logistics planning.

Ura Kamene is a staff of NBPOL and assisted the project in social mapping and logistics.

2.4.2 HCS/GHG Team

Michael Hansby is a forester by profession and owns a consultancy specialising in forest inventory and remote sensing. Michael has a Bachelor degree in Forest Science from the Australian National University and a Post Graduate Diploma in Bushfire Management from the University of Melbourne. Michael has over 10 years' experience in vegetation assessment in a range of forested ecosystems, including the temperate wet forests of Victoria and NSW and the tropical forests of the Solomon Islands, Papua New Guinea and Cambodia. Michael has worked in Australian native forestry (specialising in native forest silviculture), fire management planning and more recently has conducted High Carbon Stock Approach (HCSA) assessments in Papua New Guinea and the Solomon Islands.

2.4.3 SEIA Team

Narua Lovai is an experienced environmental scientist with extensive experience as a consultant carrying out SEIA for both the mining and the oil palm sector in Papua New Guinea. Naura has worked for over 10 years for the PNG environmental authority before becoming a private consultant. His skills include strategic planning, organizational, personnel and financial management, outcomes-based project management, policy formulation and revision, natural resources legislation compilation and revision, baseline environmental data collection, waste management and cleaner technology, water pollution assessment and mitigation, hydrological data acquisition and analysis, integrated catchment management, biophysical environment impact assessment, socio-economic impact assessment, environmental compliance and audit monitoring, stakeholder engagement for community development, and professional writing and editing.

2.5 Methods used for conducting assessments and for conducting the FPIC process

2.4.1 Basic methodology with reference to FPIC

All of the studies were conducted using the highest industry standard which incorporate FPIC as best practice. The following methodologies were utilized for each study:

HCV: The HCV assessment utilized the HCV Resource Network Common Guidance for identifying HCVs across different ecosystems and production systems. The HCV assessor is licensed by the Accredited Licensing Scheme www.hcvnetwork.org/als/assessor-profile/288 .

HCS: The HCS assessment was carried out within the auspices of cooperation with the Tropical Forest Trust (TFT) and utilized the High Carbon Stock Approach http://highcarbonstock.org/ as its guidelines.

SEIA: The SEIA was conducted by a very experienced assessor in line with best practice principles including: assessing direct, indirect and cumulative impacts; acknowledging that social, economic, cultural and environmental impacts are interconnected and cannot be treated in isolation; promotes an open, transparent and participatory process, giving due consideration to women and any vulnerable groups; providing information unique to each

potential expansion site to help ensure community aspirations and concerns, and site-specific impacts, are identified and incorporated in the assessment; providing a focus on social impacts, both positive and negative, that are most significant in the eyes of impacted stakeholders; and specifying management strategies to enhance positive impacts and minimise negative impacts.

2.5.2 FPIC in Papua New Guinea

Due to the nature of land tenure in Papua New Guinea the entire approach for acquiring land rights and maintaining long term security over the investment on that land requires the full participation and consent of the traditional land owners. An important starting point is a requirement that all proposed expansions result from the unsolicited expressions of interest from the landowners. Landownership is verified through local knowledge, which comes naturally as all the proposed areas are close to existing operations. The matter of ensuring the rightful landowners are identified and that all parties with rightful ownership are duly informed is a must so as to secure the long term investment required for agriculture. This includes consulting all sectors of these communities a process which necessarily takes time. These landowners of the proposed area know of oil palm as crop as they are from within a landscape in which oil palm has been established since 2003. However to ensure that they get more exposure to the positive and negative impacts of oil palm, all of the clan members whom lodged expressions of interest were taken to see the NBPOL operations at around 50km. Inclusive to these field trips was a trip to a similar project in which NBPOL has leased land from traditional land owners. As such the clan members were able to make direct contact with a project that serves as a model to their own proposed project. .

2.5.3 SEIA Methodology

The core purpose of the SEIA was to examine the current predevelopment environmental and socio-economic situation, verify observance with the principle of free, prior and informed consent (FPIC) in the preparatory work undertaken by RAIL, identify potential environmental and socio-economic impacts that may occur if the project goes ahead and recommend measures to monitor and manage the impacts.

This SEIA provides: (i) an explanation on the proposed oil palm project and RAIL's hitherto engagement with the local landowners, (ii) a description of the environmental and socio-economic features of the project area, (iii) an evaluation of the impacts that may arise and (iv) an outline of the measures that could be used to mitigate the negative outcomes and enhance the benefits.

The SEIA commenced with a preliminary examination of relevant literature in Port Moresby followed by a one week field-trip to the project area. The field-trip consisted of site inspections and meetings with various stakeholders including land-owner family groups, three heads of households per land-owner family group, public servants based within Zifasing Government Sub-station, Lutheran Church Chairman and Huon District Administration officials.

Meetings with other Christian denominational representatives, Zifasing Ward Councillor and his Tararan Ward counterpart as well as the Medical Officer at Zifasing Aid Post did not eventuate due to the non-availability of these persons. The meetings with the three household representatives per land-owner family group were carried out in the format of a sample socio-economic survey using a structured questionnaire. A total of 43 households were covered in the sample survey across the 15 land portions indicated for commercial lease to RAIL.

The field trip for the SEIA took place in the last week of May 2016. In addition to data collected from primary sources during the fieldtrip, the SEIA has incorporated relevant information from the draft HCV report and draft HCS report as well as other information from various secondary sources identified from an extensive literature search. The social and environment impact assessment and report compilation was conducted in accordance with the Environment Act 2000 (EA 2000), Environment (Prescribed Activities) Regulation 2002 as well as the 2015 RSPO New Planting Procedures (RSPO NPP 2015) and RSPO Principles and Criteria 2013 (RSPO P&C 2013).

The 15 blocks of land covered in this first evaluation phase are owned by family groups from Zifasing Village. The names of the clans, family groups are shown in Table 3.0.

No	**Clan**		**Family group**		**Name of Land portion**
1	Chuaif	(a)	Bampan	(i)	Ngarowafes
				(ii)	Momem
				(iii)	Gamegamen
		(b)	Min	(i)	Waifampes
		(c)	Barag	(i)	Yasinaron
		(d)	Gath	(i)	Ngarosara
2	Orogwangin	(a)	Pateg	(i)	Yadzu
		(b)	Agra	(i)	Bampurompun
3	Orogazog	(a)	Kokwan	(i)	Ngaruburub
4	Owangrompon	(a)	Zegan	(i)	Moto
		(b)	Joseph	(i)	Ampa Moachech
		(c)	Lesorowa	(i)	Orogawi
5	Oroganchon	(a)	Garry	(i)	Waiyo
6	Feref	(a)	Onogore	(i)	Ngaromugish
				(ii)	Bampu
Total	**6 clans**		**12 family groups**		**15 land portions**

Table 3.0 customary land tentatively identified for oil palm agriculture

Field data for this component of the EIA was obtained via meetings held with landowner family group representatives and interviews of members of three households from each landowner family. By the end of the one week fieldtrip, 14 family group meetings had taken place and up to 42 household interviews had been conducted. The majority of the landowning families reside in Zifasing Village and only two namely, Gath and Onogore, stay in hamlets on their respective blocks of land. The list of attendees for the family group meetings and the list of household interviewees are included in the main report.

The key questions posed to the family group representatives are listed below.

(i) Who initiated the idea to invite RAIL to conduct feasibility assessment for oil palm agriculture on the family land?

(ii) Has RAIL conducted any awareness meetings on the proposed oil palm project and RSPO?

(iii) Are there any internal disagreements over the plan to lease family land to RAIL for oil palm agriculture?

(iv) Is there any unresolved land boundary dispute with other families or clans?

(v) Are there any culturally, spiritually or archaeologically significant sites on the land, including old graves?

(vi) Is the land presently inhabited by settlers and/or used for subsistence gardening, market gardening, cultivation of cash crops such as cocoa or extraction of timber and non-timber resources?

(vii) Are family members prepared to occupy paid jobs with the oil palm project?

(viii) Do family members have any concerns, issues or questions regarding the proposed oil palm project?

Meeting with a family group

Interview with a household representative from the same family group

Figure 3 Example of a family group meeting and subsequent interview with a household representative

The various aspects covered in the household interviews are outlined below.

(i) Family size and composition

(ii) House type and size

(iii) Water sources

(iv) Sanitation and waste disposal

(v) Subsistence gardening and nutrition

(vi) Fishing and hunting

(vii) Rearing of chicken, pigs and ducks

(viii) Extraction of timber and non-timber resources

(ix) Education services and related issues

(x) Health services and associated matters

(xi) Income generating activities

(xii) Monthly income and expenditure

(xiii) Socio-economic concerns

2.5.4 HCV Methodology

(updated 5th Oct 2018)

2.5.4.1 Description of the assessment area

NBPOL has a suite of 20 proposed new development areas with a total area of 10,652 ha. These are all planned to be converted to oil palm.

Table 4. List of Proposed Estates that constitutes the Assessment Area

#	CLAN NAME	FAMILY NAME(S)	LAND NAME	Clan lands set aside for Gardens and Community Use	Number of people with a claim on the land[2]	Total Land Area (ha)
1	CHUAIF	Bampan	Ngarowafes		102	767.9
			Momem			1,057.20
			Gamegamen			333.5
		Min	Waifampes		123	265
2	OROGWANGIN (Chivasing)	Pateg	Yadzu		72	204.1
		Agra	Bampurompun		206	1115.5
3	OROGWANGIN (Tararan)	Mela	Soror 1		Not available	378.8
			Soror 2		Not available	708.7
			Gor		Not available	1,374.20
4	OWANGROMPON	Omad	Narubasab		36	388.9
		Zegan	Moto		117	359.5
5	OROGANZONG (Tararan)	Thim	Mpisugwarup		105	751.5
6	JEAGANZONG	Muachets	Ngarugayan		170	193.3
7	FEREF	Onogore	Ngaromugish			798.8
			Bampu		59	372.1
			Total			9069

'*Note there are an additional 134.1 ha of overlaps

Table 5.Ownership of each site by Area (ha). Phase 2.

#	Clan Name	Family Name	Land Name	Clan lands set aside for Gardens and	Number of people with a claim on the land	Total Land Area (ha)

[2] Not all people with a claim on the land live on the land.

				Community Use		
1	CHUAIF	Min	Yasinaron		54	251.0
2	OWANGROMPON	Joseph	Ampa Moachech		140	372.6
		Lesrowa	Orogawi		400	385.2
3	OROGANCHON	Garry	Waiyo		190	330.1
4	OROGAZOG	Kokwan	Ngaruburub		182	110.9
	Total					**1449.8**

The project is located in Morobe Province, on the main island of PNG about 50 km to the west of Lae. It is roughly within 146.468 ° E/6.504 ° S and 146.657 ° E/6.652 ° S.

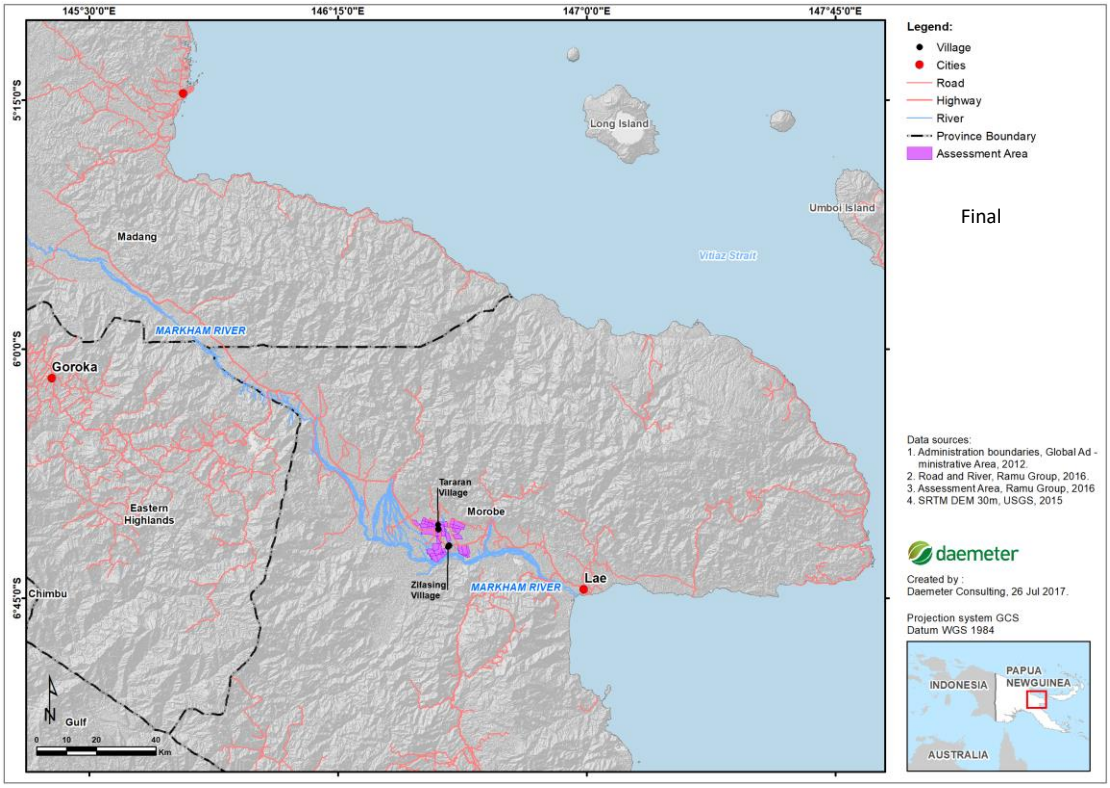


Figure 4. Location of the NBPOL new development estates in the broader landscape.

2.5.4.2 Secondary Data Collection

Secondary data was collected and analyzed (including an assessment of its spatial accuracy) during the planning phase of the assessment, as summarized below.

Land Cover

Land Cover mapping was undertaken by Hollow-wood Enterprises and used for both the HCV and HCS assessments, which were undertaken concurrently.

This project utilised range of imagery datasets to inform the assessment at different scales or resolutions. Landsat 8 was used to gain an understanding of the vegetation present across

the broader landscape. Rapid Eye satellite imagery was used for initial land cover classification. High resolution Digital Globe satellite data was used for post-fieldwork, manual image interpretation.

Topographical Data

No high resolution, vector based topographical data was available for this study, so the 30m ASTER GDEM dataset was used to understand the relative difference in topography across the study areas.

Ecosystem Mapping

For the identification of HCV 3 (*Rare or Endangered Ecosystems*), the Land Resource Survey undertaken by the CSIRO, Australia (Paijmans, 1975) was used as a proxy for ecosystems.

Species Data

The approach that is normally taken by Daemeter for species data is to compile a checklist of all the species potentially present. Secondary data on species potentially present in the assessment area is based on known distribution and habitat use. This is typically extracted from publications, field guides and supporting data, including: the IUCN Red List 2015; CITES 2015; Mammals of Papua 2014; HCV Forest Toolkit for PNG 2005; Bonaccorso 1998 article; Coates 1985 and Diamond 1972. The species list, including the conservation status of each species, are then cross-referenced and augmented by experts that join the field survey and by consulting community groups with knowledge of the area and species likely present. In this case Daemeter's research came up with natural forest species (which would inhabit the forest e.g. on the southern side of the Markham River), not the species that would live in the modified grassland environment that is extant in the assessment area.

For the previously mentioned reason, in this assessment, species lists were made up primarily from sightings and species that would likely be present based on the field team's experience.

Social Cultural Data

Secondary data for the assessment of HCV 5 and 6 were available from EIAs and Interim HCV Assessment reports provided by the company from other areas in the Ramu Valley where RAIL has its main operations. These described a range of social and economic classes, livelihoods, and village infrastructure. There was no secondary data relevant to this particular area.

2.5.4.3 Primary Data Collection

Scoping Study

A 3 day scoping study was undertaken in October 2016. This involved the following activities:

- Research into the formation of Incorporated Land Groups and how this will enable the clans' land to be leased.
- Field visit to look at the assessment area to determine which experts will be required to undertake the full assessment, also to determine which HCVs are likely to be present.
- Meeting with the local Member of Parliament to discuss his view of the scheme and why he supports it. Additionally, there was a short discussion on the economic and social situation in the area.

Threat Assessment

Threats were assessed based on :

- The assessor's past experience with HCV assessments.
- Discussions with the local community
- Discussions with NBPOL staff.

Plant Surveys

Remaining forest (as defined by satellite imagery and land cover analysis) was surveyed using a rapid assessment method that sought to understand the potential presence or absence of species considered to be HCV 1 and to confirm the quality of vegetation that could be considered HCV 3. Grasslands and scrub were not considered a priority.

While at the plot location an inventory of every tree present was made. While moving between plots semi-structured plant observations were made of trees and juvenile regeneration. Stand structure, species composition, site disturbance history and biomass values were variables used to determine habitat quality.

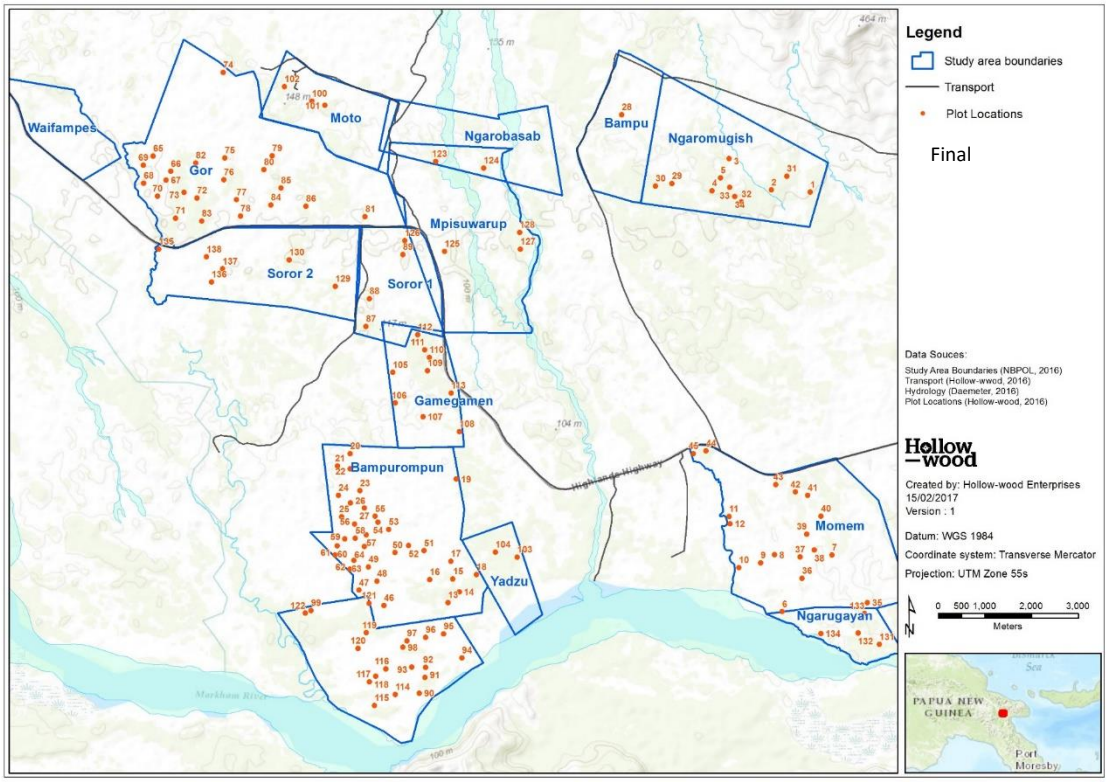


Figure 5. Location of the HCS plots; these along with the walk between the plots were part of the vegetation survey. The mammals and birds surveyor also joined this team. Additionally another surveyor travelled around the blocks with landowners and had a general look around and discuss land management and HCV 5 & 6 issues.

Mammals Surveys

Research on mammals was primarily based on analysis of secondary data to determine the likelihood of presence.

The survey of mammals and other vertebrates of concern under HCV 1 was conducted using rapid assessment techniques, combining (i) un/structured interviews with local people (including NBPOL employees), (ii) assessment of habitat quality (in combination with the botany team), and (iii) direct (visual) and indirect (prints, calls, scat) sightings whilst

undertaking habitat assessments. The mammal assessor joined the vegetation survey so Figure roughly describes the location of the bird and mammal survey also.

Bird Surveys

Bird surveys aimed to identify features of the bird community relevant to HCV 1. Survey methods included walking transects, opportunistic observations during the surveys, and interviews with local people. The combination of these methods ensured a holistic bird inventory and increased the likelihood of detecting key species that deserve conservation interventions. The assessor joined the vegetation survey.

Reptile and Amphibian Survey

This was done by the same person who was doing the mammal and bird survey. Techniques were very similar; discussions with local people, looking at habitat types and opportunistic sightings. The surveyor lived in the area so had a strong background for the survey.

Social and Cultural Surveys to Assess HCV 5 and 6, boundaries and land use plan

Using the CG as a reference, questions were prepared for meetings at the village level to evaluate the dependency of community members on natural ecosystems to fulfil basic needs (HCV 5) and identify any important cultural sites (HCV 6).

The proposed development areas were very consolidated and eleven individual interviews were undertaken these were mainly undertaken in and around Chivasing and Tararan Villages.

In all cases, meetings were attended by the clan leader and several other interested parties (e.g. women, younger people, farmers). In each interview a general introduction to the purpose and context of HCV was made. This was followed by a Focus Group Discussion (FGD) in order to collect data on social and cultural aspects. The FGD approach is an effective way to collect information on social and cultural dimensions of village life in an informal setting that permits discussion and exchange of ideas between group members.

Additionally, clan members joined the HCV survey team when Daemeter was surveying the blocks. During this time informal discussions took place about a range of topics (e.g., land ownership, disputes, resource use, population expansion and cultural identification with natural areas). This was very useful supporting information for the survey. While surveying the blocks, clan members were asked to take the team to cultural sites and places of interest. GPS points were taken where appropriate (e.g. graveyards) or, where a creek was used for taking water, this was marked on the survey map. Similarly, the land owners had made a land use plan in their own heads that divided areas into settlement areas, oil palm areas and cattle raising areas. The field team used a GPS to mark out the corners of the land use plan.

2.5.4.4 Dates of Major events in assessment chronology

Table 6. Steps and timeline for completion of the HCV assessment process

Step	Step description	Dates undertaken/scheduled
1	Compilation of secondary and available primary data, including preliminary stakeholder consultation during a short, initial visit to the license areas	October 2016
2	Rating the assessment as Tier 1 or Tier 2 and reporting this assessment to the HCVRN	October 2016

3	Team formation and briefing on project scope	October 2016
4	Planning for fieldwork and agreement on field methods for primary data collection	October 2016
5	HCV Pre-assessment (scoping study) based on available data	11 – 13 October 2016
6a	Fieldwork and primary data collection, including direct stakeholder consultation (phase 1)	16 – 28 November 2016
7a	Data analysis and interpretation (phase 1)	December 2016-January 2017
8a	Preparation of a Draft Report, including HCVMA maps and management and monitoring recommendations (phase 1)	December 2016-January 2017
9a	Public consultation to report interim HCV findings and refine threat assessment	15 -16 May 2017
6b	Fieldwork and primary data collection, including direct stakeholder consultation	15 – 21 May 2017
7b	Data analysis and interpretation	May 2017
8b	Preparation of a Draft Report, including HCVMA maps and management and monitoring recommendations	May 2017
9b	Public consultation to report interim HCV findings and refine threat assessment	May 2017
10	Amend the draft report based on the Public Consultation	May 2017
11	Report finalization based on peer review and public consultation	January 2018
12	Sign-off by the peer reviewer	14th January 2018
13	Public Summary Report written based on the final HCV report.	January 2018
14	Submission of the HCV Report to HCVRN	January 2018

2.5.5 HCS Methodology

The following section has been taken from the HCSA assessment (Hollow-wood, 2017) that was conducted in November (2016) and May (2017) as part of NBPOL's commitment to 'No Deforestation'.

Image analysis.

The initial area of interest for this assessment was a series of polygon boundaries supplied to Hollow-wood by RAIL. The areas of interest are the clanal boundaries mapped by RAIL with the community, using participatory mapping procedures outlined in Hollow-wood (2017). The landscape context of the assessment area is provide below in Map 1 and the detailed mapped extent of the final assessment areas is shown Map 2

Freely available, high resolution spatial data is difficult to obtain or non-existent in the PNG context, and as such RAIL provided two sources of higher resolution satellite imagery to inform initial and final land cover classification. A serious constraint when working in tropical

latitudes is the issue of cloud cover. All attempts were made to utilise cloud free images, but the nature of image classification / interpretation when working in such environments is that this can be difficult and at times not possible.

This project utilised range of imagery datasets to inform the assessment at different scales or resolutions. Landsat 8 was used to gain an understanding of the vegetation present across the broader landscape. Rapid Eye satellite imagery was used for initial land cover classification. High resolution World View 2 satellite data was used for post-fieldwork, manual image interpretation. Based on previous experience, it is the opinion of Hollow-wood that when combined with ground truthed field plots (such as those recorded during HCSA assessments), the visual interpretation of high resolution imagery provides the most accurate representation of the vegetation present within a study area. This output ultimately is the dataset that land use planning maps and recommendations are derived from for this study.

Pre-processing

All imagery utilised for the HCSA assessment were obtained as tiled, raster datasets, with no individual tile providing adequate coverage of the study area. Subsequently, colour-balanced, raster-mosaics were created and clipped to the relevant study area for analysis.

The Rapid Eye image that was used for classification was pre-processed to convert the original digital number (DN) values into top of atmosphere reflectance values, using a range of radiometric correction tools found in ENVI 5.1. The processed image was used for the creation of band ratios and indexes, such as those listed below in Table 5. Topographic correction (i.e. the flattening of the image to remove the shadow effect of aspect) was not performed as very little topographic relief existed throughout the study area.

Supervised classification

Initial classification was performed using *supervised classification*, utilising the 'image classification' function within ArcGIS (Spatial Analyst extension). Training samples were developed to represent six clearly identifiable classes. Once adequate training samples were developed, the 'maximum likelihood classification' method was used to provide an initial, classified image.

With many types of classified images, the initial output is 'grainy' and may contain many isolated and/or individual pixels. These may not accurately represent the larger area. Generalisation and/or smoothing was required to remove isolated pixels from the output, giving a much more consolidated result. This was achieved using generalisation tools within the ArcGIS 'Spatial Analyst'.

Error matrixes for both training samples and test pixels, as per Lunetta and Lyon (2004) and Lillesand *et al*, (2015), were prepared, and are provided below in Section 2 – Carbon stock assessment.

Rapid Eye Imagery

Rapid Eye is commercial, high resolution, multi-spectral image satellite that available as either one off purchases or on a subscription basis. Whilst not possessing the spectral range of satellites such as Landsat or Modis (five bands vs 12 bands), it does capture bands especially

useful for vegetation analysis at a spatial resolution of five meters. These bands are; red, blue, green, red edge and near-infrared.

The Rapid Eye scenes that were utilised during this study were all captured in August, 2016 between the 26th and the 31st, and a raster mosaic was created that properly covered the study area. As this imagery showed high levels of homogeneity across the mosaicked scene, this imagery was used for the initial land cover classification.

World View 2 Imagery

World View 2 is commercial, high resolution, multi-spectral image satellite available as either one off purchases or on a subscription basis. Whilst not possessing the spectral range of satellites such as Landsat or Modis (four bands vs 12 bands), it does capture bands especially useful for vegetation analysis at a spatial resolution of 2 metres. These bands are; red, blue, green and near-infrared.

The World View 2 scenes that were utilised during this study were all captured in either October 2015 or April 2016. These two capture dates were chosen as they possessed the lowest percentage cloud cover over the study area. It is acknowledged that the large difference in capture times between the images is problematic for broad scale image classification, with this fact being the main reason for the difficulty in producing a seamless, colour-balanced raster mosaic across the study area. Due to this inconsistency, this imagery was primarily used for visual interpretation, relying on the knowledge of the analyst and ground truthed points (HCSA plots) to inform the interpretation.

Band combinations, ratios and indices

During the initial image classification, and range of band ratios, combinations and Indicies were explored to find the greatest contrast between the classes of interest. These can be seen below in Table 5. Further detail is provided in Chapter 3 of HCSA (2015).

Table 7. Band ratios, combinations and Indices utilised for this study.

Name	Purpose	Bands used
True colour	Visual interpretation	Red, green, blue
Colour infrared	Vegetation vs non-vegetation	Near-infrared, red, green
Vegetation classification	Contrast between vegetation types, with SWIR responding to increasing soil moisture	Short-wave infrared, near infrared, blue
Normalised differential vegetation index (NDVI)	Measures water content (or turgor) within vegetation, with actively growing vegetation showing higher values than bare ground or dead vegetation	(NIR – Red) / (NIR + Red)
Simple vegetation ratio	Contrast between vegetation types	NIR / Red

Field Inventory

The field inventory performed for this project sought to ground truth the output of the initial image classification and to quantify the above-ground woody biomass (i.e. that within trees) found within each of the strata, across the study areas.

Sample design

Sample intensity (sample size) for each of the classes identified during image analysis was determined by:

1. The area of the strata
2. The mean and standard deviation values of HCSA strata captured during previous fieldwork in Papua New Guinea and the Solomon Islands (Hollow-wood, 2016; TFT, 2016)

The sample size was calculated using the Winrock International 'sample plot calculator spreadsheet tool', found at https://www.winrock.org. The sample size and a breakdown of those plots used for analysis can be seen in Table 8.

It was made known to Hollow-wood that *Samanea saman* (Raintree) was a dominant feature within the study area. Given the lack of research into the biomass of *S. saman*, particularly in the Pacific context, it was decided that strata means for the more intact stands of HCSA forest (HDF, MDF, and LDF) would be used to determine the sampling strategy needed for the assessment.

Due to the relative ease of access across the study area, it was decided that a stratified random sampling approach would be taken, with plots generated, by the 'create random point' function in ArcGIS, with a minimum distance of 100m being applied as a parameter within the tool. Plot locations can be seen in Map 5.

Table 8. Breakdown of plots used for analysis

Plot Type	Number of plots
Plots analysed and presented in results	184
Plots analysed and excluded from results (areas classified as Non-HCSA, such as tree gardens, plantations, or plots recorded in recent garden areas)	2
Plots excluded due to no spatial location	0
Total	**186**

Inventory method

All field inventory was performed in November/December 2016 and May 2017, and was done as per the methodology set out in Chapter 4, HCSA (2015).

This inventory method consists of two nested circular plots with plot radii of 5.64m and 12.61m, equating to 100m^2 and 500m^2 respectively. Trees between 5 -14.9 cm are measured within the 5.64m plot and all trees >15.0 cm are measured within the 12.61m plot. Further detail can be found in HCSA (2015).

All field data was collected digitally, using a data collection form specific to HCSA assessment, designed by Hollow-wood. Information collected during field inventory can be seen below in Table 9

Table 9. Data collected during HCSA field inventory.

	Attribute	Value	Method
Plot Attributes	**Date**	dd/mm/yyyy	Form calculation
	Assessors	initials	User entry
	Location	Easting / Northing	Form calculation
	Elevation	Meters above sea level	Form calculation
	Plot number	Integer	User entry
	Assessment area name	Text	User entry
	Canopy cover	Projected foliage cover (%)	Visual estimate
	Canopy height	Site tall tree (m)	Clinometer / rangefinder
	Mid height	Mid strata mean (m)	Clinometer / rangefinder
	HCSA strata	Class from initial classification	Presence / absence
	Site slope	Site slope (degrees)	Clinometer
	Basal area	m ha $^{-1}$	Dendrometer
	Plot comments	text	User entry
	Photo #1 (north)	Photo identifier	User entry
	Photo #2 (south)	Photo identifier	User entry
	Photo #3 (canopy)	Photo identifier	User entry
Tree data	**Plot type (i.e. radius)**	m	Plot radii chain
	DBHOB	cm	Diameter tape
	Species	Genus / species	User entry

Data Analysis.

All biomass calculations were performed according to the method outlined in Chave *et al.*, (2014). This method is a two-step approach and utilises two models, Equation 4 and Equation 6a. Both models are pan-tropical allometrics, with equation 4 being a biomass allometric and equation 6a being a diameter / height allometric.

Critical to Equation 6a is a climatic variable or 'E-value'. This value is a co-efficient that is derived from the combination of both temperature seasonality (TS) and climatic water deficit (CWD). The E-value increases with both increasing TS and increasing CWD, with equation 6a predicting that tree height for a given diameter will decline with increasing water and temperature stress (Chave *et al.*, (2014). The E-value dataset is supplied in raster format at resolution of 2.5 arc seconds (approximately 4.5km x 4.5km at latitude of the AOI), and the spatial locations of each of the HCSA plots were used to extract the appropriate E-value for each.

All biomass values calculated using this method were converted to carbon content using a factor or 0.47 as per HCSA (2015) pp 66.

Below-ground biomass was calculated using root to shoot ratios reported in Mokany *et al*, (2006) for moist tropical rainforests. Mokany *et al* (2006) report a value of 1.837 for 'shrub land' communities. Hollow-wood does not consider this value to be appropriate for communities classified as 'scrub' in this study, as in this context, 'scrub' communities are highly degraded 'forest' rather than 'shrub or scrublands' communities, where trees are generally absent and there are edaphic or climatic factors that inhibit tree growth (e.g. acid soils, impeded drainage or prolonged exposure to salt spray).

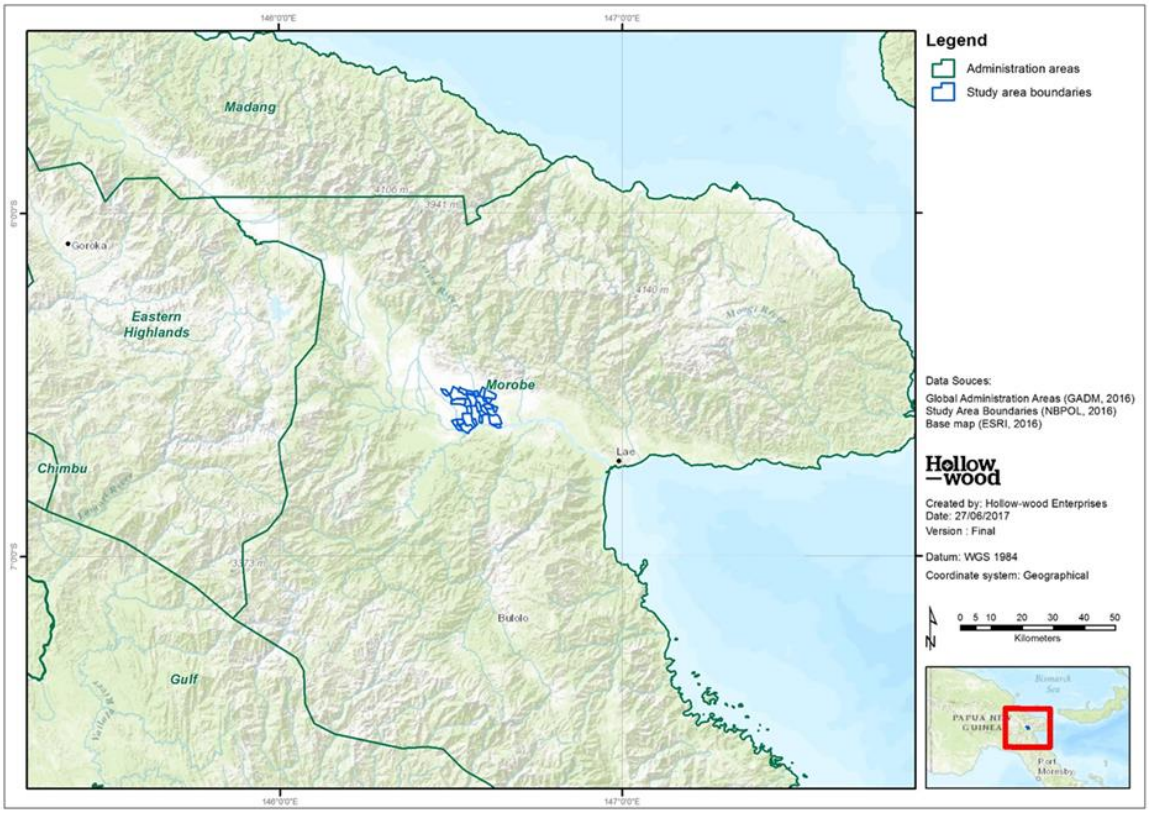
Above ground biomass in grassland communities was calculated using the default value of 7 t/ha, as published by the Climate Change and Development Authority, (2017), and the belowground biomass value was calculated using tropical grassland root to shoot ratio of 1.887, as published by Mokany *et al*, (2006).

Team responsible for developing the mitigation plan

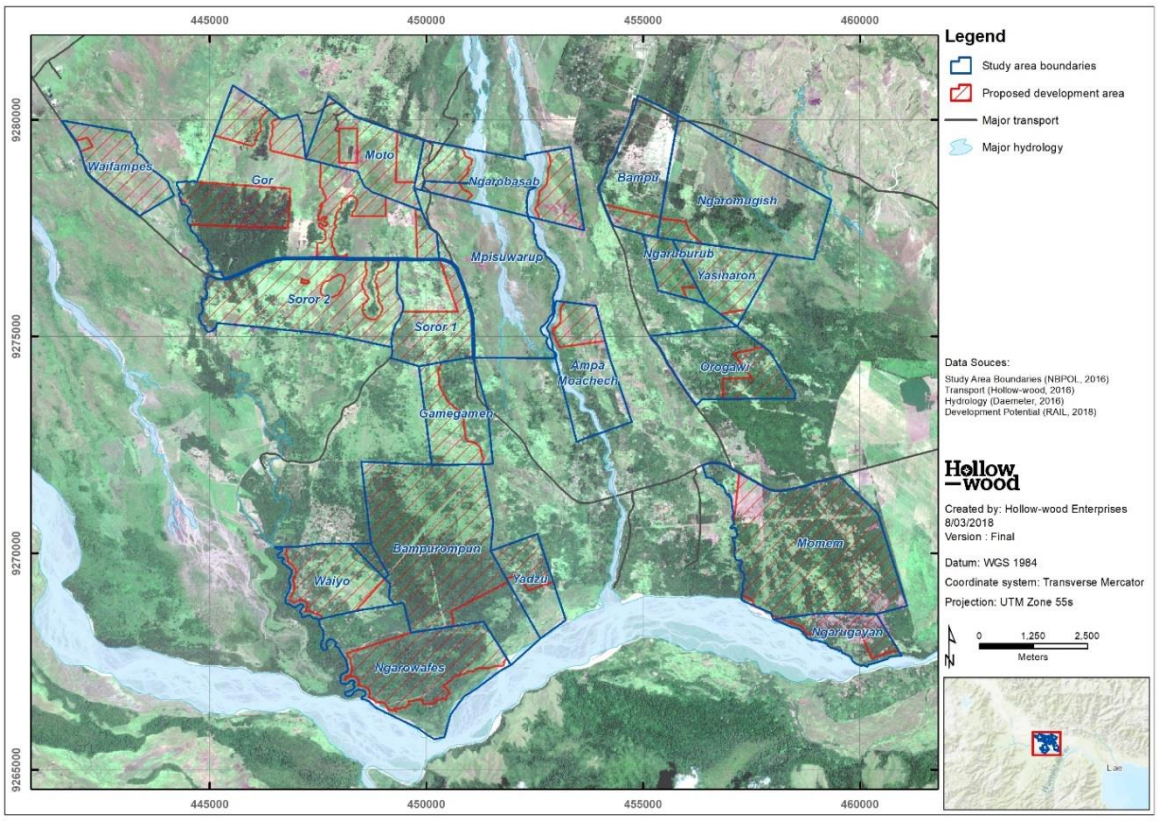
The team responsible for developing the mitigation plan can be seen below.

Table 10. Team members responsible for developing the carbon emissions mitigation plan.

Name	Organisation	Qualifications	Role
Michael Hansby	Hollow-wood Enterprises	BSc (Forest Science), Grad Dip (Bushfire Management)	GHG Lead. Forest Inventory and GIS manager
Michael Pescott	The Forest Trust	BSc (Forestry), BSc (Hons)	HCSA Lead
Sander van den Ende	NBPOL	MSc (Forestry), BSc (Plant Ecology)	Company contact



Map 1. Overview of study area locations



Map 2. Detail of proposed planting areas covered by this GHG assessment.

2.5.6 Carbon stock assessment methodology

Location maps indicating area of new plantings at landscape level and property level

See Maps 1 and 2 above.

Land cover map of the new development area (include verification process)

Mapped results of the initial image classification can be seen below in Map 3. It should be noted that this analysis was only utilised in order to prepare for field inventory, with the final land cover classifications presented below in derived from visual interpretation of the high-resolution World View 2 satellite imagery.

Land cover classification descriptions are described below and photographic examples of the classes are provided in Figure 5.

Land cover classification descriptions

Grasslands

Most of the grasslands of the Markham Valley are considered to be of anthropogenic origin, maintained by a near annual, low intensity fire regime. The grassland communities found within the AOI can generally be classified as the either the *Imperata cylindrica* (Kunai)/*Saccharum spontaneum* (Wild Sugarcane) dominated 'tall grasslands', or the *Themeda australis* (Kangaroo Grass)/*Capillipedium parvifolium* dominated 'short grasslands'. Scattered occurrences of small trees (such as *Glochidion drypetifolium*), shrubs (such as *Solanum spp*)

and the fire-resistant cycad *Cycas schumanniana* are also common features though out the grassland communities observed within the AOI.

The distribution of these broad grassland community types seems to be primarily driven by drainage, soil type and local climate (Henty, 1982), with the swards of short grasslands occupying relatively dryer sites in general, compared with those occupied by tall grasslands. No destructive sampling was undertaken for this land cover type, with the above ground biomass value sourced from PNG Climate Change and Development Authority, (2017).

Scrub

Area in this category are ecosystems that have undergone intense and/or frequent disturbance events that are mainly of anthropomorphic origin. This also includes areas of vegetation that are under a system of shifting cultivation. This may include areas in fallow (i.e. resting) or areas in current use. This vegetation is typically low in diversity, is dominated by pioneering species and shows evidence of the repeated use of fire. In the AOI, common species common species observed were; *Piper aduncum, Trema orientalis, Macaranga tanarius, M. aleuritoides, Leea indica, Kleinhovia hospita, Melanolepis multiglandulosa* and variety of *Ficus spp*.

Samanea saman (Raintree) dominated vegetation

The introduction of *S. saman* into the area as a fodder / shade tree assumed to be at least from the 1950's and the subsequent easing of grazing pressure across many of the individual study sites from the mid 1970's has resulted in large areas being dominated by stands of *S. saman* regrowth. Such vegetation includes areas of almost pure stands of *S. saman*, stands of *S. saman* mixed with young regenerating forest and stands of *S. saman* in an open woodland structure. During biomass plot data analysis, all vegetation dominated by *S. saman* was grouped into the single class called '*Samanea saman* dominated vegetation'. Vegetation classes reported below are those determined during field assessment.

Raintree - dominant

Such stands generally have a closed canopy and possess little understorey. Recruitment of S. saman is often low as the low-light conditions created by the dense canopy are not ideal for seedling establishment. This vegetation class represents the dominant form (in terms of structure and species composition) of woody vegetation throughout the AOI.

Raintree – mixed with young regenerating forest

Stands falling into this category are some of the older *S. saman* stands (40-50yrs) and possess a developing understorey of secondary rainforest species. Many of the rainforest species are currently co-dominant with the *S. saman* canopy, and it is expected that in the absence of S. saman recruitment or further disturbance, lowland rainforest species will eventually dominate the site. These stands do not qualify as young regenerating forest as the basal area of native species is < 50%. Species such as *Mangifera minor, Myristica hollrungii, Trema orientalis, Endospermum medullosum, Nauclea orientalis, Alstonia scholaris, Sterculia schumanniana, Gulubia costata* and *Dysoxylum sp* are common.

Raintree grassy woodlands (Savannah)

The grassy woodlands or savannah present within the AOI are characterised by grassland communities similar to that described above, but have a low stocking (i.e. projected canopy cover of less than 30%) of canopy trees present. The community is simple in structure and usually dominated by the exotic legume *Samanea saman* with lesser occurrences of native species with a degree of fire resistance, such as *Adenanthera novo-guineensis* or *Nauclea orientalis*.

Young regenerating forest

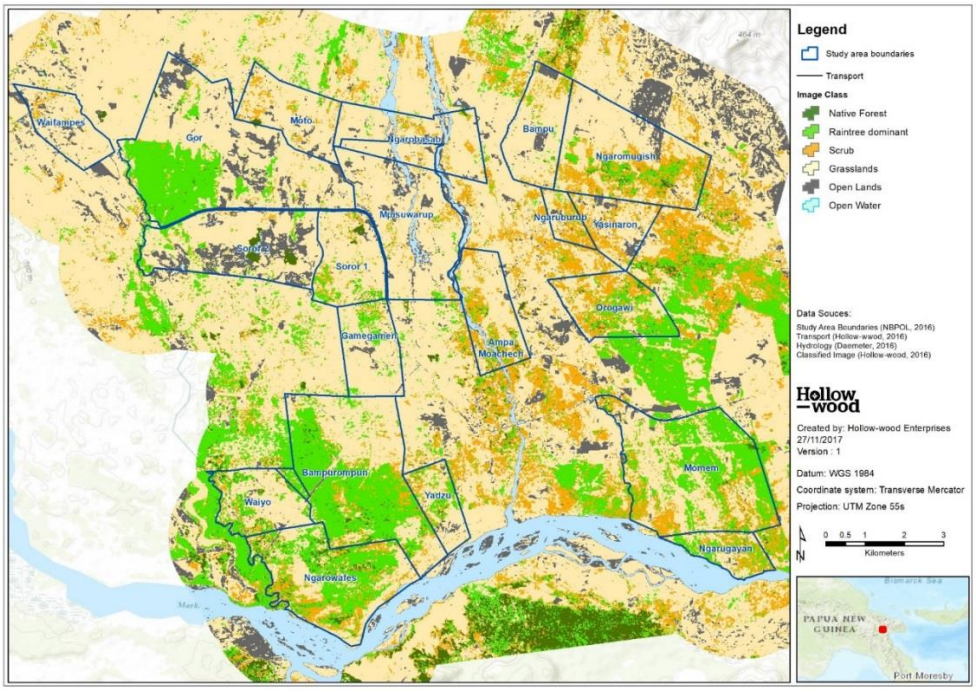
Forest represented by this category are generally native secondary rainforest species that have established under the dense *S. saman* canopy, and are in the process of dominating the site. Basal area (BA) was the primary metric used to determine the presence of this class as per the note in HCSA (2015) pp 37 'abandoned plantations with <50% of the BA consisting of planted trees could be considered to be young regenerating forest'.

Hollow-wood assumes two points when using this note to determine potential young regenerating forest; 1) that by proving this note, HCSA (2015) acknowledges the often vigorous nature of regenerating rainforest and 2) that dense stands on *S. saman* are functionally identical to 'abandoned plantations' i.e. they are both exotic, woody, perennial monocultures. Species such as *Mangifera minor, Myristica hollrungii, Trema orientalis, Endospermum medullosum, Nauclea orientalis, Alstonia scholaris, Sterculia schumanniana, Gulubia costata* and *Dysoxylum sp* are common.

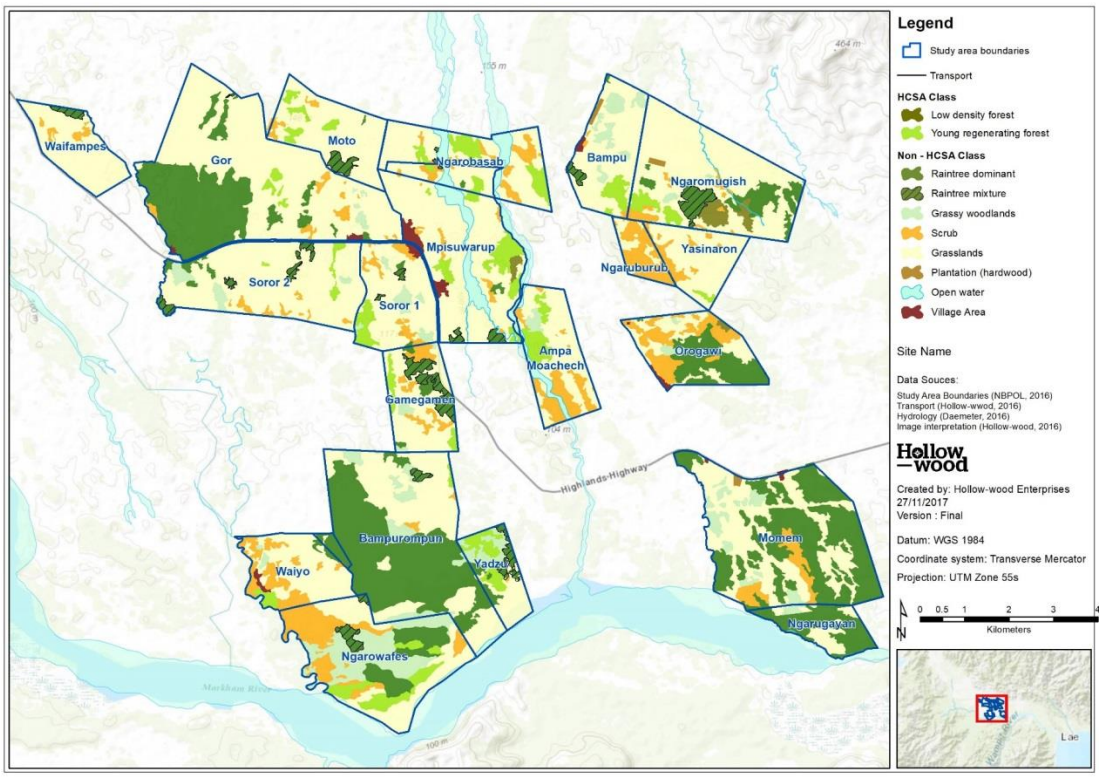
Low density forest

Forest represented by this class are either highly degraded, remnant native forest or advanced secondary regrowth forest. Stands falling into this class are of very limited extent within the AOI, and generally occur in riparian zones or in swampy areas. Characteristic species seen during this assessment are; *Ficus spp, Trema orientalis, Macaranga spp., Dysoxylum spp., Neuburgia corynocarpa, Horsfieldia irya*.

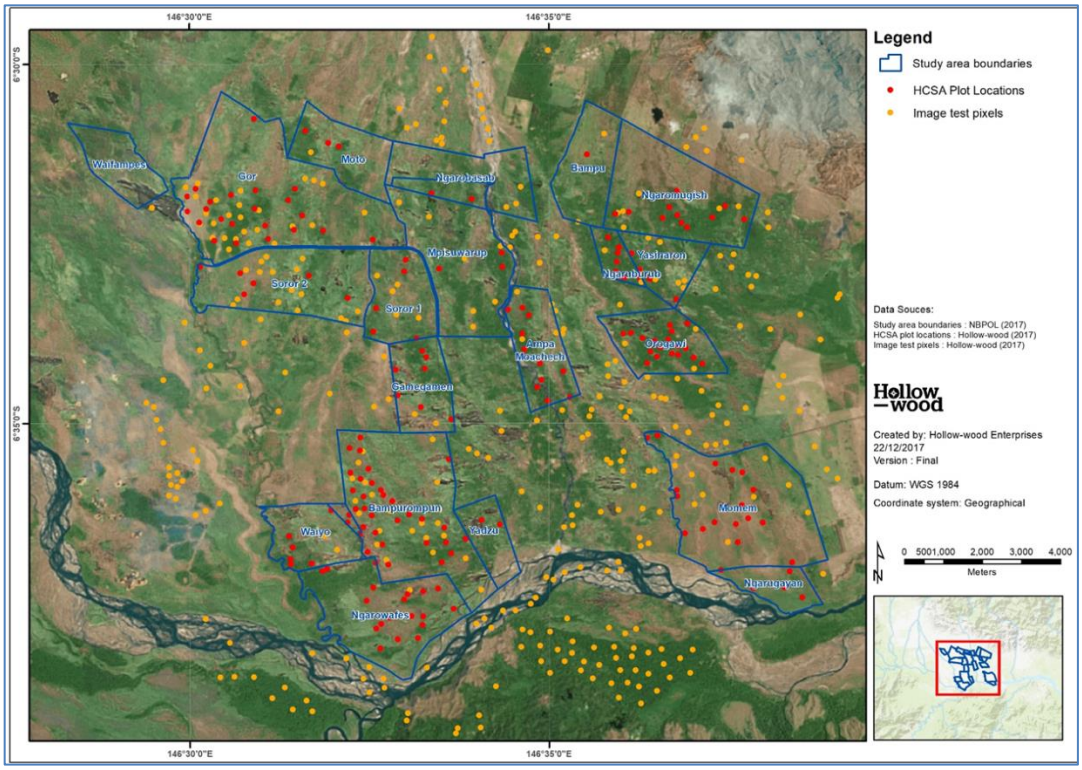
Figure 6 Photographic examples of strata encountered during assessment. 1a) 'Grasslands', 1b) grassland canopy, 2a) 'Scrub', 2b) scrub canopy, 3a) 'Grassy woodlands' (GrW), 3b) GrW canopy, 4a) 'Samanea saman dominated vegetation' (SsD), 4b) SsD canopy, 5a) 'Young regenerating forest' (YRF), 5b) YRF canopy, 6a) 'Low density forest' (LDF), 6b) LDF canopy



Map 3. Land cover classes derived from classification of Rapid Eye imagery.



Map 4. Final land cover classes derived from interpretation of World View 2 imagery



Map 5. HCSA plot and test pixel locations.

Accuracy assessment

The accuracy assessments presented in this section are conducted as per the methods outlined in Lunetta and Lyon (2004) and Lillesand *et al*., (2015). The error matrix presented in Figure 6 show an excellent result, with an overall accuracy of 97% and a k-statistic (Cohens kappa value) 0.97. Figure 7 is an assessment of the accuracy of the training samples developed for the land cover classification, with the high result being an indication of training polygon homogeneity, and therefore the spectral separability of each of the classes developed.

Figure 7 is an accuracy assessment of the classified image itself, with a sample of test pixels being compared against model output (i.e. the classified image).

60 test pixels were developed for each of the six classes (n=360) with values being assigned to each of the test pixels based on a manual interpretation of the image. This interpretation was then compared against the classified image. The overall accuracy of the classification was 89% with a k-statistic of 0.87. Both commission (over classification of a class) and omission error (under classification of a class) were generally low. A notable exception was the over-classification of the 'WW' class (woody weeds or *Raintree* dominated vegetation), where most of the committed pixels came from the 'HCSF (remnant forest) class. This indicates that there was difficulty in spectrally separating mature raintrees from native forest. Ground truth locations were derived from HCSA biomass plots and further extrapolated to test pixels across the relative vegetation strata, spatial locations can be seen above in Map 5.

The Rapid Eye imagery, supplied by RAIL, was initially classified in order to plan and undertake field assessment, with the accuracy assessment detailed above performed on this image. Higher resolution data, in the form of World View 2 imagery, was also supplied by RAIL to aid in the accurate mapping of vegetation classes across the study area.

	Reference data for training samples						
Classification Results	HCSF	WW	SCB	GRS	OL	OW	Row Totals
HCSF	**962**	0	0	0	2	0	964
WW	38	**1157**	8	0	0	0	1203
SCB	8	0	**1043**	0	11	0	1062
GRS	0	0	6	**1112**	2	0	1120
OL	0	0	0	0	**1151**	0	1151
OW	0	0	0	0	92	**1167**	1259
Column Totals	**1008**	**1157**	**1057**	**1112**	**1258**	**1167**	**6759**

Overall accuracy = (962+1157+1043+1112+1151+1167) / 6759 = 97.53%

K statistic = 0.97

Producers Accuracy (%)		
HCSF	962/1008	95.4
WW	1157/1157	100.0
SCB	1043/1057	98.7
GRS	1112/1112	100.0
OL	1151/1258	91.5
OW	1167/1167	100.0

Users Accuracy (%)		
HCSF	962/964	99.8
WW	1157/1203	96.2
SCB	1043/1062	98.2
GRS	1112/1120	99.3
OL	1151/1151	100.0
OW	1167/1259	92.7

Figure 7 Error matrix for training samples created for the initial land cover classification

Abbreviations are as follows: HCSF (Remnant forest, including young regenerating forest), WW (woody weeds or raintree dominated vegetation), Scb (Scrub-type vegetation), Grs (Grasslands), OP (open lands, such as gravels and recently burnt areas), OW (open water).

	Reference data for test pixels							Comission Error (%)		
Classification Results	HCSF	WW	SCB	GRS	OL	OW	Row Totals	HCSF	2/42	4.8
HCSF	**40**	1	0	0	1	0	42	WW	18/76	23.7
WW	16	**58**	1	1	0	0	76	SCB	3/60	5.0
SCB	1	1	**57**	1	0	0	60	GRS	7/52 =	14.7
GRS	3	0	2	**58**	5	0	68	OL	3/54	5.6
OL	0	0	0	0	**51**	3	54	OW	3/60	5.0
OW	0	0	0	0	3	**57**	60			
Column Totals	**60**	**60**	**60**	**60**	**60**	**60**	**360**	Omission Error (%)		
								HCSF	20/60 =	33.3
Overall accuracy = (40+58+57+58+51+57) / 360 = 89.16%								WW	2/60 =	3.3
								SCB	3/60 =	5.0
K statistic = 0.87								GRS	2/60 =	3.3
								OL	9/60 =	15.0
								OW	3/60 =	5.0

Figure 8 Error matrix for test pixels.

Abbreviations are as follows: HCSF (Remnant forest, including young regenerating forest), WW (woody weeds or raintree dominated vegetation), Scb (Scrub-type vegetation), Grs (Grasslands), OP (open lands, such as gravels and recently burnt areas), OW (open water).

3. Summary of findings

3.1 SEIA

Zifasing Oil Palm Project (ZOPP) will consist of a planation estate with all the required facilities and a dedicated palm oil mill. The current land acquisition work indicates that the company should be able to secure at least 10,000ha of plantable land which will render the construction of a palm oil mill commercially feasible. The entire area will be accurately surveyed and detailed layout planning will follow for the plantation estate and the palm oil mill. The layout will cater for the mandatory buffer zones, drainage, access roads, oil palm plots, seedling nursery, offices, storage sheds, workshop, palm oil mill and related structures, accommodation and associated amenities, as well as crucial utilities namely water supply, sanitation and electricity.

After management approval to proceed is given, the sequence of activities likely to be followed in the setting up of the plantation is: (i) on site demarcation of access roads, local drainage, oil palm plots, buffer zones and plantation infrastructure (ii) site preparation and construction of access roads and local drainage as well as installation of plantation infrastructure, (iii) planting of oil palm seedlings, cover crop and buffer zone plants, and (iv) maintenance as well as upkeep leading to first FFB harvest. The start of construction of the mill should ideally be such that it will be ready to process fruit from the first batch of planted palms. If the commissioning of the mill is delayed the fruit can in the interim be processed at the existing Gusap mill.

The design and placement of access roads, drainage, oil palm plots and buffer zones will be in accordance with the Environment Act 2000 and RSPO P&C 2013. RAIL has consistently demonstrated its compliance with these requirements in all its previous new plantation developments.

3.1.1Positive and negative environmental effects

The bio-physical status of the project area is such that the main environmental concern during site preparation through to the routine operation phase is the potential impact of silt and contaminant laden rainfall runoff and infiltration on local water resources. Rainfall runoff during the site preparation phase may carry high levels of silt and agrichemical residues that could impair water quality in surface watercourses and to a lesser degree, the proportion that seeps through the soil may damage groundwater quality. This contaminant load can be reduced by proper road and drainage construction, inclusion of silt containment devices, planting of leguminous cover crop, enhanced variety of vegetation in the buffer zones and coordinated application of agrichemicals. In the operation phase, the established cover crop, rigorous windrowing and thriving buffer zone vegetation as well as responsible agrichemical usage should help decrease the amount of silt and agrichemical residues in site runoff.

With respect to the socio-economic dimension to the project, RAIL as the developer will have the opportunity to influence the local society and economy in a substantial manner. The local landowner clans and families have decided to enter into commercial partnerships with RAIL to improve their current living conditions and invest for the long-term well-being of their children. As part of the project establishment work, the respective ILG committees and their members should be provided the necessary support to participate directly with the project as individual employees or as small contractors.

Consistent with NBPOL's established practice with respect to such development and the terms of the Lease Agreement, the local villagers should have the first right of refusal to job opportunities. Any unfilled position should then be offered to persons from other parts of Wampar LLG, Huon District, Morobe Province and the country. Appropriate training and personal protection gear should be provided to employees as required. In addition, remuneration rates should be set in observance of the national minimum wage level and other entitlements including accommodation provided where necessary.

RAIL is expected to ensure strict environmental compliance from start of actual project establishment so that the net negative impact on the local environment is negligible. This should be realized through an effective and adaptively implemented Environment Management Plan (EMP).

3.1.2 Socio-economic impacts to country, region and local communities

Benefits at National and Provincial Levels

The proposed development, is expected to increase the area of oil palm plantation along with associated production. The increase in production is expected to have a proportionate increase in:

- Government revenue;
- The value of goods and services procured from within Papua New Guinea;
- Employment opportunities and wage payments to Papua New Guineans;
- Skills development among Papua New Guineans; and
- Payments to landowners, out-growers (potentially) and local contractors.

The expansion will help strengthen the viability of the oil palm industry in Papua New Guinea and stimulate economic and social development in the Markham Valley.

The benefits to Morobe Province include:

- Employment and income growth; and
- Sustainable economic growth, which could lead to improvements in the general level of security.

The province will also experience continued population growth, which will place additional pressure on schools and other service providers, which will require investment by the Provincial Government to meet increased demands.

3.1.3 Socio-economic impacts in respect of emergent communities (workers, suppliers etc.)

A number of changes will occur as a result of the project. These changes, and resulting impacts, are discussed below.

Population

The expansion of oil palm will require additional employees. It is anticipated that the majority of employees for will be recruited locally. Based on an average family size of 5-7, and the

prospect of other job opportunities (ie/ Wafi Gold Mine) causing migration of work force out of the immediate area additional people will live in the Study Area as a result of the development. These people will generally come from other areas and will reside on the estates in housing compounds built by RAI. Other than for casual workers people will apply for a position, and successful applicants will be awarded a permanent position, subject to a three-month probation period. The project is therefore expected to lead to a direct increase in population as a result of this expansion. Some additional in-migration is expected, despite the limitations imposed on migrants as a result of customary land ownership. Some people from the interior of the province are likely to be attracted to the area, due to the economic opportunities and improved access to services. Note that the Wafi Gold Mine, the Yonki II power line and other potential projects in the area, ie/PNG Biomass, will also attract in-migration to the general area. Some others are likely to migrate to the area as a result of marriage. Reasonably high population growth is therefore expected to continue in the proposed area, as a result of the project, for at least a decade. The proportion of customary landowners may decline as future expansion progress as the majority of workers will originate from other provinces. The workers and their families will reside in work camps established by RAI and they will be under instruction to not use resources on customary land.

Roads

The Lae-Madang Highway, which runs through the centre of the proposed project area is unlikely to be affected or improved due to this development. This government highway has been in a state of disrepair for many years and any investment to improve this would be the result of a major government investment. Note that the project will result in a significant increase in unsealed all weather road networks into the project areas.

Income Levels

A number of different groups will benefit from higher income levels:

- Landowners who lease land to RAI;
- New oil palm employees;
- Contractors who are able to provide goods or services to RAI; and
- Other people who capitalise on higher income levels and improved road access to sell products in the local area or Honiara.

The increase in income levels will be proportionate to the area of new oil palm developed.

Health and Wellbeing

Health levels should improve as a result of the increased population covered by RAI clinics, the increase in access to emergency health services in Lae, and in some cases, improved diet, for example, an increase in protein as a result of higher income levels.

In the longer-term, where many people have enjoyed higher income levels for a decade, adverse health impacts may occur as a result of poor diets and a lack of exercise. This may contribute to an increase in diabetes and other lifestyle diseases, essentially from a gradual replacement of fruit and vegetables with store foods that have high salt, sugar and fat content. Thus, while health impacts are expected to be substantially positive in the short to medium term, the benefits may be eroded without appropriate health education and lifestyle changes in the longer term.

Education and Skills

Higher income levels should make education more affordable, and improved road access should contribute to higher enrolment and retention levels in schools, particularly in secondary school. There is a concern that increased economic opportunities will increase

absenteeism. The increase in population as a result of the expansion of oil palm will substantially increase the number of school-aged children. Some schools may struggle to accommodate a substantial increase in students without an increase in teachers, classrooms and other facilities. Over-crowding in schools could cause some tension between the children of local residents and RAI workers, which could lead to poor attendance by the children of workers.

The project will train employees in oil palm operations, along with basic knowledge on health and safety. Although the majority of employees will work in labouring positions in the plantations, the expansion offers considerable opportunity for local employees to be promoted over time. RAI provides considerable training to ensure people have the necessary skills and to maximise the proportion of workers who are from Papua New Guinea. Some of the skills learned while working with RAI could be utilised in other industries, or could benefit the broader population as skilled workers return to their communities and apply the skills they have learned.

Subsistence Resources

The increase in oil palm will reduce the land available for subsistence production. However, the expansion areas in particular, are predominantly unused and there will be a minimal reduction in available subsistence resources.

Despite this the project has gone through considerable lengths to ensure that sufficient land is set aside as community use areas. These areas are off limits to future oil palm expansion and ensure that food security and other subsistence needs that land provides in these areas are maintained.

A concern raised by several stakeholders has been the impact of oil palm on groundwater quality. Water quality is sampled by RAI on a quarterly basis, both at the point of entry to, and the point of departure from, existing estates. As results from several years indicate that the water quality is better at departure than on entry, this is not expected to be a major issue, although water quality testing will continue and is expected to be undertaken at all new estates.

Housing

An increasing number of local families are expected to capitalise on their higher income levels and invest in improved housing, including solar power, iron roofing, water tanks, and relatively modern toilets. This has a range of benefits:

- Good lighting allows children to do homework and makes detecting mosquitoes easier;
- Electricity enables family members to earn income from the use of sewing machines (dress making) or refrigerators (selling food and drinks);
- Clean drinking water and clean toilets will reduce the risk of sickness; and
- A reduction in subsistence labour may occur as a result of a decrease in time to collect water or repair the houses.

Additional workers recruited by RAI for the expansion will be accommodated in the work compounds. Additional housing may be required.

Law and Order

Higher income levels are expected to lead to an increase in alcohol consumption and alcohol abuse, which is likely to lead to an increase in domestic violence, fighting, stealing and other crimes. RAI is active in the work compounds in terms of raising awareness on domestic

violence, providing support and counselling for victims of domestic violence, reducing illegal production of alcohol, minimising excessive alcohol consumption, and promoting a peaceful and harmonious living environment. However, the tensions occurred less than two decades ago and the risk of social unrest – potentially starting with disputes and ending with property damage, violence and a disruption to oil palm production – should not be ignored. Social unrest could occur between:

- Different ethnic groups within work compounds;
- Compound residents and local residents;
- Oil palm beneficiaries; and
- People benefiting from oil palm and people not benefiting from oil palm.

Ethnic tensions within compounds can occur for a number of reasons, including extra marital affairs, stealing, excess noise, etc. These issues are likely to lead to disputes and violence when people are frustrated from poor living or working conditions.
Disputes between compound residents and local residents generally occur due to cultural differences, but can be triggered as a result of:

- Illegal use of local resources (making gardens, harvesting coconuts, etc);
- Extra-marital affairs or sexual relationships between teenagers that involve parties from the compound and local community;
- Traffic accidents involving a driver from another province and a local pedestrian;
- Refusal to assist with requests for assistance from the local community; or
- Unsociable behaviour by local residents in the work compounds, or by workers in local communities.

Disputes between oil palm beneficiaries are likely to occur in relation to the management of benefits. This includes the allocation and management of benefits by GPRDA and GPRDC. It appears that few landowners are happy with current management arrangements, and this dissatisfaction is likely to increase over time as the benefits increase with the expansion.

Finally, people benefiting from oil palm may earn much higher incomes than people not benefiting from oil palm. This could result in jealousy, disputes around the impacts of oil palm, and general unrest. The economic disparity is likely to be greatest when oil palm prices are high, or conversely, when the price of other commodities (e.g. copra, cocoa) is low.

Impacts on Women and Children

The development will continue to benefit women through greater economic opportunities and improvements in housing, improvements in road access, increased economic opportunities, improved health services and improved education affordability. All these benefits will be greater if the general level of security also improves.

3.1.4 Issues raised by stakeholders and assessors comments

Huon Gulf District Administration

The Huon Gulf District administration is fully aware of the proposed oil palm project as well as the other activities in the area including PNG Biomass project, Markham Valley Oil palm development, Wafi Gold mine and Yonki II power line installation. The administration is

confident that these activities should boost economic activity in the area but it is crucial that negative environmental and social impacts are mitigated while the positive outcomes are maximised.
The administration is assisting RAIL with ILG registration for the customary landowners and will continue to assist with title registration and negotiations with lease-lease-back (LLB) agreement if required. It is also prepared to provide other assistance if necessary. The administration stressed that the local people had depended on Markham betelnut as a major income source for so long and although its loss is regrettable, it is encouraging to see the people becoming involved in other revenue generating activities in addition to cattle farming and the sale of coconuts and banana.
The Health Inspector noted that while water supply could soon be improved further with the commissioning of the groundwater units installed by the local MP, sanitation and waste disposal need attention sooner rather than later. The consultant concurred and pointed out that residents downstream of Rumu Bridge had complained about market waste from 41 Mile being discarded on the market-side bank of Rumu River beside the bridge. Some kind of household and market waste collection and disposal system incorporating waste separation and composting of organic material could be explored.

Chairman – Zifasing Lutheran Church

The Chairman explained that while the church focuses on the spiritual well-being of the people it is also concerned about their physical welfare and does as much as it can to ensure that basic needs such as food, shelter, clothing, and education are met. The church also considers law and order as a critical aspect of society and works with various stakeholders including the police as well as the community to maintain peace and harmony in the area. The church supports the proposed oil palm project as it will bring additional income and employment into the area. However it is important that landowner issues are satisfactorily settled, any adverse impacts are minimised and the people are assisted to fully benefit from the project.

Socio-economic concerns

Several socio-economic issues, which were raised during the landowner family group meetings as well as household interviews, are listed and then discussed below. Some of them will require direct intervention by RAIL while others will need the involvement of relevant government agencies, churches and other stakeholders.

(i) Agrichemical contamination of water sources
(ii) Responsible management of ILG monies
(iii) Engagement of landowner companies in contract work
(iv) Assistance with housing, water supply and sanitation
(v) Support with education and health services
(vi) Inter-cropping with oil palm
(vii) Immigration and squatting on customary land
(viii) Law and order

Agrichemical contamination of water sources

Many queries were expressed regarding the likelihood of contamination of surface and groundwater sources by agrichemicals that will be used in the plantation. It was explained that although agrichemical use is unavoidable RAIL has a strict policy that restricts the type, quantity, time, and frequency of usage of each chemical. These substances will be handled by

competent and properly equipped personnel in order to ensure correct application and prevent accidental release. Water samples will be collected from the area regularly to test for agrichemical residues and appropriate remedial action will be taken promptly if contamination is detected. In addition and to the maximum extent possible, integrated pest management practices as well as organic fertilisers will be used to reduce the need for agrichemicals.

Responsible management of ILG monies

Many family members are wary of the potential for abuse of clan monies by members of the ILG committee and asked if RAIL had procedures in place to prevent such misuse. They also requested training in cash flow projection, budgeting and basic book-keeping. The people were informed that financial management of ILG funds was one of the main aspects examined in the recent review of the ILG legislation by the government. Two main changes intended to deter misuse are expansion of the committee including two female representatives and the need to keep financial records as well as prepare and present financial reports to ILG members. The request for training can be brought to the attention of RAIL or other government and non-government organisations that may be able to provide such training.

Engagement of landowner companies in contract work

The issue of landowner company engagement in contract work was raised. Family members wanted to know RAIL's position in relation to the awarding of contracts to landowner companies that are properly organised, competent and appropriately equipped for a given scope of works. They were advised to discuss this query with RAIL during negotiations on the LLB agreement.

Assistance with housing, water supply and sanitation

Family members asked if RAIL would build houses, install water tanks and better toilet for each family. They were advised that this was not RAIL's responsibility and it is up to them to use their ILG income for such purposes. RAIL could consider assisting with water supply system improvement for the community in partnership with the villagers, other NGOs or the provincial government.

Support with education and health services

Another similar query was in relation to RAIL's preparedness to upgrade existing education and health centres. The issue of school upgrading is important not only for the local children but also for the children of outside employees who will be recruited by RAIL. The company may consider upgrading the existing schools to accommodate its employees' children and then in the future build a separate school for them on company leased premises. RAIL is also likely to have a separate health care facility for its employees but it may provide some assistance to the existing government rural health clinics.

Intercropping with oil palm

Some family members wanted to know if intercropping can be done with oil palm in the same manner with fuelwood cultivation under the Biomass project. They were advised that while this is not impossible, it is unlikely to be part of RAIL's cultivation strategy as the priority is to foster optimum palm growth in order to maximise fruit yield, oil output and revenue.

Immigration and squatting

One of the main secondary reasons why family groups have opted for oil palm agriculture with RAIL is to render the land unavailable for illegal occupation by immigrants. Many locals believe that immigration will increase due to the start of Wafi Gold mine, operation of the Biomass power station as well as Markham Valley oil palm and this RAIL oil palm project. The villagers expect RAIL to provide accommodation and related amenities for all its external employees so that they are dissuaded from intruding on customary land to collect fuelwood, hunt, fish or make food gardens. The villagers were informed that national government laws and regulations, RSPO and RAIL's own policies require RAIL to respond as anticipated.

Law and order

Almost all family members are concerned that increased economic activity in the area could lead to increased drug abuse, alcohol related violence, theft, gambling and prostitution. It was agreed that while incidence of these activities may rise and prove difficult to manage, every person in the area should take responsibility, abide by the law and cooperate with law enforcement agencies to combat crime. As a responsible corporate citizen RAIL is expected do its part as it currently does in other host communities towards the maintenance of law and order.

3.1.5 List of legal documents, regulatory permits and property deeds related to the areas assessed

The Environment Act 2000 defines agricultural cultivation of an area greater that 1000 hectares as a Level 2 Activity , category B with sub-categories 8.5, 9.5 and 11.4) generally our activity is Level 2B.
The Act further states that a person or company who intends to carryout preparatory work in relation to a Level 2 or 3 activity is required to register that intention in writing with the Director (CEPA MD). Proponents will simply inform the Director that it is intending to undertake preparatory work for a Level 2 or Level 3 activity and within what time period.

Upon receipt the Director will determine the level of activity based on the information contained in the permit application that is compliant with the Environment Act 2000.

When the Director makes a determination that an activity is a Level 2 category A or

B (our case category B) the Director will notify the applicant of his determination and any other additional information that may be required before he can accept the application.

Once the application has been accepted an Environmental Permit is granted or an existing Environmental Permit is amended to include the proposed project area.

3.2 HCV assessment

3.2.1 National and/or regional context

The flora of Papua New Guinea is poorly known. Estimates for the number of vascular plant species for the entire island of New Guinea range from 11,000, to 13,858, to 16,203, based on species-area relationships and publishing trends, to 20,000-25000 species (including undescribed taxa) calculated on the assumption that orchid and fern species, which are relatively well known, comprise about a quarter of the overall flora. About 6% of the world's flora is found in PNG. Endemism probably exceeds 30% for Papua New Guinea and is well over 70% for Papuasia (i.e, most species that are not endemic to the country of Papua New Guinea are endemic to Papuasia – the SW Pacific region from New Guinea to the Solomon Islands).

Papua New Guinea harbours a rich array of animals including an estimated 150,000 species of insects, 314 species of freshwater fishes (82 endemic), 641 species of amphibians and reptiles (328 endemic), 740 species of birds (600 resident; 77 endemic), and 276 species of mammals (69 endemic). Overall approximately a third of the species are endemic to Papua New Guinea and more than 70% are endemic to Papuasia. (CBD, 2010). The assessment area, as a cattle farming area, largely covered in exotic tree species, can in no way be considered a representative example of PNG's biodiversity.

Economically, PNG is a very poor country with GDP / capita at USD 2528/person (128th of 186 countries surveyed) (Wikipedia,2017). Mining accounts for about 75% of exports. Recently PNG has invested heavily in LNG extraction.

Besides mining PNG's economy is dominated by subsistence agriculture, this is relied upon by approximately 75% of the population. Agriculture, timber and fish constitute products that are sold beyond a subsistence level. The main agricultural products are coffee, palm oil, cocoa, copra, tea, rubber and sugar. As such, palm oil is an important earner of foreign exchange that PNG desperately needs.

3.2.2 Landscape context

3.2.2.1 Boundaries of assessment landscape

Although the areas listed in Table 4 are the boundaries of the assessment area; the HCV concept requires taking into account a much wider "landscape" into account in the assessment. This acknowledges how oil palm development in the assessment area will influence the larger landscape. The boundaries of this "wider landscape" are the valley floor

several kilometres to the east and west of the development area and on the northern side of the Markham River. The rationale for choice of this as a wider landscape is :

- Areas in the mountains (to the north and south of the assessment area) will be unaffected by oil palm development.
- Areas on the southern side of the Markham River will be unaffected by oil palm development.
- Areas to the east and west of the development area, down and up the valley respectively, will be affected. The general nature of the valley will be affected as this grassland, scrub, raintree mosaic gets converted to oil palm. Also, success of this scheme in the assessment area will likely have a contagious effect. Many other landowners will in turn participate.

Land Ownership

All the land which is to be included in this project is owned by clans under traditional ownership. Land is patrilineal and ownership and rights is passed down through the sons of the family. User rights amongst the land-owning clans are shared differentially between clan members based on their agreed history of settling the areas. The clans have delineated the boundaries of their land that they want included in this project. This mapping has been done in conjunction with NBPOL staff.

All land involved in the project will be leased – NBPOL has a policy of leasing, not buying land.

3 2.2.2 Land use surrounding the assessment area

The assessment area is primarily an agricultural area. However, its current productivity / utilisation is very low. Agriculture in the area has involved the trial of many crops with none being successful. Landowners are now very wary of getting into new ventures without proof of success.

The main land uses in the area are:

- Grasslands (not put to any commercial use)
- Cattle grazing
- Rain trees (not put to any commercial use)
- Subsistence Farming
- Gold Mining
- Biomass Project
- Markham Valley Farms (oil palm project)

3.2.2.3 Land cover

The vegetation in the assessment area consists predominantly of open grassland. Studies indicate that these grasslands are anthropogenic and the original forests were converted 1500-2000 years ago (Garret-Jones, 1979). The people in the area have a most unusual fascination with fire and seem to setting fire to areas of grass. This can be seen on the roadside

and even right up on the hills. In some cases, this is for hunting, but often there doesn't seem to be any purpose to this, just something to do.

The grassland climax, now established is maintained by burning and cattle grazing. Based on these factors Daemeter considers the grassland areas to be a highly modified environment of very low biodiversity value.

The other vegetation in the area consists of copses of trees. These introduced trees are predominantly rain trees *(Samanea saman)* which were planted by the graziers to give shade to the cattle. They have subsequently seeded out, spread by cattle. They have now become quite widespread and should be classified as invasive. In some areas stands of *Glyricidia sepium* remains from abandoned vanilla farms. Although this is an exotic tree it is not considered invasive as the *Samanea saman* is. There are some intermediate pioneer native species forming beneath the canopy; these are *Myristicia, Litsea, Dysoxylum* and *Elaeocarpus* also rattan vines.

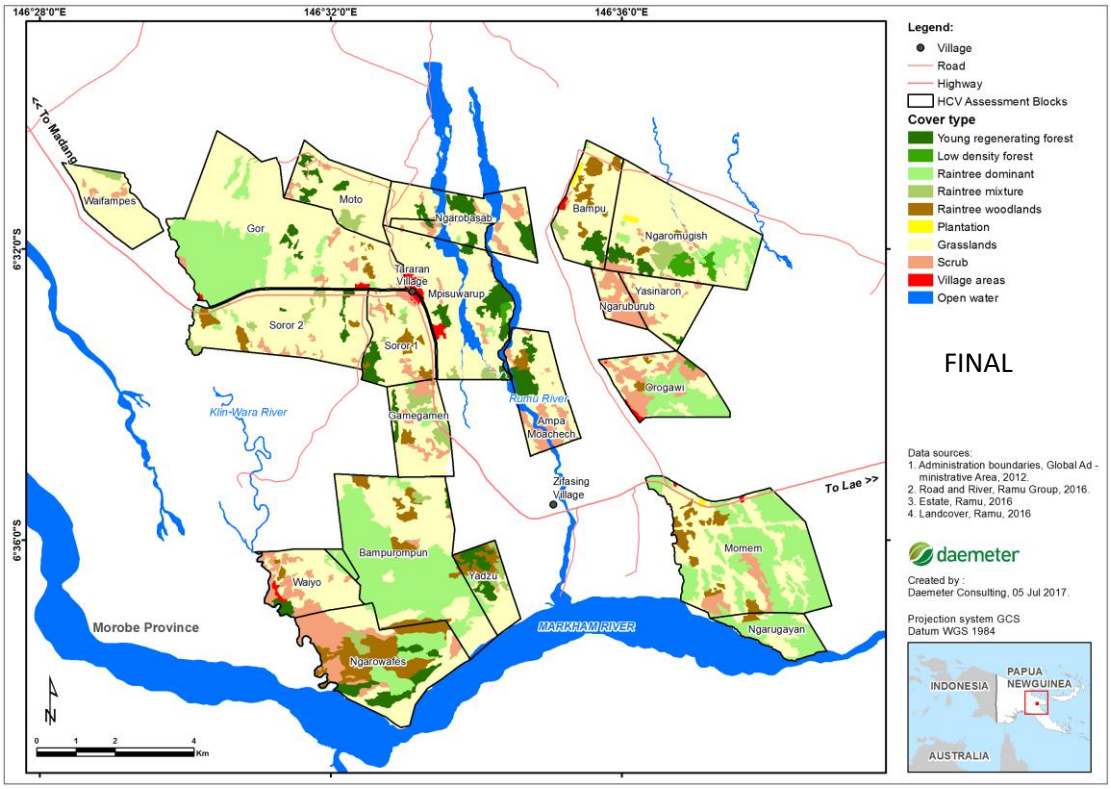


Figure 9. Landcover in and around the assessment area.

Table 11. Landcover definition

Classification	Description

Grasslands	Most of the grasslands of the Markham Valley are considered to be of anthropogenic origin, maintained by a near annual, low intensity fire regime. The grassland communities found within the assessment area can generally be classified as the either the *Imperata cylindrica* (Kunai)/*Saccarum spontaneum* (Wild Sugarcane) dominated 'tall grasslands', or the *Themeda australis* (Kangaroo Grass)/*Capillipedium parvifolium* dominated 'short grasslands'. Scattered occurrences of small trees (such as *Glochidion drypetifolium*), shrubs (such as *Solanum spp*) and the fire resistant cycad *Cycas schumanniana* are also common features though out the grassland communities observed within the assessment area. The distribution of these broad grassland community types seems to be primarily driven by drainage, soil type and local climate (Henty, 1982), with the swards of short grasslands occupying relatively dryer sites in general, compared with those occupied by tall grasslands.
Scrub	Area in this category are ecosystems that have undergone intense and/or frequent disturbance events that are mainly of anthropogenic origin. This also includes areas of vegetation that are under a system of shifting cultivation. This may include areas in fallow (i.e. resting) or areas in current use. This vegetation is typically low in diversity, is dominated by pioneering species and shows evidence of the repeated use of fire. In the assessment area, common species common species observed were; *Piper aduncum, Trema orientalis, Macaranga tanarius, M. aleuritoides, Leea indica, Kleinhovia hospita, Hibiscus tiliaceus and variety of Ficus spp.*
Rain Tree *(Samanea saman)* dominated vegetation	The introduction of *S. saman* into the area as a fodder / shade tree from the 1950's and subsequent easing of grazing pressure across many of the individual study sites from the mid 1970's has resulted in large areas being dominated by stands of *S. saman* regrowth. Such vegetation includes areas of almost pure stands of *S. saman*, stands of *S. saman* mixed with young regenerating forest and stands of *S. saman* in an open woodland structure.
Rain Tree *(Samanea saman)* - dominant	Such stands generally have a closed canopy and possess little understorey. Recruitment of *S. saman* is often low as the low-light conditions created by the dense canopy are not ideal for seedling establishment. This vegetation class represents the dominant form of woody vegetation throughout the assessment area.
Rain Tree *(Samanea saman)* – mixed with young regenerating forest	Stands falling into this category are some of the older *S. saman* stands (40-50yrs) and possess a developing understorey of secondary rainforest species. Many of the rainforest species are currently co-dominant with the *S. saman* canopy, and it is expected that in the absence of *S. saman* recruitment or further disturbance, lowland rainforest species will eventually dominate the site. These stands do not qualify as young regenerating forest as the basal area of native species is < 50%. Species such as *Mangifera minor, Myristica hollrungii, Trema orientalis, Endospermum medullosum, Nauclea orientalis, Alstonia scholaris, Sterculia schumaniana, Gulubia costata and Dysoxylum sp* are common.
Open grassy woodlands (Savannah)	The grassy woodlands or savannah present within the assessment area are characterised by grassland communities similar to that described above, but have a low stocking (i.e. projected canopy cover of less than 30%) of canopy trees present. The community is simple in structure and usually dominated by the exotic legume *Samanea saman* with lesser occurrences of native species with a degree of fire resistance, such as *Adenanthera novo-guineensis* or *Nauclea orientalis.*

Young regenerating forest	Forest represented by this category are generally native secondary rainforest species that have established under the dense *S. saman* canopy, and are in the process of dominating the site. Basal area (BA) was the primary metric used to determine the presence of this class as per the note in HCSA (2015) pp 37 'abandoned plantations with <50% of the BA consisting of planted trees could be considered to be young regenerating forest'. Hollow-wood assumes two points when using this note to determine potential young regenerating forest; 1) that by proving this note, HCSA (2015) acknowledges the often vigorous nature of regenerating rainforest and 2) that dense stands on S. saman are functionally identical to 'abandoned plantations' i.e. they are both exotic, woody, perennial monocultures. Species such as *Mangifera minor, Myristica hollrungii, Trema orientalis, Endospermum medullosum, Nauclea orientalis, Alstonia scholaris, Sterculia schumaniana, Gulubia costata* and *Dysoxylum sp* are common.
Low density forest	Forest represented by this class are either highly degraded, remnant native forest or advanced secondary regrowth forest. Stands falling into this class are of very limited extent within the assessment area, and generally occur in riparian zones or in swampy areas. Characteristic species seen during this assessment are; *Ficus spp*, *Trema orientalis*, *Macaranga spp*., *Dysoxylum spp*., *Neuburgia corynocarpa*, *Horsfieldia irya.*

3.2.2.4 Major landforms, watersheds and rivers

Landforms

The Ramu/Markham valley is unique to PNG. It affords wide open country with very little forests flanked by high mountain ranges. A prominent feature of the Ramu-Markham Valley landform is the vast amount of sediment carried down the rivers. The majority of this is coming from the uplifting Finisterre and Saruwaged Ranges. Just north of the proposed project area Rumu River has created a fan deposition sometimes referred to as a piedmont. The repeated shifting of a stream from one side of a fan to the other spreads the sediment widely and almost uniformly. As the sediment eventually grows together, the slope may extend outward from the mountain front to a distance of several kilometres. This is seen in the case of the Rumu River and more so in the cases of the Klin Wara River, both of whose large sediment load have acted to deflect the course of the Markham River southward.

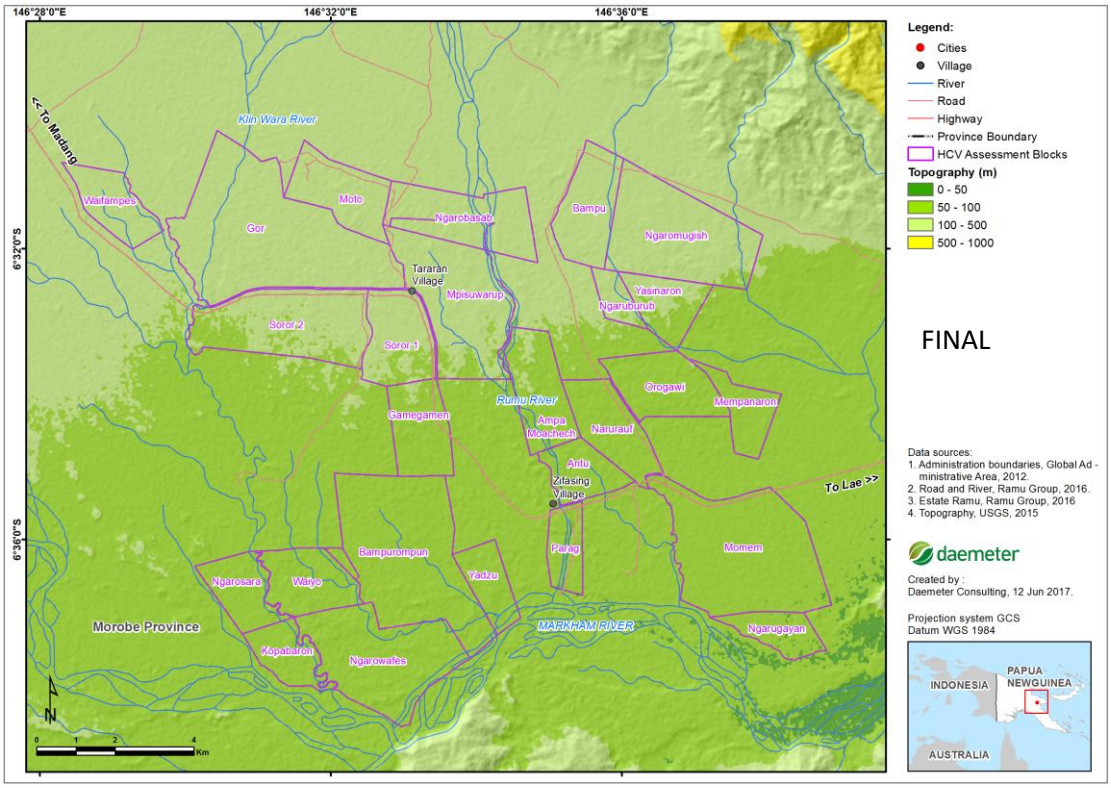


Figure 10. Elevations – blocks near the Markham River are approximately 50 masl. There is a gentle slope upwards to the main road, with most blocks to the north of the main road just over 100 masl.

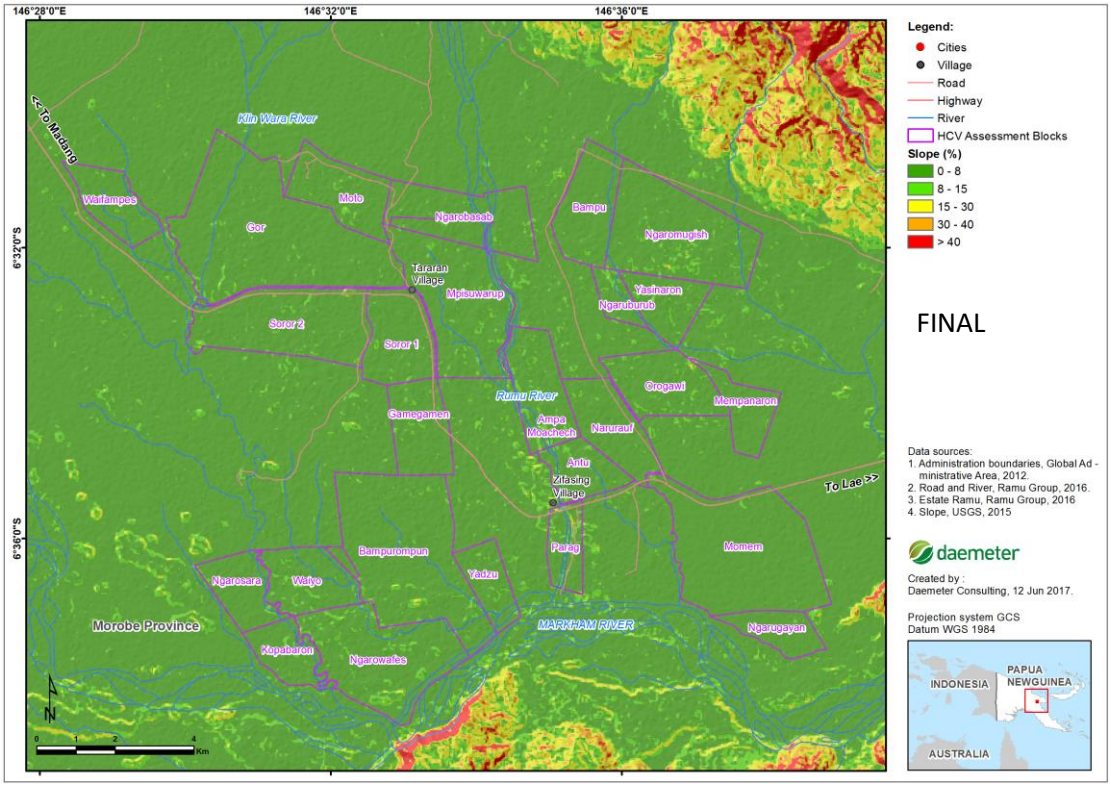


Figure 11. Slopes - all the blocks are on very flat areas. Slopes are less than 8% throughout the assessment area.

Rivers

The Markham valley is drained by the Markham River. This river, where it traverses the assessment area, is several hundred metres across. It forms braided canals which are turbid and fast flowing. The base of the river is river gravels.

From the mountains that line either side of the valley are a number of tributaries which feed into the Markham River. All the tributaries that run through the assessment area have their headwaters in the Finisterre Range (to the north).

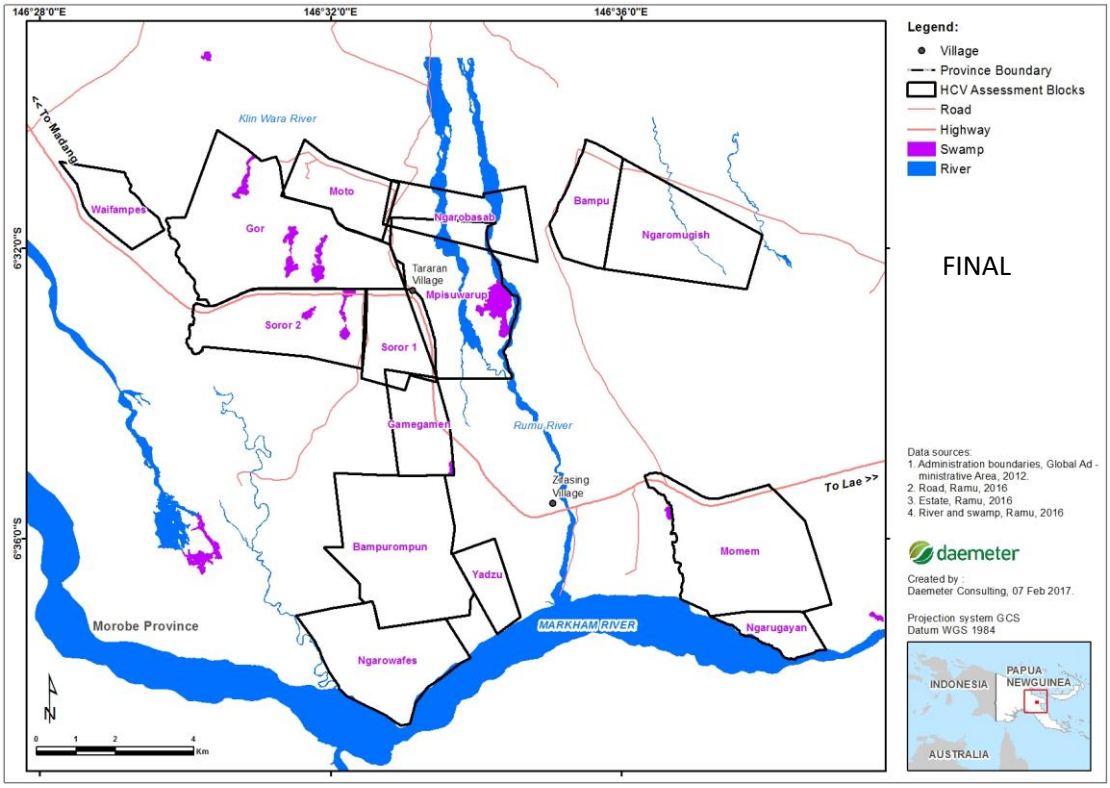


Figure 12. Rivers - the largest river is the Markham which flows along the southern boundary of the assessment area. The other significant river is the Rumu, which has its headwaters in the Finisterre Ranges. There are other smaller rivers and swamps within the assessment area.

3.2.2.5 Land Ownership and Leases

All the land in the assessment area are customary land and owned by clans in the area. NBPOL will be offering leases of a 25 or 45 year term.

3.2.2.6 Social and Cultural Values

The two main villages in the area are Tararan and Chivasing which are located on the main road between Lae and Madang / Goroka (the location of these villages is mapped in Figure 12). Most people living in these areas have gardens located near these villages. These villages have sprung up after the construction of the main road when people moved closer to the road and old villages were abandoned. Additionally, there are small hamlets that consist of a few houses dotted around the area.

The lands that will be part of this new development are owned by families. They may have additional area beyond what is included for development

Based on the 2011 census figures the population of Tararan is 1,423 and Chivasing is 2,554 (PNG,2011). There are basic services available in the area such as churches, primary school, health clinic and police station. Most of the people are Christian denominations such as Lutheran, Revival, Seventh Day Adventist, Evangelical Brotherhood.

3.2.3 HCV outcomes and justification including summary table

Of the total assessment area 10,652 ha, 1062 ha was considered HCV and the remaining 9590 ha was non-HCV.

HCV Presence

Table 12. Summary of HCV Presence

HCV	Definition	Present	Potential	Absent
1	Species diversity			
2	Landscape-level ecosystems and mosaics			
3	Ecosystems and habitats			
4	Ecosystem services			
5	Community needs			
6	Cultural values			

3.2.3.1 HCV 1 - Species Diversity

Protected areas

Key Question	Outcome
Does the assessment area or surrounding landscape contain either of the following categories of Protected Areas (PA)? • Legal Protected Areas, • Global conservation priority sites	**Not Present**

Justification

No protected areas are known within the assessment area.

Concentrations of biological diversity

Interpretation

Key Question	Outcome
Is the assessment area or the adjoining landscape known or likely to contain areas with concentrations of biological diversity including endemic	**Not Present**

species, and rare, threatened or endangered (RTE) species that are significant at global, regional or national levels?	

Birds

Twenty one bird species were sighted during the survey that are classified as :

- IUCN Vulnerable or more threatened.
- Or CITES Appendix I or II
- or Endemic.

This yielded a list of 23 bird species. All of these are locally abundant and are forest dwelling species. It was thought by the assessor that they were transiting from the forest areas on the south of the Markham River to the forest areas to the north of the assessment area. The exception are grassland species:

• The Black Kite (Milvus migrans) which seem to do exceptionally well in oil palm areas in PNG, thriving on the rats that live in the oil palm.

• The Whistling Kite (Haliaster sphenurus) are able to forage for food over a wide area across the landscape. They have also been observed to spend a considerable amount of time along the highway which traverses the landscape. They feed on roadkill and also capture animals that are fleeing from bush fires which are a common occurrence within the Ramu-Markham valleys. They may not be considered of the conservation value in the local context since they easily adapt to new areas adjacent to the development areas once these areas are cleared for planting of oil palm.

The assessment area is not an area that lends itself to rich biodiversity. The areas surveyed were originally completely grassland or savannah. The Samanea saman trees that now litter the landscape only started appearing after the introduction of cattle and horses. The low diversity of bird species in patches of Samanea saman trees shows that native bird species have not yet adapted to feeding on Samanea saman trees. Though Torresian Crows seem to favour Samanea saman patches for roosting and foraging in the understory for food. They display similar adaptability to oil palm plantations and are often found in them. The grassland areas are foraging areas for some bird species, but not all. Most of the forest dwelling bird species tend to remain within natural forested areas and venture occasionally to the forest edges and transition areas between forest and grassland.

Regarding endemic species (e.g. New Guinea Scrubfowl and Red-legged Brush-turkey), the assessor didn't believe the population within the assessment area was "representing a substantial proportion of the regional population." These species a locally common and the HCV 1 corridors that are defined in the next element of HCV1 will cater for these species.

Flora

Examination of the flora that was present in the area showed that there was an over-storey of rain trees (*Samanea senam*) which is an exotic tree species, introduced to provide shade for the cattle. These trees have subsequently spread throughout the assessment area. Beneath the rain trees are a mix of native pioneer and mid pioneer species. It is not clear when these regenerating forests will, if ever consist of solely native species and do not

represent the forests that are considered natural in this anthropogenic landscape. Although these are native species, none of these are IUCN listed.

Mammals

Literature reviews of the Ramu-Markham Valley indicate that there are no extant mammal species that falls within the Threatened categories of the IUCN listings. This was confirmed in the assessment area by the field survey.

Reptiles

Crocodylus novaeguineae are CITES Appendix II. Crocodiles were not observed in the area. Anecdotal accounts purport that there would not be a population of crocodiles in the Upper Markham rivers (where the assessment area is located) due its fast-flowing nature and the difficulties that may pose to crocodiles in searching for food resources. Populations of crocodiles are concentrated downstream towards to mouth of the Markham River (50 km away).

Summary

Findings in the assessment area

All the vegetation, reptiles, amphibians and mammals that are present or potentially present in the assessment area are not under any threatened category or IUCN listing. For birds, some of which are endemic and / or CITES listed, the crucial point is that the species that were sighted are forest birds that were thought to be transiting this raintree woodland. The birds were using this area as a corridor not as a place to live.

For this reason, this element of **HCV 1 was deemed not present in the area.**

Spatial and temporal concentrations of species

Interpretation

Key Question	Outcome
Is the assessment area or the adjoining landscape known or likely to contain critical temporal concentrations of species?	**Present**

Justification

Corridors

The critical word in the guidance here is “corridors.” Currently forest birds such as Blyth's Hornbills and the Palm Cockatoo are using swamp areas (where natural vegetation still remains) as stepping stones as they migrate between the forests to the north and south of the assessment areas. Currently the rain trees, the dominant vegetation cover, do not act as

corridors for birds (only Torresian Crows were seen in the rain tree patches). However, if NBPOL plants high standing trees and fruit trees within the buffer areas along the creeks and rivers, in between the rain trees, or selectively clear the rain trees. This will increase the viability of these buffer areas to accommodate for bird species that are moving across the landscape.

All the endemic species (which are locally common) are natural forest dwelling species. The natural forest areas are to the south of the Markham River and to the north of the assessment area. The assessor believes the birds were transiting over the assessment area between the forest blocks.

The Rapid Biodiversity Assessment that was undertaken as part of the HCS assessment has found a couple of forest patches where natural forest species have now become the dominant cohort in the patch (Hansby 2017a). The rain trees have been acting as a nurse crop, but it is thought that the natural forest species will grow above the rain trees and these light demanding species will die out. These will act as stepping stone areas for all bird species; but of particular concern are the endemic and CITES listed bird species. These will enable them to migrate from the northern to the southern side of the valley.

Migration

The avifauna that have been observed in the development areas surveyed were mostly resident species. The only species which was identified as a possible migrant was the Torresian Imperial Pigeon (*Ducula spilorrhoa*). Observations in the field suggest that the Torresian Imperial Pigeon is feeding on flowering trees on the natural forest[3] edges; i.e. the transition between grassland savannah and the secondary forest areas. This species may be temporarily inhabititing forest edges and secondary forest en route to the southern coastal regions of Papua New Guinea. Locals pointed out that they were unfamiliar with the species and that it had just moved into the area recently and is only seen seasonally. It is likely that the species traverses the Ramu-Markham Valley from the north coast of PNG and the makes its way to the southerm part of PNG especially towards Western Province.

Two migratory species that are known to traverse this area are the Eastern Great Egret and the Oriental Dollarbird. Neither are threatened species. The former has a resident and migratory variety (visitor from Australia). The bird specialist has sighted the resident variety in the Ramu-Markham Valley but not the migrant variety. The Oriental Dollarbird visits PNG during the Australian winter. This species was not observed during this survey, but has been observed in other surveys in the Ramu-Markham Valley (at Ramu in May 2016 and Leron in September 2017).

The Whistling Kite (*Haliaster sphenurus*) is listed as migratory but the assessor believes that the website may be referring to populations of the species in other parts of the globe. Populations of Whistling Kites in the Markham are thought to be resident.

[3] The forest areas in the assessment area are not really “natural forest” as they are predominantly introduced species. But there is natural forest on the southern side of the Markham River.

Findings in the assessment area

Birds that are either endemic or CITES listed are forest birds that would be transiting between forest areas to the north and south of the assessment area. They are currently using forest areas around swamps as stepping stones. The assessor believes that if efforts were made to transition the rain tree dominated riparian strips to natural forest species, these areas would be considered HCV as corridors. Additionally, two patches of forest with secondary forest species present were added to HCV1 as it was felt they may well be used by birds as stepping stones.

Therefore, this element of **HCV 1 was deemed present in the swamps and riparian areas.**

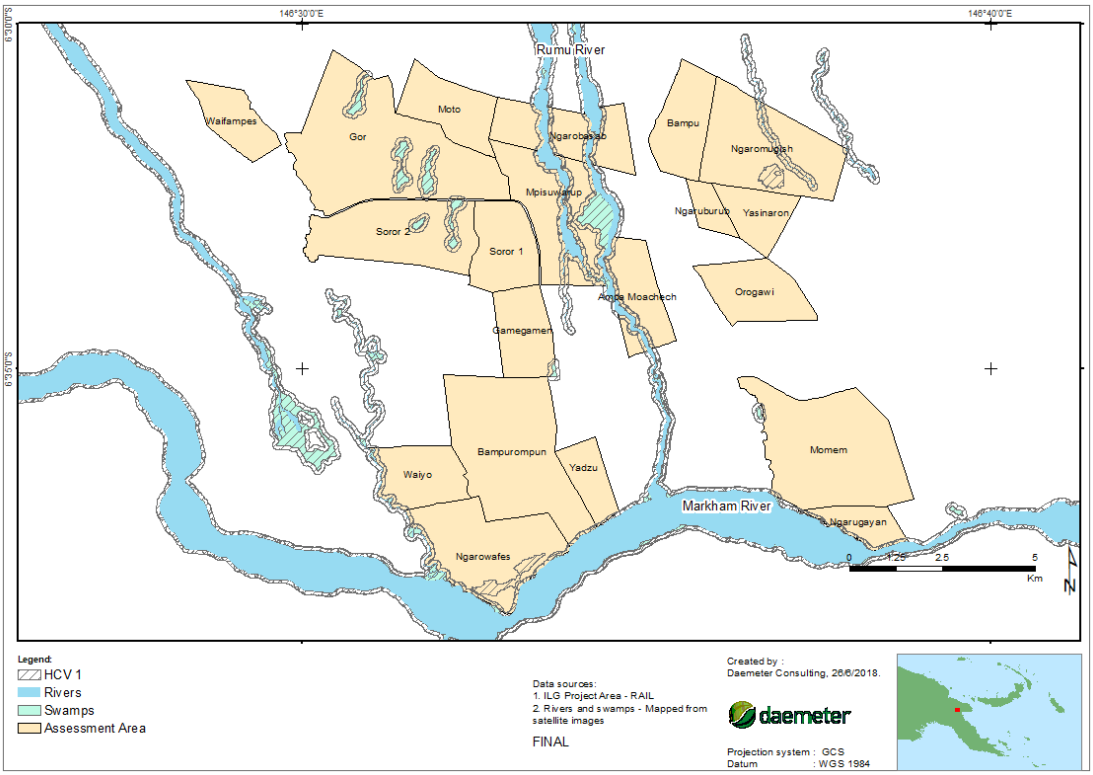


Figure 13. The HCV 1 area, which includes swamps and small secondary forest patches as stepping stones for birds. Also the river buffers as potential bird corridors. This would involve planting natural forest species along the river corridors. The total area of this HCV is 1048.75 ha (within the assessment areas).

3.2.3.2 HCV 2 - Landscape-level ecosystems and mosaics

Interpretation

Key Question	Outcome
Does the assessment area or surrounding landscape contain intact forest landscapes (IFL), natural ecosystems or ecosystem mosaics which are large in extent, largely un-fragmented, form significant components of the landscape or are of significant importance at a local, regional of national level, and which contain most of the naturally occurring species?	**Not Present**

Justification

The IFL are confined to the mountain tops and there is no connectivity with the assessment area. Furthermore, the landscape is heavily altered by humans, with no few patches of undisturbed forest on the plains and none in the assessment area.

3.2.3.3 HCV 3 - Ecosystems and Habitats

Interpretation

Key Question	Outcome
Does the assessment area or surrounding landscape contain ecosystems that are naturally rare, have become rare due to past processes, or threatened by current and future processes?	**Not Present**

Justification

Unfortunately, Daemeter was not able to identify any ecosystem mapping that had been undertaken over this area. To identify HCV 3 based on the CG criteria for HCV 3, a combination of geomorphology and vegetation mapped by the Land Research Mapping Program conducted by the Australian Government in the 1970s were used as a proxy for ecosystem types. (CSIRO,2010a and CSIRO, 2010b). These maps show that the assessment area overlays a very common ecosystem type – that is "grasslands on alluvium." These are not considered **endangered**.

Findings in the assessment area

"Grasslands on alluvium" are geomorphologies and vegetation types that are dominant throughout the Ramu – Markham Valley and used as a proxy for an ecosystem in this study. These are not considered endangered because they are not forest and the grasslands that are present are ex-agricultural grasslands and not native grassland eco-systems. **HCV3 is therefore deemed Not Present.**

3.2.3.4 HCV 4 - Ecosystem services

Protection of water catchments:

Interpretation

Key Question	Outcome
Does the assessment area or surrounding landscape contain areas that are critical to the protection of water catchments?	**Present**

The main river that flows through the assessment area is the Ramu with the Markham flowing alongside a number of blocks. There are many small watercourses (2 – 3 m in width) that run

through the blocks e.g. Kiln wara which flows which flows within Gor Block. Additionally, there are many swamps.

For this assessment the RSPO PNG riparian buffer guidelines are used (Table 29). Additionally, 100 m buffers are required around permanent swamps. Once again, many of these swamps are very small and do not require a 100 m buffer. The seems excessive given that the communities often use these areas to plant crops in the swampy areas during dry season. 100m buffers are mapped around the larger (mapped) swamps. For small swamp areas the buffer should be 20 m.

Important Note: For this assessment, Daemeter attempted to map watercourses and swamp areas, but this should not be considered a comprehensive mapping exercise. Any unmapped watercourses or swamps within the blocks should have the riparian buffer maintained or re-established with a 10 m or 20 m buffer respectively.

Findings in the assessment area

Numerous rivers are present throughout the assessment area. Communities are dependent on all of these rivers. Additionally, there are lakes and swamps in the assessment area. **This element of HCV 4 is therefore Present.**

Control of erosion of vulnerable soils and slopes

Interpretation

Key Question	Outcome
Does the assessment area or surrounding landscape contain areas that are critical for preventing soil erosion?	**Present**

HCV 4 occurs in areas where natural vegetation types (e.g. forest or native grasslands) in good condition are required to help prevent erosion, landslip and gullying, especially where such events would have a critical impact on people or the environment.

Justification

The assessment area is generally flat, so there is very little risk of hillside erosion. Nevertheless, there are a number of areas where the estates border a main river. Riparian buffers will reduce erosion, but in times of flood any vegetation more significant than grasses will be ripped out and washed down the river. Therefore in buffer areas where the natural vegetation has been lost, selection of species to be planted in this area is very important.

Fire Prevention

This area is very fire prone. The local people have something of an obsession with lighting fires in the grasslands. Sometimes fire is used for hunting. Usually the fires just burn out due to wind changes blowing them back on themselves or the fire runs up against a recently burnt area. Nothing in the area can be considered a natural fire break.

Findings in the assessment area

Some blocks are located next to large rivers where the river bank area requires protection. **For this reason, this element of HCV 4 is deemed to be present.**

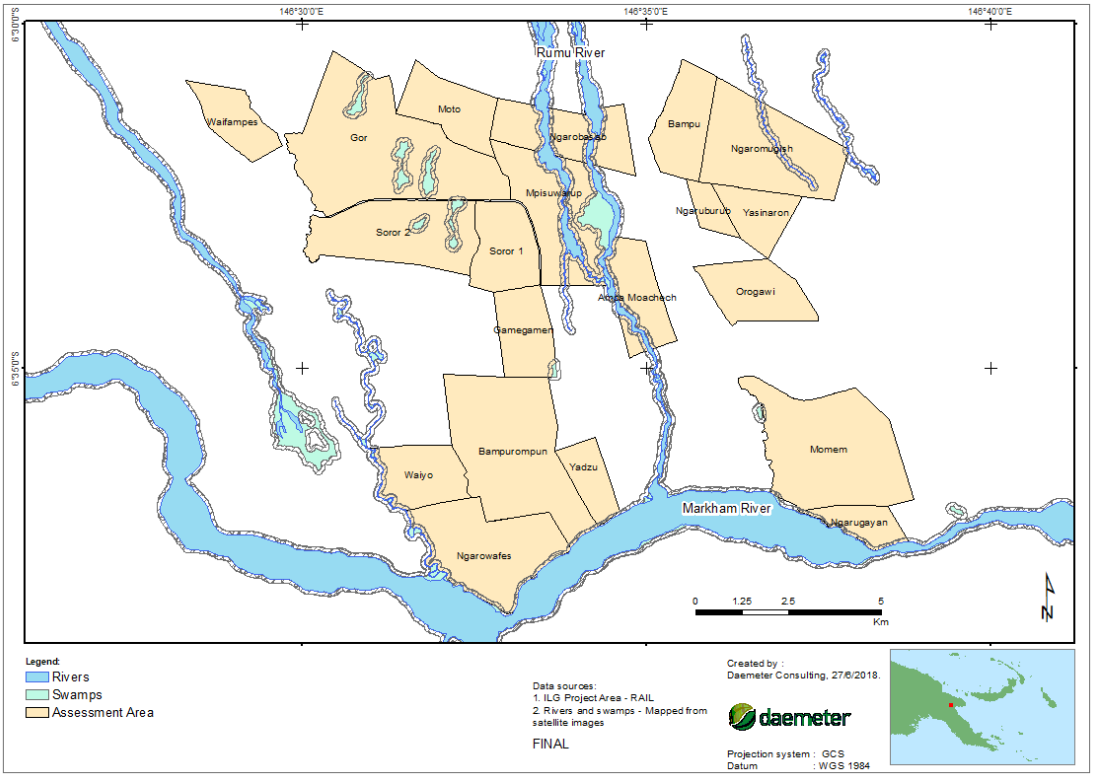


Figure 14. HCV 4 - which includes 100 m buffers around swamps and 50 m buffer (left and right) around smaller (but mappable) rivers and 100 m buffer (left and right) beside large rivers (Rumu and Markham). These buffer are wider than the guidelines given the shifting nature of the rivers. The total HCV 4 area is 943 ha

3.2.3.5 HCV 5 - Community needs

Interpretation

Key Question	Outcome
Does the assessment area or surrounding landscape contain sites and resources fundamental for the basic necessities of local communities or indigenous peoples?	**Present**

Discussion of each basic need

Food

The area around the villages is made up of a matrix of secondary forest, scrub, grassland and gardens. Most food is cultivated in gardens, however there is other food that is gathered in the forest or from scrub and grassland.

Carbohydrates

The basic carbohydrates that are grown are bananas, taro, tapioca (cassava), pumpkin and kumara (kaukau). These are the crops that the community is most dependent upon. Sago is

harvested from naturally growing sak-sak that grows in swampy areas, however this is a fall back foodstuff. It seems that sak-sak constitutes a small proportion of the diet.

Interestingly there is a transition towards eating rice.

There are some gardens located in the assessment area. Almost all gardens are currently located in and around the Tararan and Zifasing villages, which are outside the assessment area.

Fruits

The main fruits grown are watermelon, pawpaw, guava, bananas, sugar cane and pineapples. Coconuts are harvested from palms that grow in the area – both the milk and the meat are key ingredients in the peoples' diets. Bread fruit, coconuts and mangoes are harvested from trees that grow in the forest. The coconuts tend to grow on forest margins and have been planted. Generally, there is fruit in season throughout the year, but fruits are more plentiful in dry season. The availability of these fruits would not be affected by the development.

Vegetables

The main vegetables grown are aibika (like silverbeet), capsicum, spring onions, eggplants, cucumbers, taro, pumpkin, pumpkin tips (the leaves of pumpkin) and sweet potatoes. Importantly, a lot of other vegetables are brought down from the highlands and can be bought at the markets; these include carrots, cabbage, broccoli, beans and onions.

Sigoga (watercress), ferns, bread fruit, mosong (ficus leaf) and two-leaf are harvested from the forest (or areas that are not cultivated). Typically, "gathered" vegetables are not a large part of the diet.

Nuts such as garlip nuts and taun nuts are gathered from the forest. These forests are not in the assessment area.

Protein

People mentioned that they ate either fish or meat on average 4 days per week.

Fish

Fish is an important source of protein. Fish are caught in the rivers that flow around the area, the most important is the Markham River. There is also the Chichingaimoro Lake which is used by the Orogwangin Clan as a place for fishing. Fish are caught with nets, lines and spears. Some people mentioned using poison rope *(Derris trifoliata)* for killing fish.

Additional to caught fish, people bought both fresh and tinned fish at the market.

Meat

Meat is either sourced from domestic animals (pigs or chickens) or hunted (wild pigs, bandicoots, flying foxes, bats). Fire hunting is an important source of protein for the local communities.

Meat is also available from the market, this includes sausages, sheeps' tongues, lamb flaps, crocodiles and tinned spam. Without refrigeration, obviously, meat has to be eaten very promptly.

Water

Water availability was good throughout the area. People relied on ground water that was accessed through wells. The wells were typically 7 – 8 m deep and lined with drums. Water could be drunk directly from the wells.

Toilets in the area were typically just simple pit latrines with no associated plumbing. Once they were full they were covered up and dug somewhere else.

Some people rely on water within the assessment area, though water availability and quality should not be affected by the development. This is the reason why all river and swamps are buffered by a riparian strip which is considered HCV 5.

Construction Material

Almost all material used for home construction is sourced from the natural environment. Kunai grass or sago is used for roofs. These are surprisingly waterproof and much cooler than tin roofs, with the only disadvantage that thatched rooves last for 5 – 10 years and are not good for collecting rain water. The house piles and framing material is made from kwila (the timber that they call kwila is actually *adenanthera* spp that is common on the grasslands). Many of the buildings were held together with rattan rather than nails.

Occasionally houses are made from tin roofs and sawn boards. These were very expensive to construct. A lot of the houses have dirt floors and all use long drops as toilets.

People take construction material from within the assessment area. Although, they have access to these materials in their vast lands outside the assessment area. These lands external to the assessment area are mapped as HCV 5.

Furniture / Utensils / Equipment

PNG houses do not typically do not have a lot of furniture. People sit on the floor using mats made from sak-sak leaves, but plastic tarpaulins seem to be more common. Utensils and plates are usually bought.

Cooking Fuel

All cooking is done on open fires. These are fueled by coconut shells / husks and various wood species collected from the gardens or the forest. People don't have to walk far to gather appropriate material. Cooking fuel availability would not be affected by the development.

Medicine

There was a local clinic in Chivasing which people accessed for all but very simple maladies. The clinic cost K3 per visit, so must be funded by the government. Anything that was more complicated had to be referred to Lae, it was very expensive to access healthcare there. Traditional medicine was still used for minor issues. Traditional medicine availability would not be affected by the development because the plants were planted around villages.

Fodder

Fodder consisting of leftover food of no special variety is used to feed pigs and chickens.

Clothes

People wear western clothes but during festivals (sing-sings, weddings) they wear tapas cloth (made from bark and paper mulberry) and grass skirts (made from sago).

Cash Income

Food grown in excess of peoples' own requirements is usually sold in the market to get cash for various purchases (e.g. vegetables from the highlands). Other sources of income included cash from leasing land to PNG Biomass, running cattle on their land, selling cocoa or simple handicrafts such as billim bags at the markets.

Hunting

Hunting is typically done by men. They use spears (for cuscus, pigs and bandicoots), trapping and slingshots (for birds and flying-foxes). People often use fire as a hunting tool, burning the grassland which scares out various animals. See the above section on utilizing fire to hunt.

Spotted cuscus are hunted but they live in the natural forest areas outside the wider landscape. There were even crocodiles in the Markham River, supposedly 2 – 3 of these get killed every year and the meat is shared out. As stated in the HCV 1 section, the Markham River is fast flowing where it passes by the assessment area (which would be dangerous to hunt and not crocodile habitat). Based on community interviews, the crocodiles are hunted in the lower stretches (near the delta), which are outside even the wider landscape.

People do hunt in the assessment area, but there is a vast amount of land available outside the assessment area (which the currently hunt on also). This land outside the assessment is HCV 5 area.

General Comments about Resource Usage

There were a number of common observations or comments that came through in the interviews and general discussions with the people during the survey. In summary, these are as follows:

- There are land disputes everywhere which inhibits the effective utilization of land. The assessors saw where NBPOL had planted some oil palms (as test palms) and these had been subsequently sprayed with herbicide – retribution for a land dispute. Resolving these disputes is an expensive and time-consuming process. Consequently, they have been left unresolved. The people are looking to NBPOL to help resolve these disputes.
- Theft has inhibited utilization of land. Cattle theft is common and a major disincentive to run cattle on properties.
- The land is very fertile and wild fruits, particularly paw-paws grow everywhere. It appeared that relatively little land is required to support the population. There is a lot of land available and the level of utilization is very low.
- People were asked about the availability of fish and animals that are hunted over their lifetime. Everyone said that there had been no major change with respect to fish and

if anything pigs had become more abundant (probably as the rain trees became more abundant and the size of habitat increased). This indicates that the rivers and the general environment are in good condition.

- Probably because of the abundance of resources, there did not seem to be the same necessity to move to a cash economy compared with other areas that had been assessed by Daemeter in PNG.
- The major villages were on the side of the highway and there were power lines within the village. Only a few houses were connected to electricity, which was generally used just for lighting. One respondent mentioned that he had a rice cooker. Nevertheless, most people had solar panels, which charged car batteries and these in turn were used for charging hand phones and running lights.

A participatory mapping exercise was undertaken to show that external to the assessment area, the ILGs had very extensive areas that they could still source grass, poles and pigs (as such these areas would be classified as HCV 5). The resulting participatory map is shown in Figure 15, which shows the extent of the ILGs' lands external to the assessment area (hatched area). Given that there is such a large land bank for resource extraction "outside" the assessment area. This external area is mapped as HCV5.

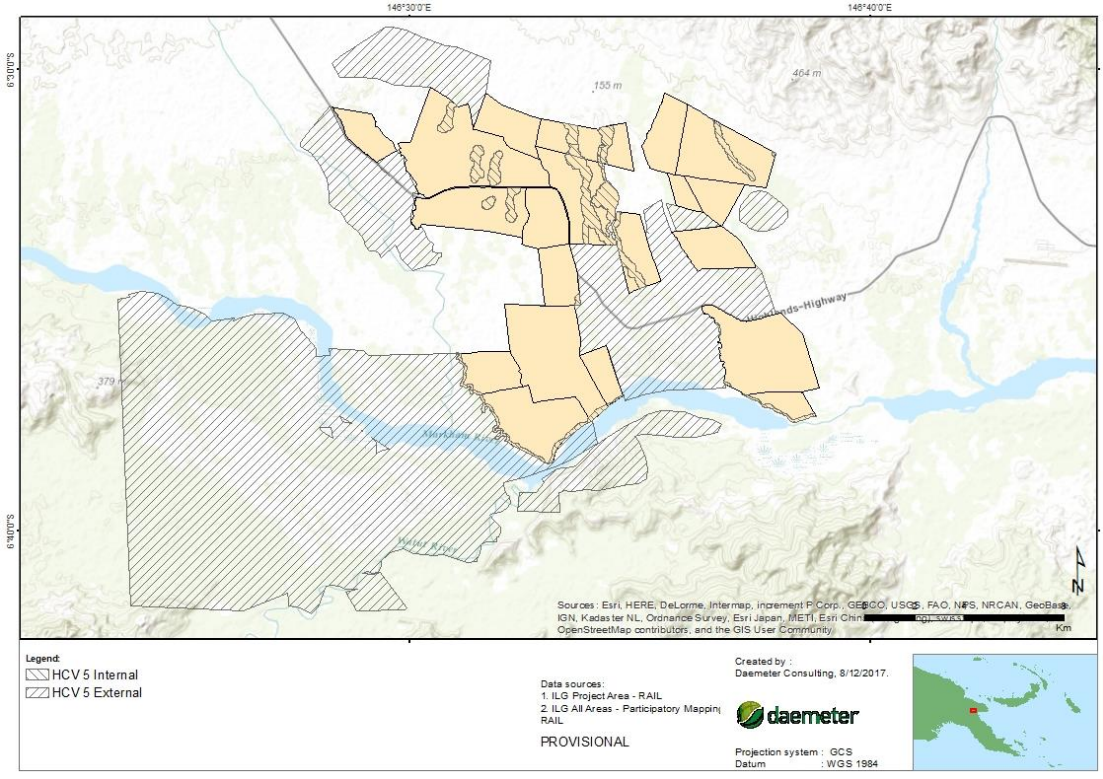


Figure 15. HCV 5 areas consist of internal areas 943.36 ha and 37131.5 ha external to the project area. The internal HCV 5 areas are focused around buffers around rivers, swamps and springs in recognition that the water must remain potable (there is a heavy reliance on these areas as a source of drinking water). The health of the river is important also as a source of fish. The map is labelled "provisional"

because there are a number of disputes that are currently being resolved, these will cause boundaries to change.

Findings in the assessment area

The communities living in and around the assessment area are reliant on natural areas for meeting their basic needs. Of note are timber and grass for house construction and the occasionally hunted animal for eating. These resources are currently sourced throughout the whole landscape at a very very low extraction density. The plan is that post-development; hunted meat, timber and kunai grass will be sourced external to the assessment area. HCV 5 (hunted meat, timber and kunai grass) is mapped over the areas **external** to the assessment area. This is considered a vast and largely unutilised land bank for resource extraction. Additionally, HCV 5 is mapped **within** the assessment area over the swamps, springs and rivers; these areas are important as a source of fish and water (drinking water was typically taken from ground water). **Therefore HCV 5 is deemed Present**.

3.2.3.6 HCV 6 - Cultural values

Interpretation

Key Question	Outcome
Does the assessment area or surrounding landscape contain areas that are tied to cultural values critical to the traditional cultural identity of local communities, including areas of cultural, ecological, economic, religious or archaeological significance?	**Present**

Justification

There are a number of old villages, cemeteries and sacred places *(ples masalei)* within the development area. When the highway was built, people moved their villages close to the road. In many cases the old village sites are used as gardens and most villagers said these places were marginal as areas to be reserved from development. *Ples masalei* tended to be sak-sak areas; in many cases they were protected by mythical two-headed snakes and any development around these areas would require sacrificing an animal and calling out to the snake and explaining what was happening.

Sago harvesting was something of a grey area. Everyone said it was part of their culture, but at the same time, when the assessor asked how often they harvested sago. People stated it was a thing of the past and few people knew how to harvest it anymore. Using the precautionary approach, as sago was considered part of the local people's culture. It was considered HCV 6. Sago areas are labelled in Figure 16 they are very small and only grow where a spring rises to the surface.

A 50 m buffer zone is demarcated around HCV 6 sites to ensure there is no disturbance of the area. There are seven HCV sites identified, with a total area of 22.21 ha.

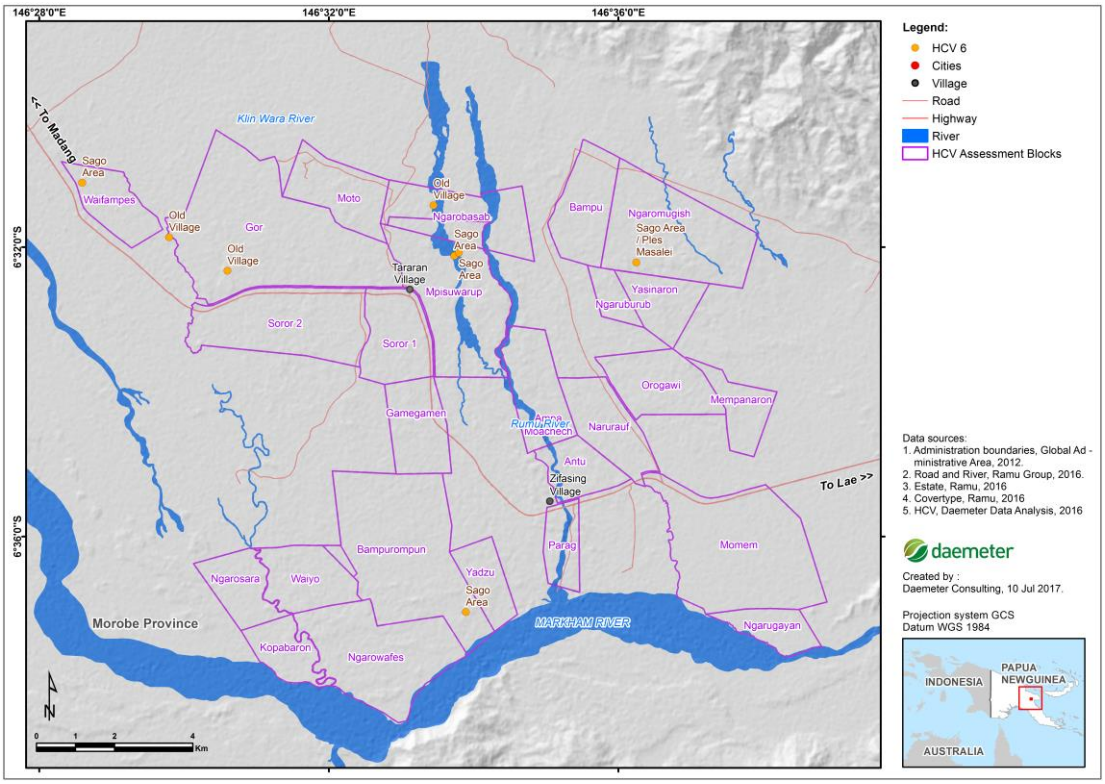


Figure 16 Location of cultural sites that were mentioned during the focus group discussions. A buffer is required around each site to make sure it is not disturbed by oil palm operations.

Findings in the assessment area

Old villages, cemeteries and sacred places *(ples masalei)* located inside proposed development areas are considered HCV 6, **therefore this HCV is deemed to be Present.**

3.2.4 Stakeholder consultation outcomes

At the stakeholder consultation stage, Daemeter was mainly gathering information from the stakeholders, much of this was background information. There were not really responses from Daemeter. It was at the **Public Consultation** stage that Daemeter presented maps and outcomes.

No NGOs were consulted, not because Daemeter didn't want to talk with social NGOs, rather there were no relevant NGOs operating in this area. The only NGO that was mentioned was "Save PNG" which made documentaries about cultural events in the area – which was not terribly relevant.

Table 13 Summary of Stakeholders Consulted

Date	Organisation	Name	Position	Summary of the interviews
12th October 2016	Huon Gulf District Administration	Ross Seymour	Huon Gulf Member of Parliament	Ross has been actively encouraging land owners to be part of this new OP development project. In fact, his clan is taking part in the project. He explained that his motivation for taking part in this project was to encourage

				economic development in the area. Additionally, with the start-up of the Wafi gold mine he is expecting there to be a lot of settlers coming to the area. If the land is not occupied there will likely be a lot of landowners selling blocks to settlers on an informal basis. So by planting areas with OP this will be a way of preventing this happening.
21 November 26, 2016	Provincial Government	Kome Velea	Provincial Livestock Officer	This consultation revolved around land use in the local area; especially why the cattle industry had not been successful in the area. There are two professionally managed cattle farms in this area, which is Trukai Cattle Ranch and RAIL. Chivasing Cattle Ranch still operates and leases land from the community. The lease payments are very low and there is no pasture management. The community are now withdrawing from the leases. An additional problem is that cattle thefts are very common.
24 November, 2016	Police	Ambrose Mara	Senior Sergeant	The consultation revolved around law and order in the community. The officer that was interviewed mentioned that most of the issues were reasonably minor. There were 1 – 2 complaints a day and 2 – 4 arrests per month. Most of these revolved around insulting words, stealing, assaults and violence. Most of the issues were referred to village courts (which are a recognised part of the PNG judicial system) where they were resolved. He mentioned that crime was getting more sophisticated with cattle rustlers stealing from local farms.
24 November, 2016	Community Health Clinic		Community Health Worker	The community health clinic provides primary health care. More serious cases are referred to the Wanpar Health Centre and even more to Anggao Hospital in Lae. There are trained midwives in all the villages.
22 May, 2017	Huon Gulf District Office	Aaron Ambang Cliff Webivong	District Administrator and Assistant District Administrator	A meeting was held with the District Administrator and the Assistant District Administrator. The purpose of this was to inform them of the development and the purpose and the process of the HCV assessment. Daemeter showed a number of maps of the assessment area and the area that had been mapped out as being reserved from development. Points that were raised were : - Questions over areas with court restrictions over the area. It was explained that these had been removed from potential developments until the restrictions were removed. - Questions over who exactly NBPOL was dealing with. It was explained that NBPOL did not deal with individuals – it dealt with the ILG. This lead in to a discussion that NBPOL was currently in a process of National Identification (NID) registration. This had proved difficult because there was reluctance to be registered amongst the community e.g. pastors had suggested NID was "the work of the devil." The administrators said that they understood the process and supported the development. They pointed out that there was a lot happening in the Markham Valley at the moment (e.g. PNG Biomass, Wafi Gold Mine, PNG Pawa) and they wanted to put together a forum that enabled each party to understand each others' projects.
12 December, 2017	CEPA			The purpose of the meeting was as a consultation regarding NBPOL's proposed new oil palm plantation at Zifasing and Tararan in Morobe Province. In particular the consultation focused on the identification and management of any High Conservation Values that have been identified in or around the proposed development areas. It was agreed that there are no Protected Areas on or near the proposed areas. It was explained that several studies have been conducted including a High

				Conservation Value Assessment and a High Carbon Stock Assessment.

Village Stakeholder Consultations

The village stakeholder consultations were all very similar. The focus was on **obtaining** information to determine the presence or absence of HCV 5 and 6. This was followed up with site visits to produce a land use plan that focussed on participatory mapping to set aside areas for community use. There were no specific concerns and assessor responses at this stage. However the assessor took these discussions into account particularly for mapping HCV 5.

Table 14. Village stakeholder consultations

Land Name	No. People
Ngarowafes	21 +2
Momem	
Gamegamen	
Waifampes	
Yadzu	6
Bampurompun	12
Soror 1	7
Soror 2	
Gor	
Narubasab	18
Moto	
Mpisugwarup	17
Ngarugayan	10
Ngaromugish	7
Bampu	
Yasinaron	5
Ampa Moachech	6
Orogawi	7
Waiyo	18
Ngaruburub	6 + 9

3.2.8 HCVMA Maps

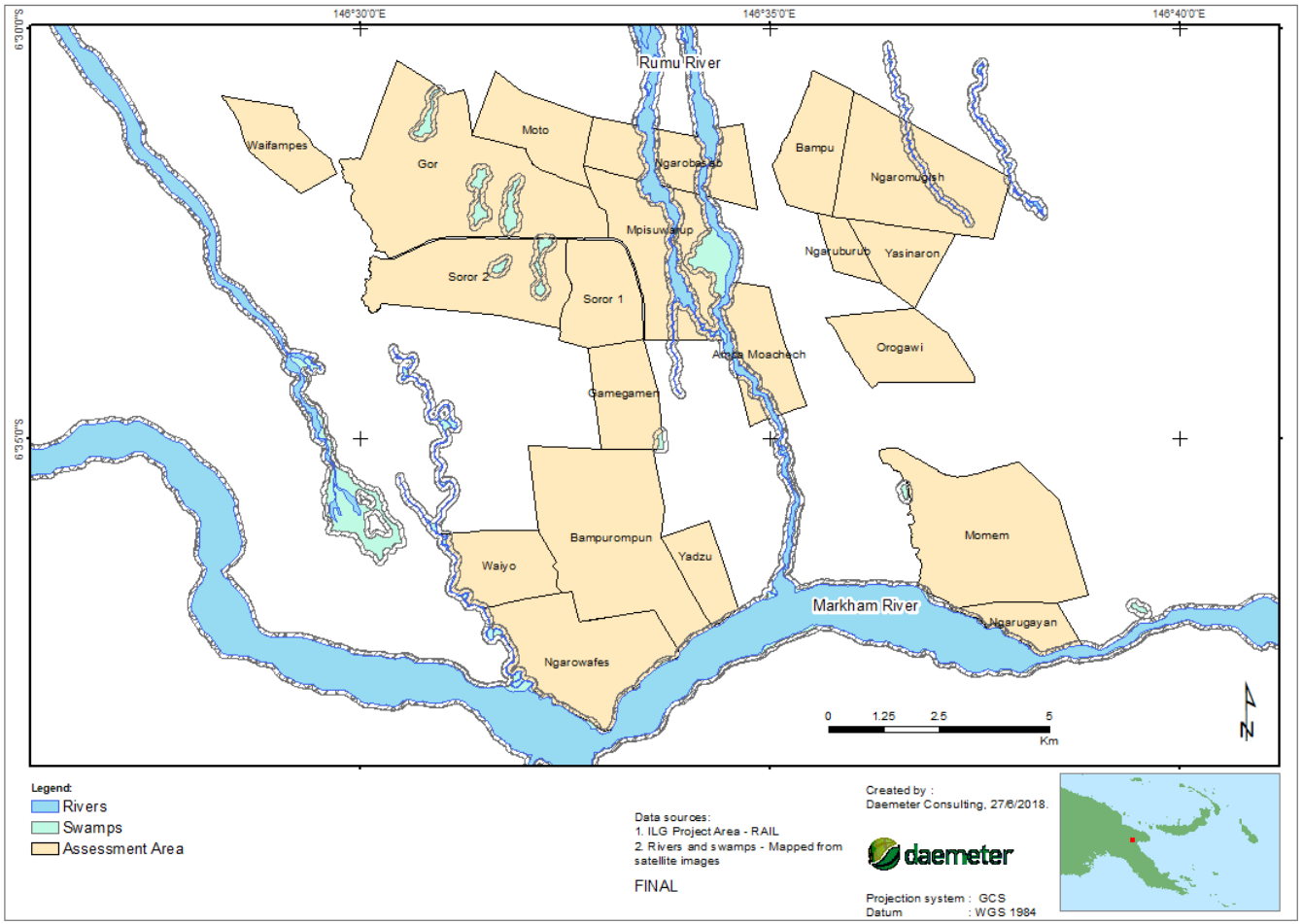


Figure 17. Synthesis of HCVs - this includes HCV 1, 4 - 6 (HCV 2 and 3 are not present). This map is deemed to be provisional because the boundaries of all the blocks are not gazetted as ILGs yet.

3.2.9 HCV Area Summary

Table 15 shows the HCV areas within the project area. In this report the assessor does not split HCV Area and HCV management area. If an area is classified as HCV it is "NO GO" for Oil Palm development. There are a further 37,131 ha of HCV 5 external to the project area.

Table 15. Area (ha) of each HCV by block within the project area. Also Non-HCV Area and Block Area are provided.

Land	HCV 1 (ha)	HCV 4 (ha)	HCV 5 (ha)	HCV 6 (ha)	HCVArea(ha)[4]	Non-HCV Area(ha)	Grand Total
Ampamoachech	79.87	79.87	79.87		79.87	292.73	372.6
Bampu					19.22	352.88	372.1
Bampurompun	16.09	16.09	16.09	3.14		1,115.50	1115.5
Gamegamen	8.70	8.70	8.70		8.70	324.80	333.5
Gor	157.09	157.09	157.09	3.98	161.07	1,213.13	1374.2
Momem	6.66	6.66	6.66		6.66	1,050.54	1057.2
Moto						359.50	359.5
Mpisuwarup	298.99	298.99	298.99	5.67	299.43	452.07	751.5
Ngarobasab	91.11	91.11	91.11	3.14	91.32	297.58	388.9
Ngaromugish	96.42	66.55	66.55	3.14	99.56	699.24	798.8
Ngarowafes	132.29	86.62	86.62		131.90	636.00	767.9
Ngaruburub						110.90	110.9
Ngarugayan	32.76	32.76	32.76		32.76	160.54	193.3
Orogawi						385.20	385.2
Soror 1						378.80	378.8
Soror 2	67.23	67.23	67.23		67.23	641.47	708.7
Waifampes				3.14	3.14	261.86	265
Waiyo	27.81	27.81	27.81		27.81	302.29	330.1
Yadzu	3.90	3.90	3.90		3.90	200.20	204.1
Yasinaron						251.00	251
Mpisuwarup / Ngarobasab	29.83	29.83	29.83		29.83	80.67	110.5
Bampurompun / Waiyo						23.50	23.5
Grand Total	1048.75	943.36	943.36	22.21	1,062.40	9,590.40	10652.8

[4] The areas of the individual HCVs do not sum to the total HCV area because of overlaps

3.3 Soil and topography

A soil suitability study was carried out by an independent soils expert in June 2017. Following are the results of the findings.

3.3.1 Marginal and fragile soils

Marginal soils identified in proposed development areas

Swamps and riparian zones

There are 3 major water ways. Markham River to the south, Rumun River to the west and Erap to the east. There are also a number of creeks and channels that run through all the land units into these main water ways and swamps during wet season.

The land units intended for development will at some degree have an impact on these water ways and therefore proper management system are to be put in place during the development phase to reduce soil losses and stability of vulnerable sites.

There are also sites which are poorly drained and are either swampy or seasonally inundated for long periods. These sites are somewhat depressed and tend to be located along creeks, water channels or flood plains. Bampu, Mwipisuwarup, Moto, Gor and Yadzu land units have some of these poorly drained sites and need to be considered when placed under development.

Peat soils

There are no peat soils in the project area.

Shallow sandy-gravelly soils

These soils are common in the Markham Valley as well as other parts of Papua New Guinea and tend to be found within the relict coarse fans. This was observed in Mwpisuwarup, Ngarubasap, Soror and Ngaromugish. Vegetation composition was dominated by grassy species in particular Pennisetum purpureum (elephant grass), Cenchrus ciliaris (buffel grass) and Imperata cylindrical (kunai) with sparsely spaced trees. Depth of water table was difficult to determine due to low penetrability. Bleeker, (1983) described this soil under the Soil order Entisols; sub order Orthent and Great Groups Troporthents identifying it as having a chemical fertility ranging from moderate to high. The soils of these group are young thus do not have a distinct profile development. Samples used for morphological description and chemical analysis are represented by Pit # 4 in Ngaromugis. The samples were taken from 30cm intervals to a depth of 120cm and sent to Hills Laboratories Ltd (New Zealand) for analysis.

3.3.2 Excessive gradients

There are no steep slopes found within the project area. River boundaries in the Markham Valley are known to develop high rates of erosion due to the force of the rivers and the loose soil structure. Rivers and creeks will be afforded ample buffer zones. Meandering rivers and creeks may eat into or away from buffer zones. Buffer zones are adjusted only during replants.

3.4 Summary of carbon stock assessment and GHG emissions

3.4.1 Table presenting carbon stock estimated per ha (tC/ha) per land cover class

Field survey results (HCSA plot results)

For this analysis, plots classed as *Raintree* – dominant', '*Raintree* – mixture' or '*Raintree woodlands*' have been grouped into the single class *Raintree dominant vegetation'*. All plots in this class have raintree basal areas accounting for 50% or more of the plot total. Whist this grouping is a simplification of the results presented the methodology section, it does reflect the fact that all plots in these classes are dominated by the woody weed *S. saman*. The low standard error for biomass shown in this class suggests that this grouping is not misplaced and the mean value is relevant for these areas.

As discussed above in Section 2.2.1,basal area (BA) was the primary metric used to determine the presence of young regenerating forest, as per the note in HCSA (2015) pp 37 'abandoned plantations with <50% of the BA consisting of planted trees could be considered to be young regenerating forest'.

Hollow-wood assumes two points when using this note to determine potential young regenerating forest; 1) that by proving this note, HCSA (2015) acknowledges the often vigorous nature of regenerating rainforest and 2) that dense stands of *S. saman* are functionally identical to 'abandoned plantations' i.e. they are both exotic, woody, perennial monocultures

Table 13 shows that there is a large amount of variation present in the 'Low density forest' class. This is likely explained by the low sample size (n=8) and the presence of a large outliers, such as plots 31 and 32, where high carbon values were measured. Plots 31 and 32 recorded carbon values of 190.2 and 309.7 tC/ha (above ground biomass) respectively. Such high values may fall into the range of medium or high density forest strata, but field observation during this assessment confirmed these classes to not be present across the site. HCSA (2015) intends that these strata represent intact or moderately degraded rainforest communities and such high-quality forest was not observed within the AOI during this study. Given the land use history of the area, Low density forest was the most appropriate class for native forest plots. Plots in this class were mainly either degraded rainforest or advanced secondary regrowth forest.

Table 16 Total carbon stock (above and below-ground) estimates for vegetated land cover classes defined in the carbon study.

Strata	Area (ha)	N	Stems ha^{-1}	Basal Area (m^2 ha^{-1})	Above ground Biomass (t ha^{-1})	Shoot:Root ratio	Below ground Biomass (t ha^{-1})	Total Biomass (t ha^{-1})	Carbon (t ha^{-1})	Carbon (t ha^{-1}) s.e	Carbon total (t)
Low density forest	58.87	8	617.5	37.2	331.7	0.205	68.0	399.7	187.9	25.4	11059.78
***Raintree* dominant vegetation**	2924.53	89	531.5	24.5	211.2	0.205	43.3	254.5	119.6	5	349812.16
Young regenerating forest	535.53	29	655.9	15.2	108.3	0.205	22.2	130.5	61.3	5.3	32846.80

Scrub	934.84	55	841.5	10	59.3	0.205	12.2	71.5	33.6	2.8	31396.05
Grasslands	5979.48	0	0	0	7	1.887	13.2	20.2	9.5	n/a*	56794.48
Total											**481,909.27**

3.4.2 Table summarising the total development area (ha) and carbon stock estimate per land cover class

The total areas assessed for High Carbon Stock reports the results of the 'patch analysis decision tree' as found in Module 5 (HCSA, 2017), and integrate the results of the High Conservation Value (HCV) assessment areas for community use, as identified using participatory mapping methods. As such, Table 13 reports across the gross study area.

As part of implementing the HCSA methodology, and as part of being a member of the Palm Oil Innovation Group, sufficient land is set aside for 'community use' so as to ensure that food security and future expansion of living areas are available. The 'community use' areas were mapped through participatory means and resulted in areas being set aside by the communities. These areas are considered 'enclaved' i.e./removed from the potential conversion areas and excluded from the identification of GHG emissions. The results of the HCSA exercise, including the community use areas to be 'enclaved' can be seen in the table below in Table 18. After negotiations with the landowners including their assessment of opportunity costs related to conservation the areas reported in Table 17 have been authorized for development by the landowners.

Table 17 Carbon study land classifications and development options for gross area (ha).

Classification	Conserve (ha)	Develop (ha)	Enclave (ha)	Grand Total
Grasslands	412.94	3164.34	2402.21	5979.48
Low density forest	3.76	0.00	55.11	58.87
Open water	123.88	0.00	35.97	159.85
Raintree dominant	42.38	1561.07	490.96	2094.41
Raintree mixture	14.50	98.21	126.49	239.20
Raintree woodlands	12.15	472.70	106.06	590.91
Scrub	44.94	471.46	418.44	934.84
Village areas	0.00	0.00	59.73	59.73
Young regenerating forest	105.88	231.00	198.65	535.52
Grand Total (ha)	**760.43**	**5998.77**	**3893.62**	**10,652.82**

Table 18. Net area (ha) authorized for development

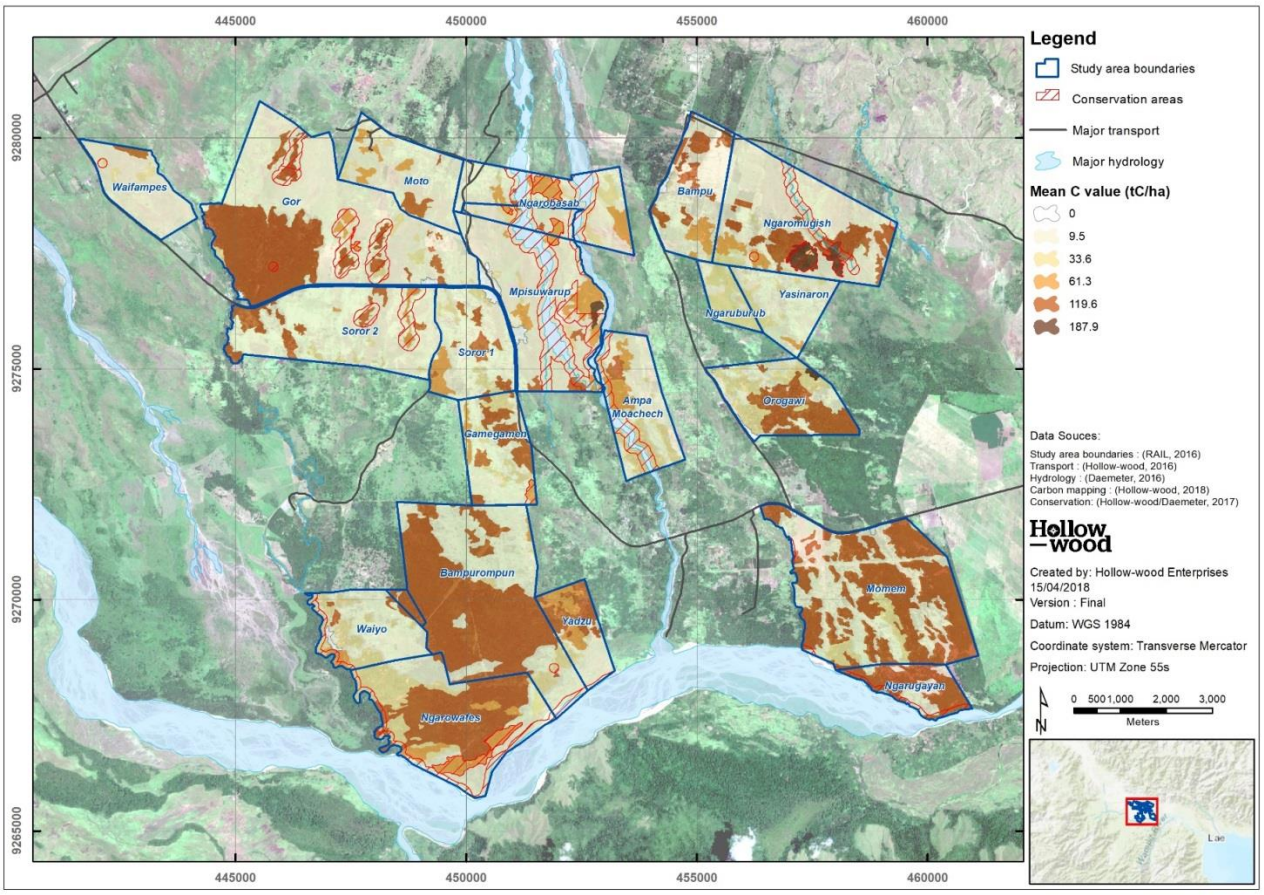
Classification	Conserve	Develop	Total Area (ha)	Carbon /ha	Total Carbon (tC)
	Area (ha)	Area (ha)			
Grasslands	228.1	3164.34	3392.44	9.5	32,228.18
Open water	4.18	0	4.18	0.0	0.00
Raintree dominant	42.22	1561.07	1603.29	119.6	191,753.10

Raintree mixture	9.9	98.21	108.11	119.6	12,929.52
Raintree woodlands	12.05	472.7	484.75	119.6	57,976.11
Scrub	38.01	471.46	509.47	33.6	17,118.19
Young regenerating forest	74.66	231	305.66	61.3	18,736.73
Grand Total	**409.12**	**5998.77**	**6407.89**		**330,741.82**

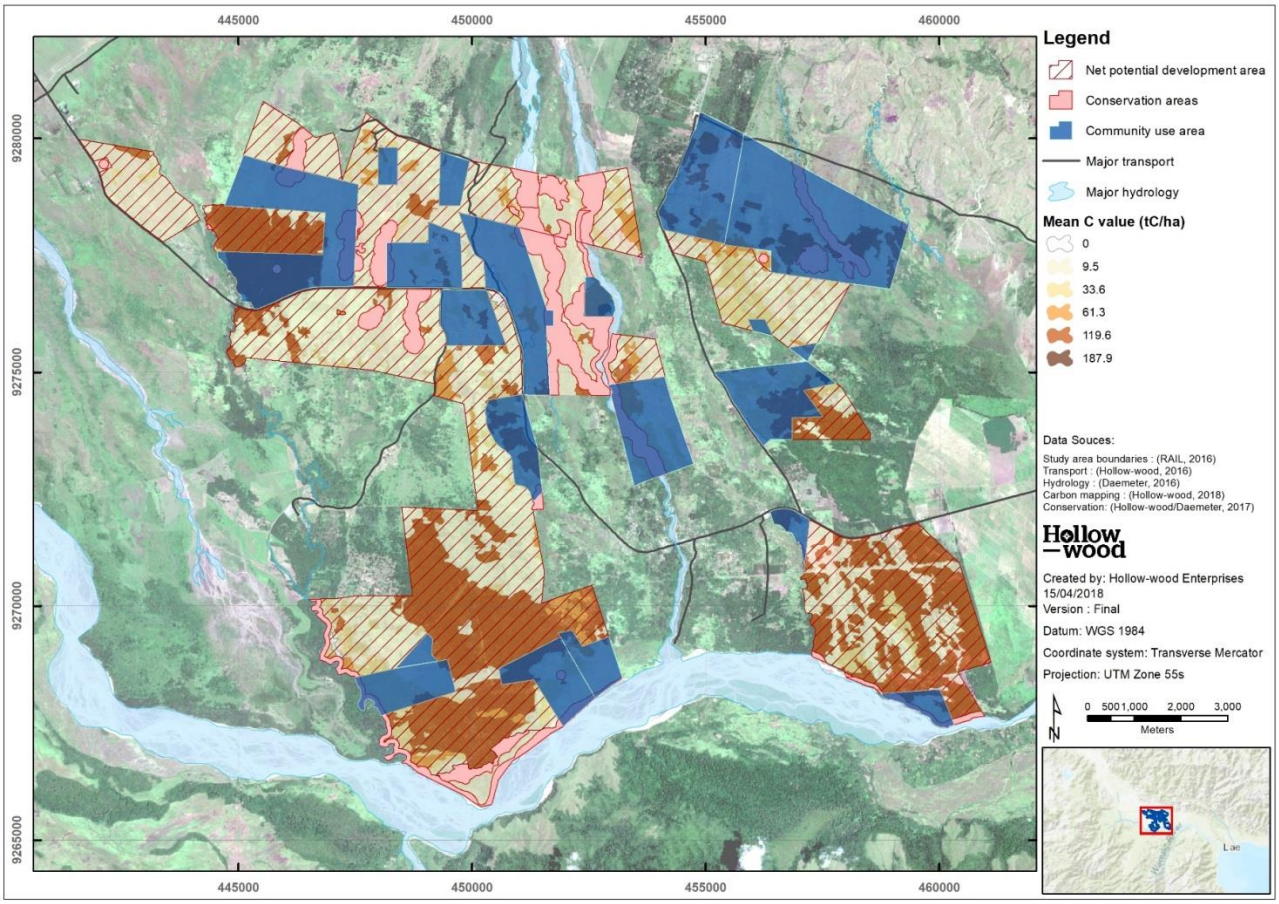
Note that the above include carbon stored in above and below ground biomass.

3.4.3 Carbon stock maps

Map 6 reports the total carbon stock estimated for the gross study areas and Map 7 report on the total carbon stock estimated for the net developable areas (as discussed above). Maps for individual study areas are provided in Annex 1.



Map 6. Carbon stock estimates for the gross study area



Map 7. Carbon stock estimates for the net area authorised for development

3.4.4 GHG emissions management and mitigation plans

Measures taken to mitigate net GHG emissions associated with oil palm cultivation and processing in the new development

Land conversion scenarios

In order to assess the emissions potential of the proposed conversion the net areas to be managed (Table 18) are tested through 4 different scenarios. Each conversion scenario makes a different assumption regarding the type of conservation type which will be retained or converted into oil palm. All of the scenarios assume that there will be no methane capture during the first rotation of the oil palm plantation, though this may change depending on financing. The scenarios that were tested are described in the following table.

Table 19 Land conversion scenarios. HCVMA = 'High Conservation Value Management Area', HCSF = 'High Carbon Stock Forest'

Scenario	Description
Scenario 1	Only areas indicated as 'HCVMA' are conserved. No 'HCSF' areas are conserved, all other classes are developed. No Methane capture is installed in the next 5 years.

Scenario 2	Only areas indicated as 'HCSF' are conserved. No 'HCVMA' areas are conserved, all other classes are developed. No Methane capture is installed in the next 5 years.
Scenario 3	All areas classified as 'HCVMA' or 'HCSF' are conserved. All other classes are developed. No Methane capture is installed in the next 5 years.
Scenario 4	All areas classified as 'HCVMA' or 'HCSF' are conserved. All vegetation dominated by as Raintrees (i.e. 'Raintree dominant', Raintree mixture', and 'Raintree woodlands') are conserved. All other classes are developed. No Methane capture is installed in the next 5 years.

The resulting amounts of hectares potentially converted or retained are summarised in the following tables.

Table 20. Summary of conversion scenarios. Preferred scenario outlined in yellow.

Classification	Scenario 1		Scenario 2		Scenario 3		Scenario 4	
	Conserve	Develop	Conserve	Develop	Conserve	Develop	Conserve	Develop
Grasslands	181.14	3211.30	46.96	3345.48	228.10	3164.34	228.10	3164.34
Open water	4.18	0	0	4.18	4.18	0.00	4.18	0
Raintree dominant	42.22	1561.07	0	1603.29	42.22	1561.07	1603.29	0
Raintree mixture	9.90	98.21	0	108.11	9.90	98.21	108.11	0
Raintree woodlands	12.05	472.70	0	484.75	12.05	472.70	484.75	0
Scrub	37.71	471.46	0	509.16	37.71	471.46	37.71	471.46
Young regenerating forest	74.54	231.00	45.28	260.25	74.54	231.00	74.54	231.00
Grand Total	**362.16**	**6045.73**	**92.24**	**6315.65**	**409.12**	**5998.77**	**2541.10**	**3866.79**

Table 21. Conversion scenario 1

Classification	Conserve		Develop		Total Area (ha)	Total Carbon (tC)
	Area (ha)	Carbon emission (tC)	Area (ha)	Carbon emission (tC)		
Grasslands	181.14	1720.87	3211.30	30507.31	3392.44	32228.18
Open water	4.18	0.00	0.00	0.00	4.18	0.00
Raintree dominant	42.22	5049.14	1561.07	186703.96	1603.29	191753.10
Raintree mixture	9.90	1183.63	98.21	11745.89	108.11	12929.52
Raintree woodlands	12.05	1440.89	472.70	56535.22	484.75	57976.11
Scrub	37.71	1277.29	471.46	15840.90	509.16	17118.19
Young regenerating forest	74.54	4576.62	231.00	14160.10	305.53	18736.73
Grand Total	**362.16**	**15248.44**	**6045.73**	**315493.38**	**6407.89**	**330741.82**

Table 22. Conversion scenario 2.

Classification	Conserve		Develop		Total Area (ha)	Total Carbon (tC)
	Area (ha)	Carbon emission (tC)	Area (ha)	Carbon emission (tC)		
Grasslands	46.96	446.09	3345.48	31782.09	3392.44	32228.18
Open water	0.00	0.00	4.18	0.00	4.18	0.00
Raintree dominant	0.00	0.00	1603.29	191753.10	1603.29	191753.10
Raintree mixture	0.00	0.00	108.11	12929.52	108.11	12929.52
Raintree woodlands	0.00	0.00	484.75	57976.11	484.75	57976.11
Scrub	0.00	0.00	509.47	17118.19	509.47	17118.19
Young regenerating forest	45.28	2775.65	260.38	15961.08	305.66	18736.73
Grand Total	**92.24**	**3221.74**	**6315.65**	**327520.08**	**6407.89**	**330741.82**

Table 23. Conversion scenario 3 (*preferred development scenario*)

Classification	Conserve		Develop		Total Area (ha)	Total Carbon (tC)
	Area (ha)	Carbon emission (tC)	Area (ha)	Carbon emission (tC)		
Grasslands	228.10	2166.96	3164.34	30061.22	3392.44	32228.18
Open water	4.18	0.00	0.00	0.00	4.18	0.00
Raintree dominant	42.22	5049.14	1561.07	186703.96	1603.29	191753.10
Raintree mixture	9.90	1183.63	98.21	11745.89	108.11	12929.52
Raintree woodlands	12.05	1440.89	472.70	56535.22	484.75	57976.11
Scrub	38.01	1277.29	471.46	15840.90	509.47	17118.19
Young regenerating forest	74.66	4576.62	231.00	14160.10	305.66	18736.73
Grand Total	**409.12**	**15694.53**	**5998.77**	**315047.29**	**6407.89**	**330741.82**

Table 24. Conversion scenario 4.

Classification	Conserve		Develop		Total Area (ha)	Total Carbon (tC)
	Area (ha)	Carbon emission (tC)	Area (ha)	Carbon emission (tC)		
Grasslands	228.10	2166.96	3164.34	30061.22	3392.44	32228.18
Open water	4.18	0.00	0.00	0.00	4.18	0.00
Raintree dominant	1603.29	191753.10	0.00	0.00	1603.29	191753.10
Raintree mixture	108.11	12929.52	0.00	0.00	108.11	12929.52
Raintree woodlands	484.75	57976.11	0.00	0.00	484.75	57976.11
Scrub	38.01	1277.29	471.46	15840.90	509.47	17118.19
Young regenerating forest	74.66	4576.62	231.00	14160.10	305.66	18736.73
Grand Total	**2541.10**	**270679.61**	**3866.79**	**60062.22**	**6407.89**	**330741.82**

Results of the greenhouse gas emissions scenario modelling.

The land conversion scenarios were utilised as basic inputs into modelling the potential Green House Gas emissions resulting from the implementation of each scenario. The following tables summarize the results of modelling obtained by using the RSPO New Development Greenhouse Gas Calculator RSPO-PRO-T04-003 V2.0 ENG and utilising the above land cover classifications coupled with the carbon density values found during the High Carbon Stock study. For the vegetation type classified as 'grassland', default values were used. Note that for each scenario a different amount of land is assumed to be put into conservation. Table 23 summarises net field emissions and sinks results of the 4 land conversion scenarios.

3.4.5 Measures taken to maintain and enhance carbon stocks within the new development areas

After consideration of the lands that have been made available by land owner consent and the removal of areas that are either High Conservation Value or High Carbon Stock, Scenario 3 has been chosen as the preferred development option. The greatest contributor to reduction of GHG emissions from the new development is through avoided emissions that would have been derived from land use change through the application of the High Carbon Stock Approach and the protection of High Conservation Values

By the application of the HCSA 'patch analysis decision tree', a range of land use types have been excluded from development. This includes any areas of high conservation value or natural vegetation classes with a carbon density higher than that of 'scrub', patches of 'young regenerating forests' with a core less than 10ha or outside of the 200 meter proximity of significant carbon. This has greatly reduced the potential emissions from land use change. Figures 16 – 18 illustrate the emissions of Scenario 3 as estimated by the GHG calculator.

Scenario 3 also accounts for the 414 ha of High Conservation Value Management Area (HCVMA) and High Carbon Stock Forest (HCSF) that RAIL have committed to the lease and management of. Such areas include riparian zones, wetland areas and a significant area of native forest that will be regenerated using native forest species seed of local provenance.

Table 25 Results of the greenhouse gas emissions scenario modelling, yellow box indicating preferred Development Scenario. Field emissions and sinks assume vigorous growth for oil palm, used by large scale operations. Data derived from RSPO GHG Calculator (RS

	Scenario 1			Scenario 2			Scenario 3			Scenario 4		
Field emissions & sinks	**tCO2e**	**t CO2e/ha**	**tCO2e/tFFB**	**t CO2e**	**t CO2e/ha**	**t CO2e/t FFB**	**t CO2e**	**t CO2e/ha**	**t CO2e/t FFB**	**t CO2e**	**t CO2e/ha**	**t CO2e/t FFB**
Land clearing	46272.38	8.07	0.38	48036.28	8.03	0.38	46206.94	8.13	0.38	8809.13	2.40	0.11
Crop sequestration	-53647.97	-9.36	-0.44	-56005.99	-9.36	-0.44	-53231.20	-9.36	-0.44	-34312.67	-9.36	-0.44
Fertilisers	1330.04	0.23	0.01	1388.50	0.23	0.01	1319.71	0.23	0.01	850.68	0.23	0.01
N2O	1287.96	0.22	0.01	1344.58	0.22	0.01	1277.96	0.22	0.01	823.77	0.22	0.01
Field fuel	651.34	0.11	0.01	679.97	0.11	0.01	646.28	0.11	0.01	416.59	0.11	0.01
Peat	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Conservation credit	0.00	0.00	0.00	0.00	0.00	0.00	-1035.58	-0.18	-0.01	0.00	0.00	0.00
Total	-4106.24	-0.72	-0.03	-4556.66	-0.76	-0.04	-4815.88	-0.85	-0.04	-23412.50	-6.39	-0.30
Mill emissions & credit	**tCO2e**	**t CO2e/ha**	**tCO2e/tFFB**	**tCO2e**	**t CO2e/ha**	**tCO2e/tFFB**	**tCO2e**	**t CO2e/ha**	**tCO2e/tFFB**	**tCO2e**	**t CO2e/ha**	**tCO2e/tFFB**
POME	23858.61	4.16	0.20	24907.28	4.16	0.20	23673.26	4.16	0.20	15259.71	4.16	0.20
Mill fuel	1434.93	0.25	0.01	1498.00	0.25	0.01	1423.79	0.25	0.01	917.77	0.25	0.01
Purchased electricity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Credit (excess electricity exported)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Credit (sale of biomass for power)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	25293.54	4.41	0.21	26405.29	4.41	0.21	25097.05	4.41	0.21	16177.48	4.41	0.21
Total emissions, tCO2e (field and mill)	**21187.31**			**21848.62**			**20281.16**			**-7235.02**		
t CO2e/t CPO	**0.58**			**0.58**			**0.56**			**-0.31**		
t CO2e/t PK	**0.58**			**0.58**			**0.56**			**-0.31**		

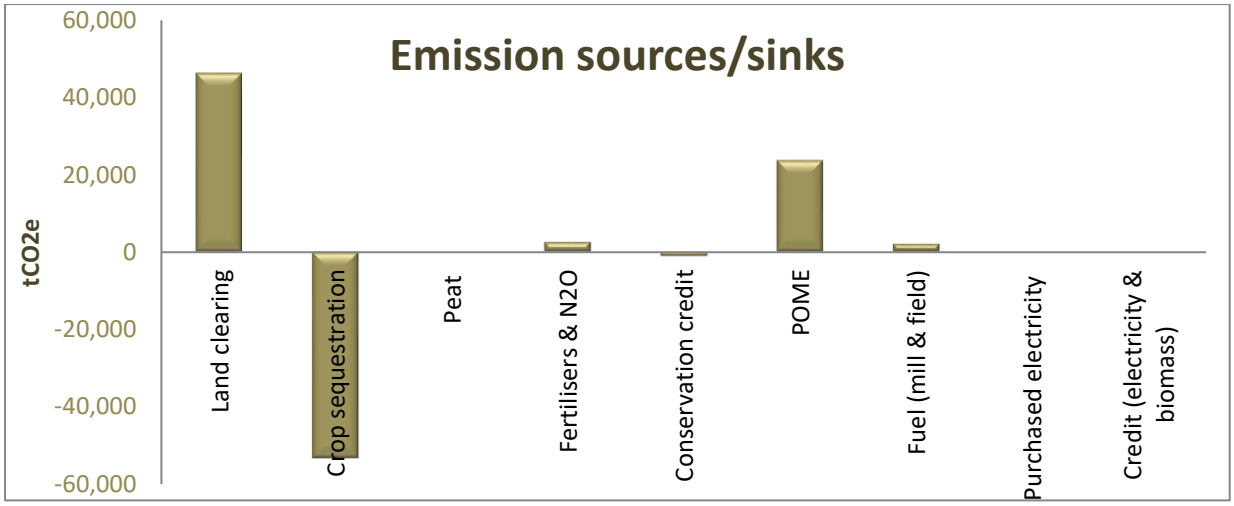


Figure 18. Carbon (tons of CO_2 equivalents) emission sinks and sources from Development Scenario 3

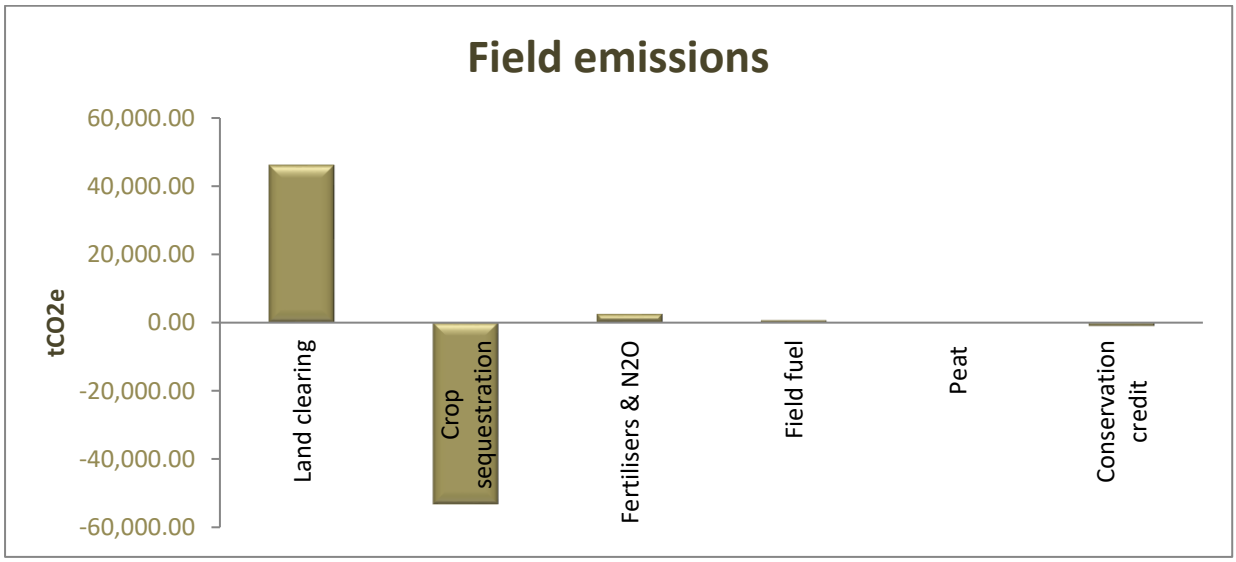


Figure 19. Field based emissions from Development Scenario 3

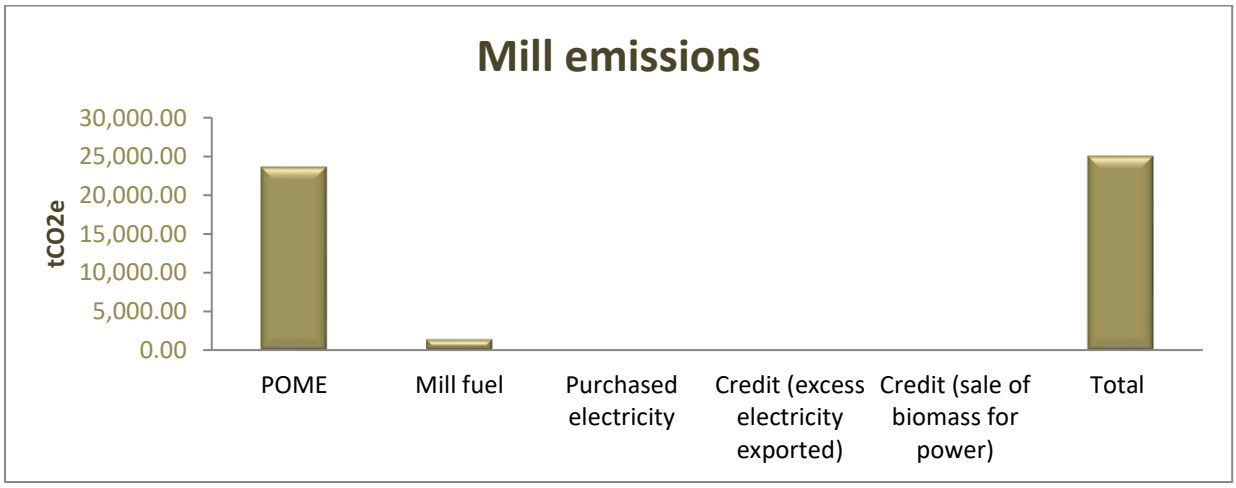


Figure 20. Mill emissions from Development Scenario 3

3.4.6 Justification for the selection of optimal development scenario

The selection of Development Scenario 3 is the result of a long process of engagement with the land owners. During this process information regarding the biophysical limitations to development of their lands (i.e. HCVMA or HCSA), were shared with them and the implications that this would have on their options for income generation were discussed. Utilising this information the landowners took an informed decision to indicate which lands they would set aside for their own use and which lands they would authorise NBPOL to develop.

Under Scenario 3, the development of area classed as 'Raintree dominant vegetation' is a significant contributor to the emissions derived from the land use change emissions associated with this development. This is clearly evident when comparing Scenarios 3 and, where the conservation of all raintree dominated vegetation saw an 80% reduction in carbon emissions. Although the raintree dominated vegetation class has a relatively high mean carbon value, it is an invasive species, and few HCV's were found in areas dominated by this vegetation class. Figure 17 shows crop and plantation sequestration to be an important emissions sink, with this fact balancing carbon emissions from land use change to the point that (based on the assumptions of the GHG calculator) Development Scenario 3 is carbon negative.

Other measures that may be taken into consideration to mitigate the net GHG emissions are methane capture at the palm oil mill, local sourcing of fertilisers, reducing usage of inorganic fertilisers, reducing fuel consumption when deemed economically feasible as per Principle 3 of the RSPO.

When the above discussed factors are taken into consideration, Hollow-wood considers the development across the Zifasing/Tararan AOI, that is consistent with that set out in Scenario 3, is justified.

3.4.7 Plan for monitoring the implementation of selected scenario for new development including measures for enhancing carbon stock and minimising GHG emissions.

The entire approach utilized for this development results in the conversion of only those vegetation types and patches of vegetation that are allowable under our Forest Policy and as per the High Carbon Stock Approach. In practical terms this means that any vegetation that is exceeds scrub in its successional stages, i.e. has become young regenerating forests, is not converted and will be protected. This makes the entire conversion process a carbon negative affair, meaning that from the point of view of the atmosphere, there will be more carbon absorbed from this than released. The estimated amount of carbon absorbed as expressed a tons CO2 equivalent under the preferred scenario is -4,789.71 tCO2e. Note the negative sign indicating that this is going to be the net reduction resulting from this development considering all emission factors. Such being the case, the only other management practice required for mitigating further emissions is to ensure the best management practice maximize growth and yield of the stand through optimizing soil nutrient management and minimizing losses to erosion through best agricultural practices. In addition to this is the need to ensure that all the HCS and HCV areas identified are to be effectively protected so as to maximize the

estimated conservation credit (-1,022.80 tCO2e) that can be gained from this. The management and monitoring requirements for this are described in the HCV/HCS reports as well as the NPP summary report thus do not need to be repeated here.

All developments will be implemented as per the findings of the approved HCV and HCSA assessments, comply with the requirements of the RSPO and adhere to NBPOL/RAI Standard Operating Procedures relating to the establishment of New Plantings.

The following management plan is derived from the GHG report recommendations and is relevant to all areas identified in that reports. These recommendations will be incorporated into the Plantation Management whose coordination is responsibility of the Field Department.

Table 26 GHG Management Plan

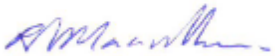
Parameter to be monitored	*Proposed Enhancement / Mitigation Measures*	*Location*	*Measurement*	*Frequency*	*Responsibility*	*Estimated Time-frame for completion of task*
Mitigate net GHG emissions associated with oil palm cultivation	Implementation of the High Carbon Stock Approach prior to development. No conversion of HCSA vegetation with carbon stocks greater than that contained in Scrub	*All areas to be leased*	GIS Map	*Once*	*Sustainability Manager* *Field Manager*	*Completed*
Enhancement of Carbon Stocks	All HCV/HCS areas to be leased to company to be managed as conservation areas allow for carbon sequestration.	*All areas to be leased*	GIS Map Field inspection	*Quarterly*	*Sustainability Manager* *Field Manager*	*January 2019 onwards*
	Awareness to be carried out on the importance of maintaining HCV/HCS areas identified. Fund raising, ie/ through HCSA, for funding into the conservation of these areas	*All areas to be leased*	GIS Map Field inspection	*Annual*	*Sustainability Manager* *Field Manager*	*January 2019 onwards*
	Monthly monitoring of all conservation areas within areas leased to NBPOL. Enforcement of incursions (ie/gardening) through consultation with communities, removal of crops and if that is not effective enforcement through stop payments of lease payments over conservation areas.	*All areas to be leased*	Field Inspections	*Annual*	*Sustainability Manager* *Field Manager*	*January 2019 onwards*

3.4.8 Internal responsibility

Statement of acceptance of responsibility for assessments

GHG notification statement
(updated 5 Oct 2018)

This is a Confirmation by the Grower that the above has been undertaken using the latest available version of the RSPO GHG Assessment Procedure for estimating the carbon stock of above ground and below ground biomass for land earmarked for new oil palm development and that the potential net GHG emission arising from the development has been estimated. In addition, the Grower confirms that the assessment includes a management and mitigation plan to minimise net GHG emissions which takes into account avoidance of land areas with high carbon stocks and/or sequestration options.

Responsible person	Date	Signature
Michael Hansby - Director / Primary consultant, Hollow-wood Enterprises	16/04/2018	
Ruari MacWilliam – General Manager, Ramu Agri Industries Limited.	5/10/2018	

Organisational information and contact persons

Michael Hansby, Director / Primary Consultant

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ABN: 55 625 579 240
160 Victoria Street
Brunswick, Victoria, 3056
Mob: +61 418 539 061
www.hollowwood.com.au

3.5 Land Use Change Analysis

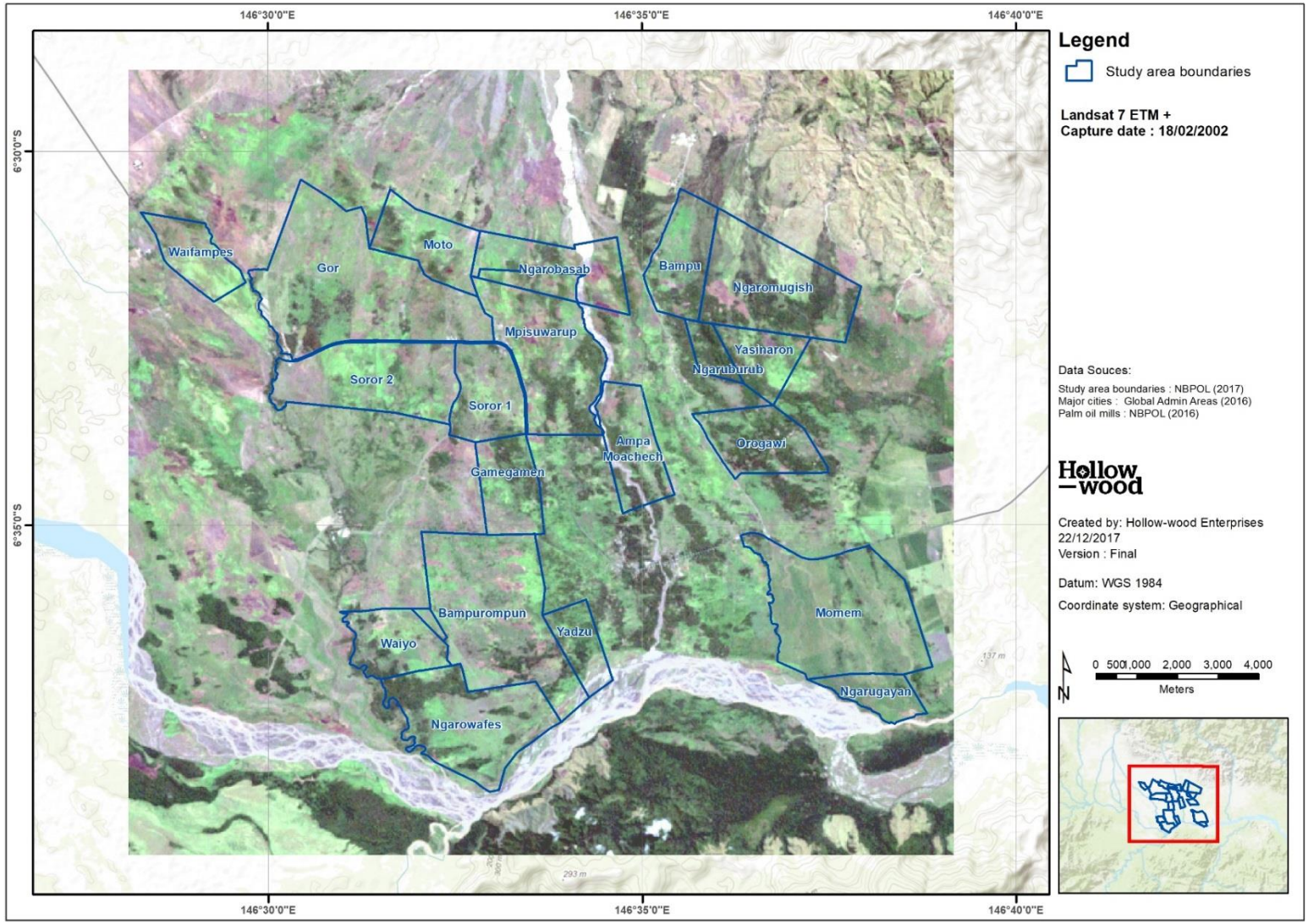
3.5.1 Methods

3.5.1.1. Relevant time of clearance period - *please tick*		
✘ **November 1, 2005-November 31, 2007**	✘ December 1, 2007-December 31, 2009	
✘ **January 1, 2010-May 9, 2014**	✓ After May 9, 2014	
3.5.1.2. Date of satellite image acquisition for each time of clearance period		
Period	**Date of acquisition**	**Cloud cover (over study area) (%)**
Before November 1, 2005 (baseline)	13/08/2002	None
November 1, 2005-November 31, 2007	13/02/2006	< 20 %
December 1, 2007-December 31, 2009	14/10/2007	< 20 %
January 1, 2010-May 9, 2014	22/12/2009	None
After HCV areas identified	19/02/2017	None
After becoming RSPO member (if relevant)	n/a	n/a
After the management unit acquired (if relevant)	n/a	n/a
Latest satellite image used for ground truthing	31/08/2016	None
3.5.1.3. Satellite images used in the LUC Analysis		
Satellite name	Landsat 7 ETM + for land use change and Rapid Eye for accuracy assessment	
Resolution	30m and 5m respectively	
3.5.1.4. List of data and document used in the LUC Analysis		
1. Land clearance progress map (monthly)	☐ Available/used	✘ Not available
2. Land clearance progress data (monthly)	☐ Available/used	✘ Not available
3. Planting year map	☐ Available/used	✘ Not available
4. Planting year data	☐ Available/used	✘ Not available
5. Land compensation progress map (if applicable)	☐ Available/used	✘ Not available
6. Land compensation progress data/document (if applicable)	☐ Available/used	✘ Not available
7. Soil map. ***Please attach the maps (in jpg/png/pdf format) AND submit the files (in shp/tab/dwg format).***	☐ Available/used	✘ Not available
8. Slope map. ***Please attach the maps (in jpg/png/pdf format) AND submit the files (in shp/tab/dwg format).***	☐ Available/used	✘ Not available
9. Watershed-hydrology map (rivers and streams, water bodies, springs, etc.). ***Please attach the maps (in jpg/png/pdf format) AND submit the files (in shp/tab/dwg format).***	☐ Available/used	✘ Not available
10. HCV assessment report. ***Please attach the maps (in jpg/png/pdf format) AND submit the files (in shp/tab/dwg format).***	✓ Available/used	☐ Not available
11. Others:	*Please list. HCSA report (Hollow-wood, 2016)*	
3.5.1.5. Image processing - *please tick*		
Radiometric correction	✓ Conducted	☐ Not conducted
Geometric correction	☐ Conducted	✘ Not conducted

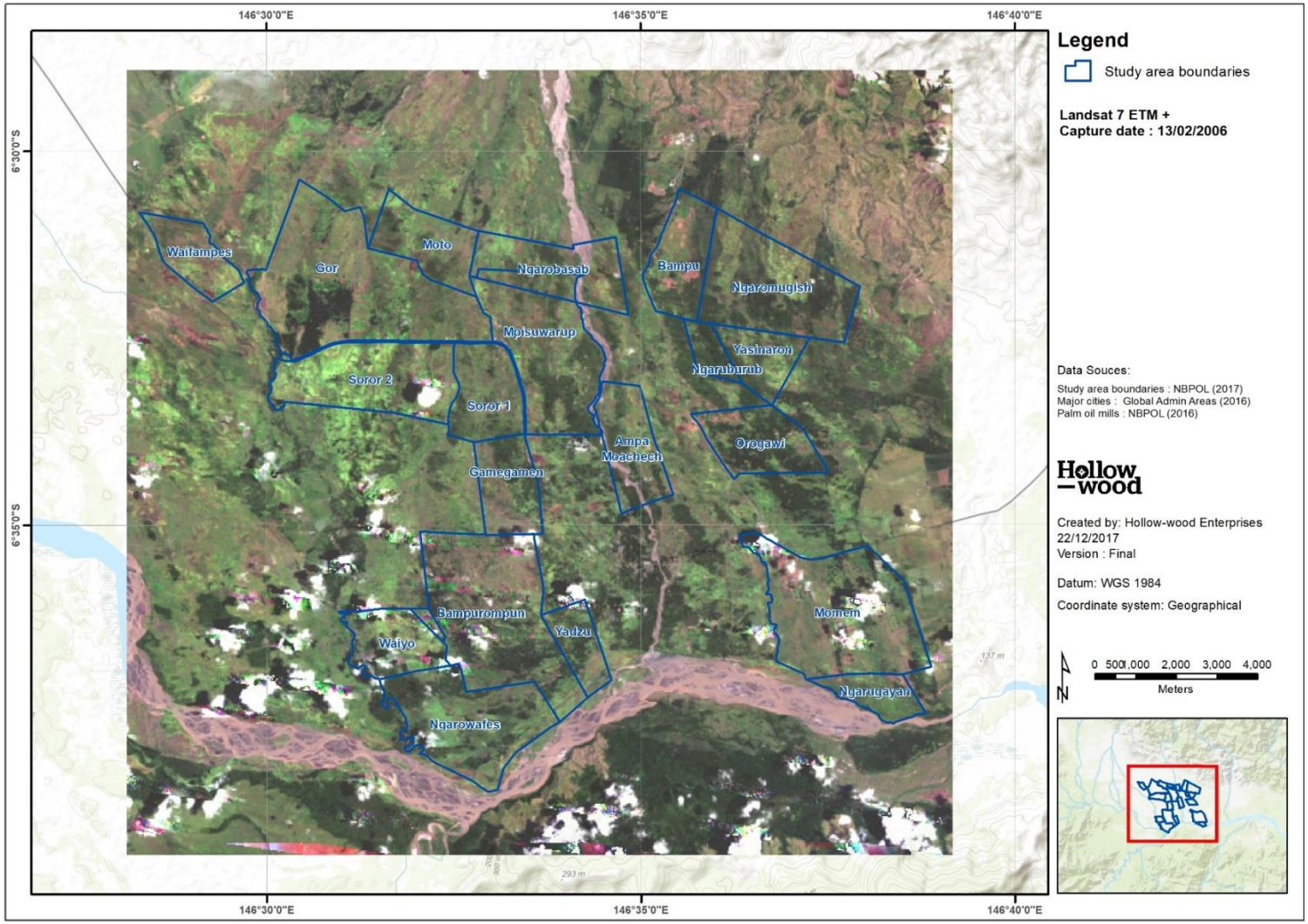
3.5.1.6. Image analysis - *please tick*		
✓ **Supervised classification**	☐ Unsupervised classification	☐ Object based visual interpretation

3.5.1.7. Survey design	
Number of samples	186 ground truthed (HCSA plots) and 360 visually interpreted test points from Rapid Eye Imagery.
Sampling method	Stratified Random Sampling. Sample rate determined by using Winrock International 'Sample Plot Calculator Spreadsheet Tool' (Walker *et al*., 2014).
Reference for sampling method	Congalton & Green, (2008); Jones & Vaughn, (2010); Lunetta & Lyon, (2004).
3.5.1.8. Field verification - *please describe the method and process used in the LUC analysis*	
Validating the land cover data	Summary statistics using error matrix and Cohens Kappa coefficient
Compiling information related to historical land use in the study area	Review of publicly available literature and reference to HCV and HCSA assessment reports
Identifying the loss of social HCVs	Not applicable.
Identifying the loss of areas where planting is prohibited by RSPO P&C or by country's specific legislation (e.g. riparian zones, steep slope, deep peat)	Not applicable as no areas have been planted at this site.
3.5.1.9. Image validation	
Method used for LUCA accuracy assessment	Reference pixels and test pixels created and 'Combine' function in ArcGIS (Spatial Analyst) was used to create dataset from which error matrix and descriptive statistics can be derived

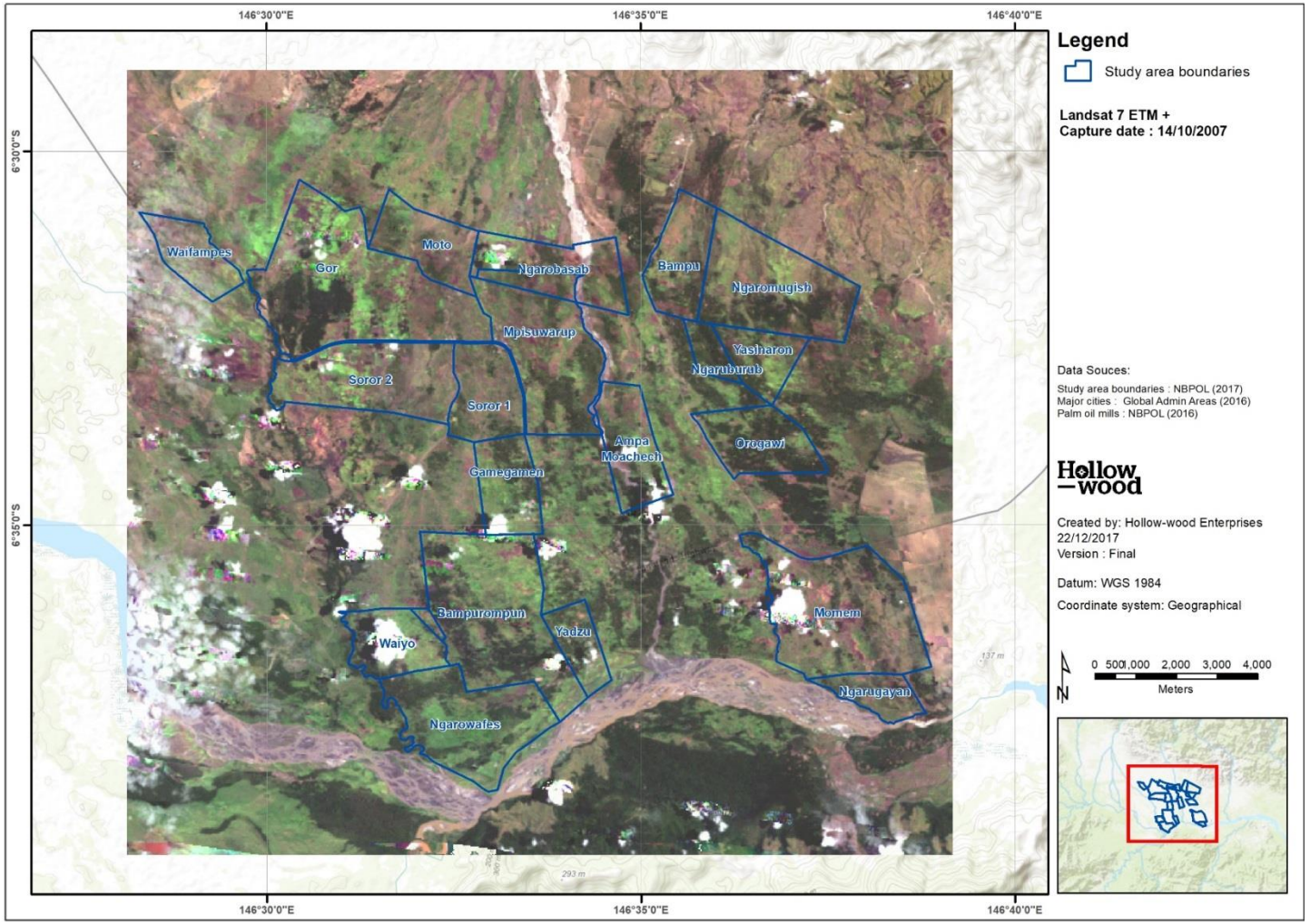
3.5.1.10. Change detection analysis
Describe the method used and process conducted in this stage of LUC analysis
The 'Tabulate Area' tool was used perform a 'to and from' analysis that calculated area by land cover class on a pixel by pixel basis. The output of the classification was converted to vector (feature class) format to enable an accurate area or each class to be calculated. This dataset was then rasterised so that the 'tabulate area' analysis could be performed. There is a 1.65 ha difference between the raster and vector datasets that occurred during this process. Change detection analysis was performed on the classified image from 2010 (period 4) and the image captured after the HCV assessment (2017).
3.5.1.11. Vegetation coefficient
Describe the method used and process conducted to determine and categorize the land cover class into vegetation coefficient
The translation of land cover classes into vegetation co-efficients is deemed not applicable for this analysis for the following reasons; • Analysis has been performed for an NPP rather than a RaCP • The landscape under assessment is currently under customary land tenure • No oil palm has been established within the study area and • No land clearing has taken place within the study area



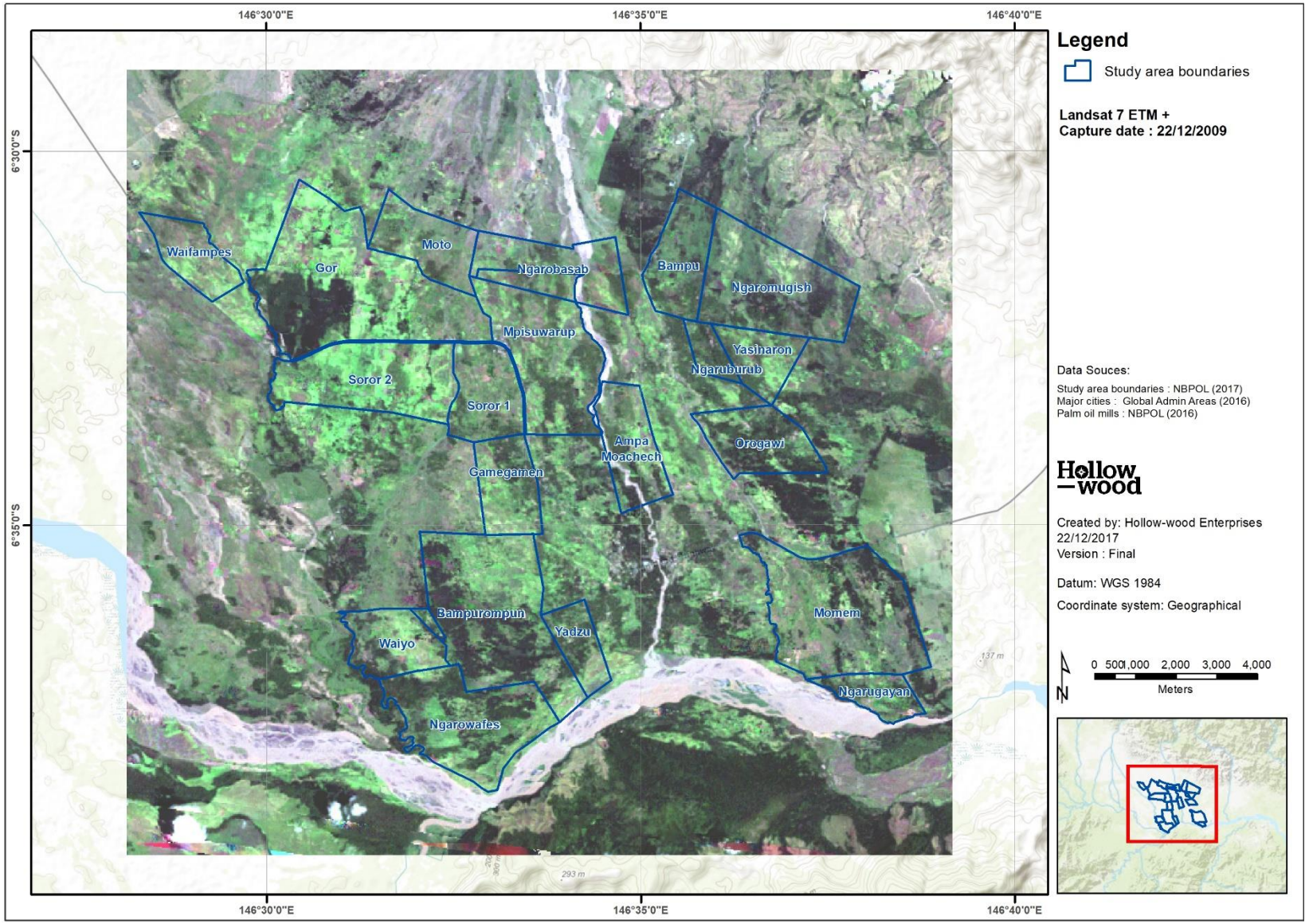
Map 8. Landsat 7 ETM + scene used for classification, captured on the 18/02/2002



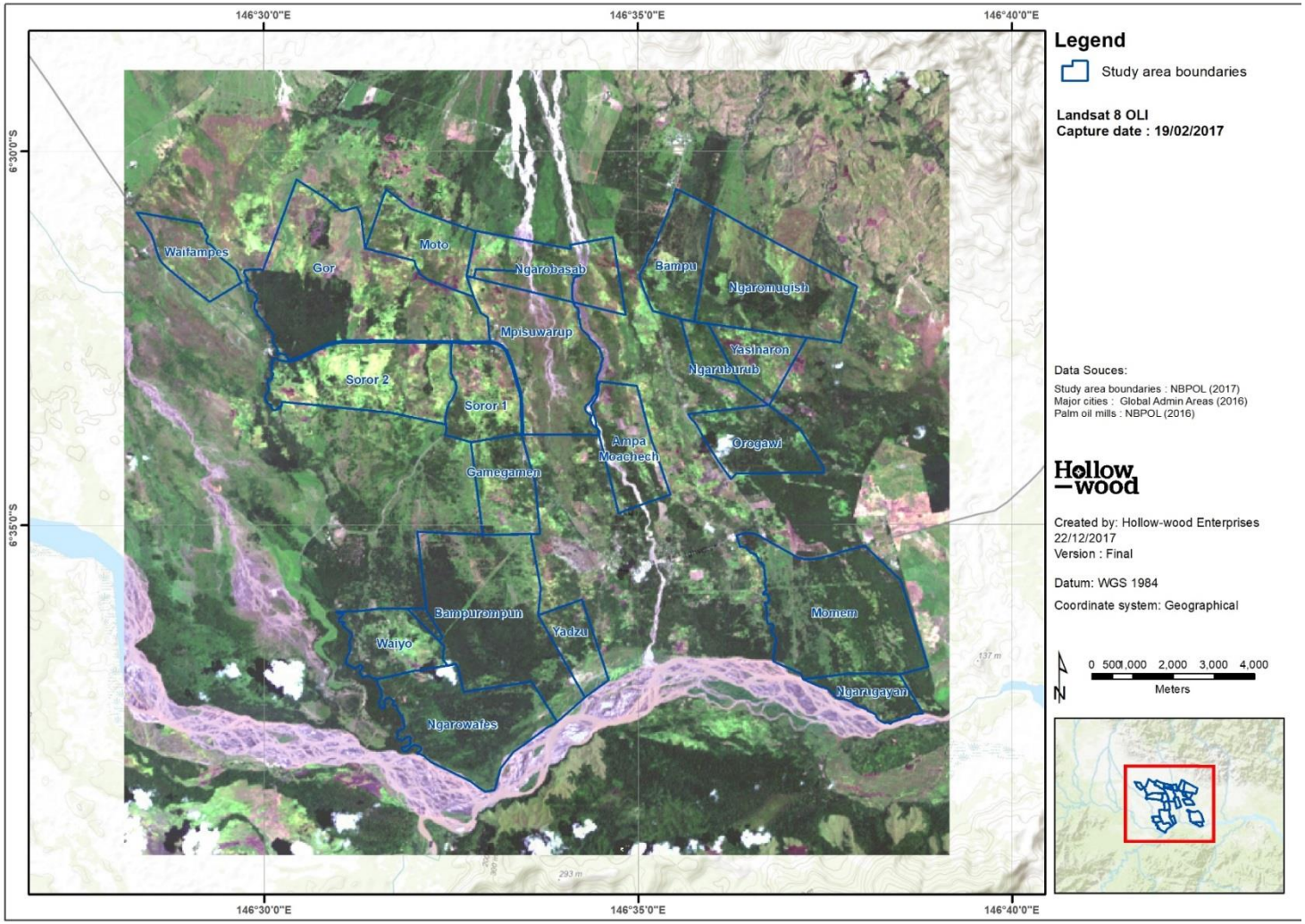
Map 9. Landsat 7 ETM + scene used for classification, captured on the 13/02/2006



Map 10. Landsat 7 ETM + scene used for classification, captured on the 14/10/2007


146°30'0"E
146°35'0"E
146°40'0"E
6°30'0"S
6°35'0"S
Waifampes
Gor
Moto
Ngarobasab
Bampu
Ngaromugish
Mpisuwarup
Yasiharon
Ngaruburub
Soror 2
Soror 1
Ampa
Moachech
Orogawi
Gamegamen
Bampurompun
Yadzu
Waiyo
Momem
Ngarugayan
Ngarowafes
137 m
293 m
Legend
Study area boundaries
Landsat 7 ETM +
Capture date : 22/12/2009
Data Souces:
Study area boundaries : NBPOL (2017)
Major cities : Global Admin Areas (2016)
Palm oil mills : NBPOL (2016)
Hollow-wood
Created by: Hollow-wood Enterprises
22/12/2017
Version : Final
Datum: WGS 1984
Coordinate system: Geographical
N
0 500 1,000 2,000 3,000 4,000
Meters

Map 11. Landsat 7 ETM + scene used for classification, captured on the 22/12/2009



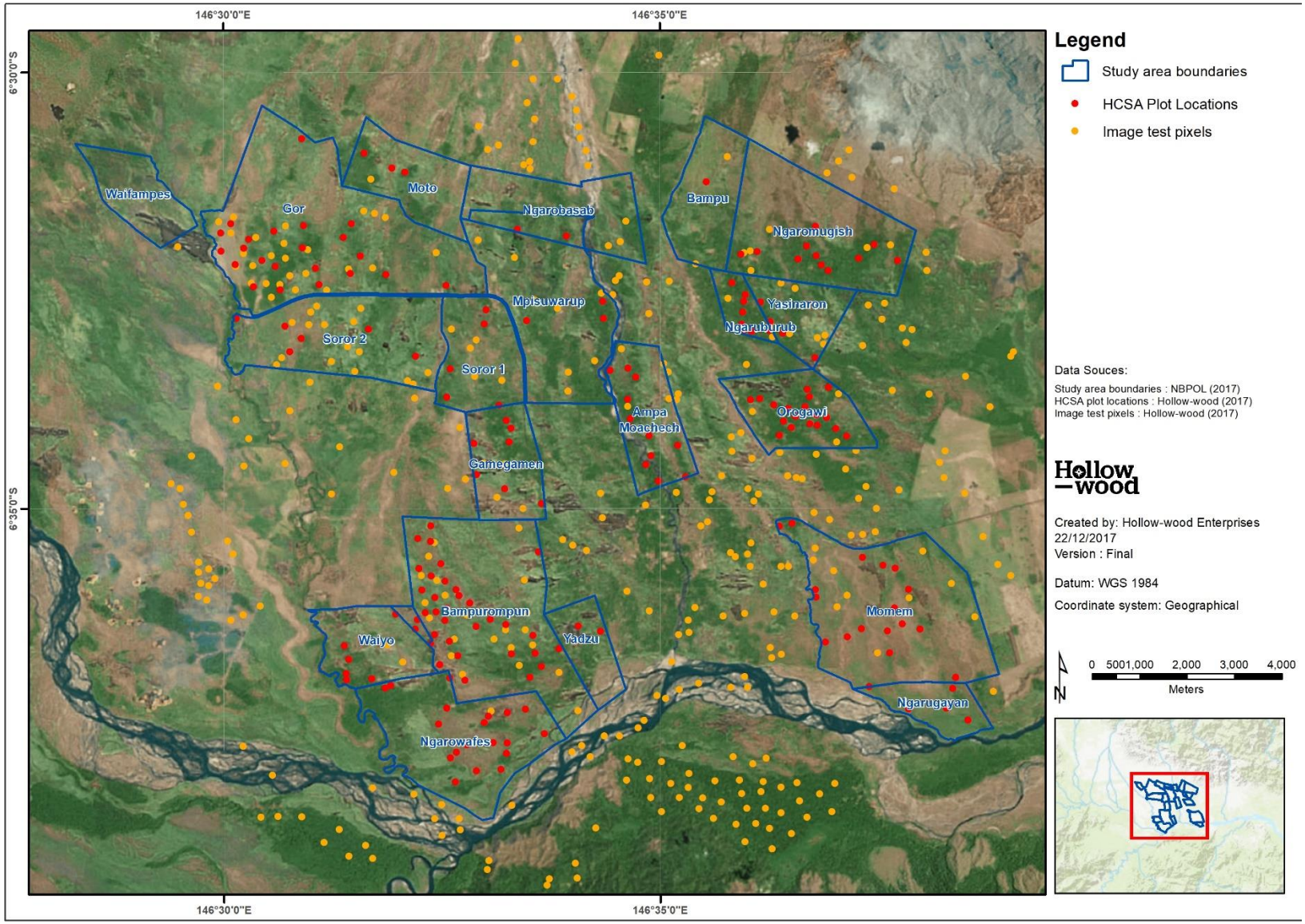
Map 12. Landsat 8 OLI scene used for classification, captured on the 19/02/2017

3.5 2 Results

3.5.2.1. Desktop analysis
3.1.1. Pre-processed georeferenced satellite images for entire concession area for each time of clearance period and additional cut-off periods.
See Maps 2 – 6.

	3.5.2.1.2. Sampling location						
	a. Number of sampling locations for each land cover class.						
		Woody regrowth	Shrub/ scrublands	Grasslands	Open lands	Open water	Total
Number of sampling locations	60	60	60	60	60	60	360
	b. Sampling location map.						
	See Map 7						

3.5.2.2. Field verification
3.5.2.2.1. Brief information on historical land use in the study area.
The study areas are located in the Markham Valley, Morobe Province in the north-east of the Papua New Guinea mainland (Map 1). The Markham River Valley is a broad, alluvial plain that is bounded by the Finisterre and Saruwaged Ranges in the north and the Kratke and Herzog Ranges (the northern extent of the Owen Stanley Range) in the south Garret-Jones (1979). Its widest point is at the confluence of the Leron River, where it reaches approximately 22km. The narrowest point is approximately 3km wide, at the Ramu-Markham divide at Gusap (Garret-Jones, 1979). Along its 140km course, discharging into the Huon Gulf near Lae, the Markham River and tributaries drain an area of approximately 12,000km2. The AOI is centered on the alluvial fan of the Rumu River, which drains south from the Saruwaged Ranges. The two other main tributaries of the Markham (the Erap and Leron Rivers) are east and west of the AOI respectively. The majority of the AOI is located within the Wampur – Rural Local Level Government Area (LLG), with a small fraction of the Ngaromugish area (NE AOI) being located within the Wain-Erap – Rural LLG. Two major villages are located within the AOI, Chivasing and Tararan. The Markham Valley has been a major area of agricultural development in the recent past (Connell, 1979 and Ningal *et al*., 2008). The post war development of a beef industry centered around the grazing leases at Gusap and Chivasing are good examples of this (Connell, 1979), as is the establishment of the mixed sugar and oil palm enterprises at Gusap, currently operated by Ramu Agicultural Industries Limited (RAIL). The recent PNG Biomass venture along with the Markham Farms Oil Palm Estate shows the continuing interest in the area. Ningal *et al*., (2008) state that there are obvious reasons for the interest in development, namely the combination of good soils, gentle terrain and good access to major markets, along the Highlands Highway. Land use change has been rapid in the Morobe Province, particularly the Huon District, with Ningal *et al*., (2008) reporting agricultural land increasing considerably between 1975 and 2000, at a rate of 3% per annum between 1975 and 1990 and 0.9% between 1990 and 2000. The same publication links agricultural development with population growth, and specifically identifies the suitability for the Markham Valley for agricultural expansion. Given the current high rates of population growth present across Papua New Guinea, the situation of rapid population growth and land use change is unlikely to change into the future.


146°30'0"E
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6°35'0"S
Watfampes
Gor
Moto
Ngarobasab
Bampu
Ngaromugish
Mpisuwarup
Yasinaron
Ngaruburub
Soror 2
Soror 1
Ampa
Moachech
Orogawi
Gamegamen
Bampurompun
Waiyo
Yadzu
Momem
Ngarugayan
Ngarowafes
Legend
Study area boundaries
HCSA Plot Locations
Image test pixels
Data Souces:
Study area boundaries : NBPOL (2017)
HCSA plot locations : Hollow-wood (2017)
Image test pixels : Hollow-wood (2017)
Hollow-wood
Created by: Hollow-wood Enterprises
22/12/2017
Version : Final
Datum: WGS 1984
Coordinate system: Geographical
N
0 500 1,000 2,000 3,000 4,000
Meters

Map 13. Image accuracy test sample locations.

Map 14. RSPO operational constraints

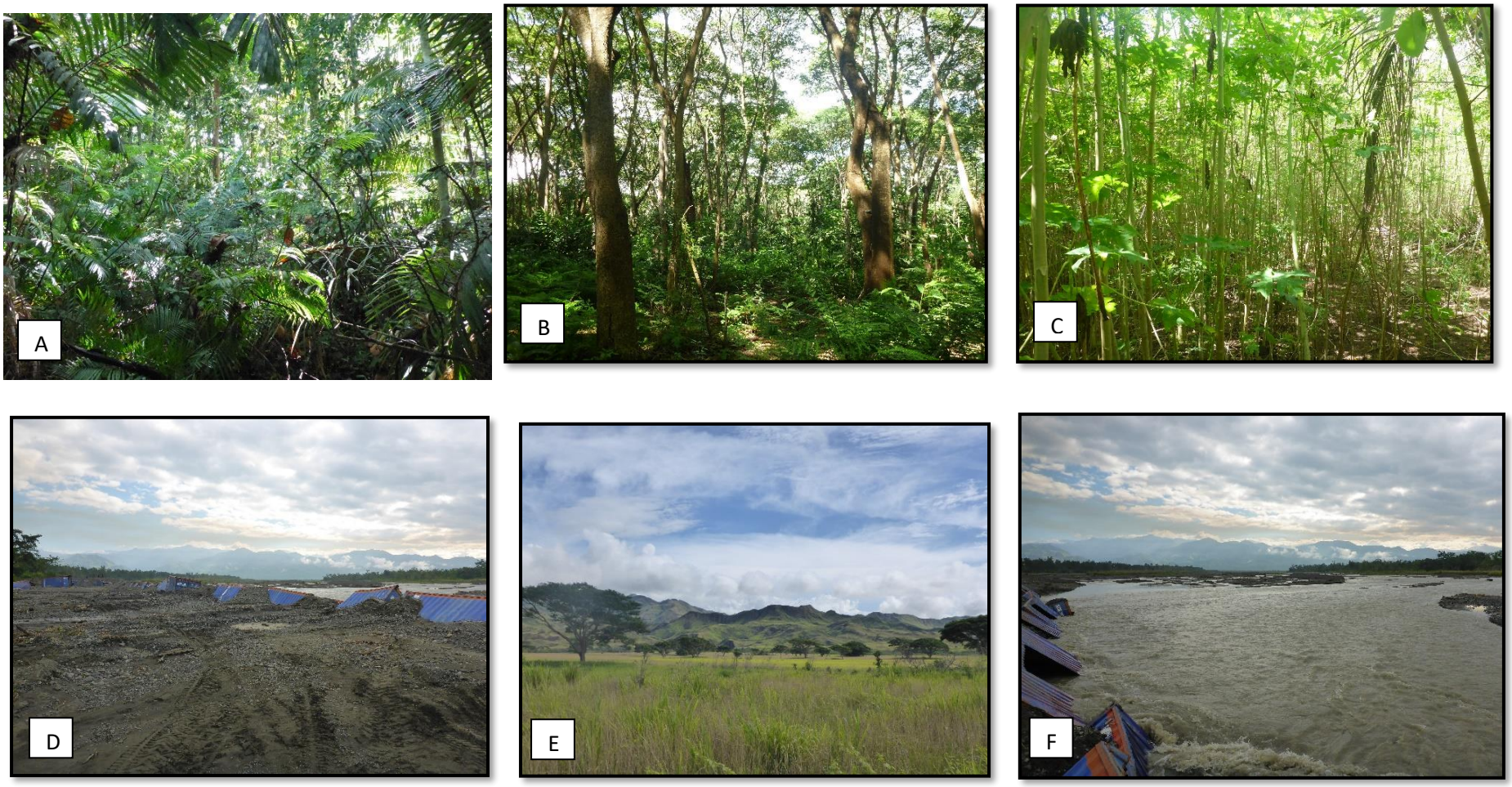


Figure 21. Examples of the vegetation types encountered during this LUCA assessment. a) Remnant native forest, b) Raintree dominated regrowth, c) Cultivated garden regrowth (Scrub), d) Open lands, e) Anthropogenic grasslands, f) Open water.

3.5.2.2.2. Documentation related to current and historical land cover class found in the study area (pictures and brief description of each land cover class).

This is a brief description of the lands cover classes developed for the project. Photographic examples of each of the classes can be found above in Figure 21.

Remnant native forest

Forest represented by this class are either highly degraded, remnant native forest or advanced secondary regrowth forest. Stands falling into this class are of very limited extent within the AOI, and generally occur in riparian zones or in swampy areas. Characteristic species seen during this assessment are; *Ficus spp*, *Trema orientalis*, *Macaranga spp*., *Dysoxylum spp*., *Neuburgia corynocarpa*, *Horsfieldia irya.* An example can be seen in Figure 21

Samanea saman dominated regrowth (woody weeds)

The introduction of *S. saman* into the area as a fodder / shade tree from the 1950's and subsequent easing of grazing pressure across many of the individual study sites from the mid 1970's has resulted in large areas being dominated by stands of *S. saman* regrowth.

Such stands generally have a closed canopy and possess little understorey. Recruitment of *S. saman* is often low as the low-light conditions created by the dense canopy are not ideal for seedling establishment. This vegetation class represents the dominant form of woody vegetation throughout the AOI. An example can be seen in Figure 21.

Shrub or Scrublands

Area in this category are ecosystems that have undergone intense and/or frequent disturbance events that are mainly of anthropomorphic origin. This also includes areas of vegetation that are under a system of shifting cultivation. This may include areas in fallow (i.e. not being currently cultivated) or areas in current use. This vegetation is typically low in diversity, is dominated by pioneering species and shows evidence of the repeated use of fire. In the AOI, common species common species observed were; *Piper aduncum, Trema orientalis, Macaranga tanarius, M. aleuritoides, Leea indica, Kleinhovia hospita, Hibiscus tiliaceus and variety of Ficus spp.* An example can be seen in Figure 21

Anthropogenic grasslands

Most of the grasslands of the Markham Valley are considered to be of anthropogenic origin, maintained by a near annual, low intensity fire regime. The grassland communities found within the AOI can generally be classified as the either the *Imperata cylindrica* (Kunai)/*Saccharum spontaneum* (Wild Sugarcane) dominated 'tall grasslands', or the *Themeda australis* (Kangaroo Grass)/*Capillipedium parvifolium* dominated 'short grasslands'. Scattered occurrences of small trees (such as *Glochidion drypetifolium*), shrubs (such as *Solanum spp*) and the fire-resistant cycad *Cycas schumanniana* are also common features though out the grassland communities observed within the AOI.

The distribution of these broad grassland community types seems to be primarily driven by drainage, soil type and local climate (Henty, 1982), with the swards of short grasslands occupying relatively dryer

sites in general, compared with those occupied by tall grasslands. An example can be seen in Figure 21.

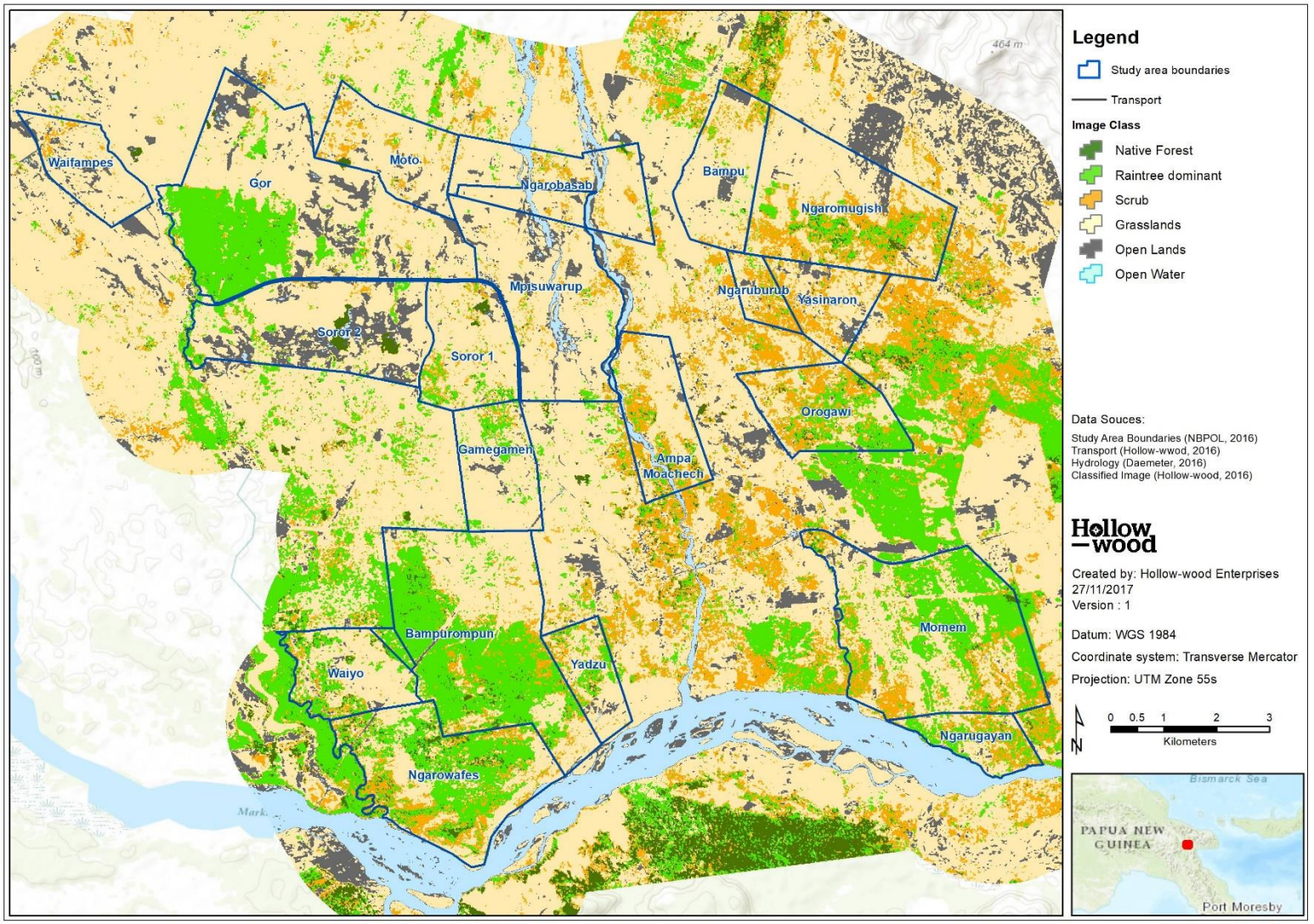
Open water

Features in this class are (as the title suggests) either open water such as river channels, lakes (natural or man-made) or open swamplands. Recently exposed wet soil may also be classified as open water due to fact that NIR and SWIR wavelengths are increasingly absorbed by water / wet soil. An example can be seen in Figure 21.

Open lands

The class represents a range of highly reflective, recently exposed bare ground such as bare soil, river channel gravels or grasslands that have been recently burnt. See Figure 21.

3.5.2.3. The loss of social HCVs and areas where planting is prohibited by RSPO P&C or by country's specific legislation
3.5.2.3.1. Brief information on the loss of social HCVs (if any). This includes estimated number of hectares and current condition of these areas.
n/a. No social HCV's impacted
3.5.2.3.2. Map of social HCV areas lost (if any)
n/a
3.5.2.3.3. Brief information on the loss of areas where planting is prohibited by RSPO P&C or by country's specific legislation (e.g. riparian zones, steep slope, deep peat) (if any). This includes estimated number of hectares and current condition of these areas.
No area has been cleared yet as the NPP is the outcome of a feasibility study. Any planned Oil Palm establishment will be in accordance with RSPO prescription
3.5.2.3.4. Map depicting the loss of areas where oil palm establishment is prohibited by RSPO P&C
See Map 8
3.5.2.3.5. Summary of the LUC accuracy assessment result
The accuracy assessments presented in this section are conducted as per the methods outlined in Congalton & Green (2008), Lunetta and Lyon (2004) and Lillesand *et al*., (2015). Congalton & Green (2008) state that error analysis is only possible if the reference data is at least one step closer to reality than the remotely sensed product on which the map is based. This being the case, an accuracy assessment was performed on the classified results of higher resolution satellite image than the Landsat data used for the LUCA. This image was sourced from Rapid Eye during August 2016 and was of 5m spatial resolution. The classified image is shown below in Map 15. The error matrix presented in Figure 22 shows an excellent result, with an overall accuracy of 97% and a k-statistic (Cohens kappa value) 0.97. Figure 22 is an assessment of the accuracy of the training samples developed for the land cover classification, with the high result being an indication of training polygon homogeneity, and therefore the spectral separability of each of the classes developed. Figure 23 is an accuracy assessment of the classified image itself, with a sample of test pixels being compared against model output (i.e. the classified image). 60 test pixels were developed for each of the six classes (n=360) with values being assigned to each of the test pixels based on a manual interpretation of the image. This interpretation was then compared against the classified image. The overall accuracy of the classification was 89% with a k-statistic of 0.87. Both commission (over classification of a class) and omission error (under classification of a class) were generally low. A notable exception was the over-classification of the 'WW' class (woody weeds or *S. saman* dominated vegetation), where most of the committed pixels came from the 'Native Forest' class. This indicates that there was difficulty in spectrally separating mature raintrees from native forest



Map 15. Classified Rapid Eye image that was used for accuracy assessment

Reference data for training samples								Producers Accuracy (%)		
Classification Results	HCSF	WW	SCB	GRS	OL	OW	Row Totals	HCSF	962/1008	95.4
HCSF	**962**	0	0	0	2	0	964	WW	1157/1157	100.0
WW	38	**1157**	8	0	0	0	1203	SCB	1043/1057	98.7
SCB	8	0	**1043**	0	11	0	1062	GRS	1112/1112	100.0
GRS	0	0	6	**1112**	2	0	1120	OL	1151/1258	91.5
OL	0	0	0	0	**1151**	0	1151	OW	1167/1167	100.0
OW	0	0	0	0	92	**1167**	1259			
Column Totals	**1008**	**1157**	**1057**	**1112**	**1258**	**1167**	**6759**	Users Accuracy (%)		
								HCSF	962/964	99.8
Overall accuracy = (962+1157+1043+1112+1151+1167) / 6759 = 97.53%								WW	1157/1203	96.2
								SCB	1043/1062	98.2
K statistic = 0.97								GRS	1112/1120	99.3
								OL	1151/1151	100.0
								OW	1167/1259	92.7

Figure 22. Error matrix for training samples created for the classified Rapid Eye image

Reference data for test pixels								Comission Error (%)		
Classification Results	HCSF	WW	SCB	GRS	OL	OW	Row Totals	HCSF	2/42	4.8
HCSF	**40**	1	0	0	1	0	42	WW	18/76	23.7
WW	16	**58**	1	1	0	0	76	SCB	3/60	5.0
SCB	1	1	**57**	1	0	0	60	GRS	7/52 =	14.7
GRS	3	0	2	**58**	5	0	68	OL	3/54	5.6
OL	0	0	0	0	**51**	3	54	OW	3/60	5.0
OW	0	0	0	0	3	**57**	60			
Column Totals	**60**	**60**	**60**	**60**	**60**	**60**	**360**	Omission Error (%)		
								HCSF	20/60 =	33.3
Overall accuracy = (40+58+57+58+51+57) / 360 = 89.16%								WW	2/60 =	3.3
								SCB	3/60 =	5.0
K statistic = 0.87								GRS	2/60 =	3.3
								OL	9/60 =	15.0
								OW	3/60 =	5.0

Figure 23. Error matrix for test pixels created for the classified Rapid Eye image.

3.5.2.4. Historical land use change from period to period - *in hectares* Updated 5th Oct 2018					
Reference date	**Before November 1, 2005 (baseline)**	**November 1, 2005-November 31, 2007**	**December 1, 2007-December 31, 2009**	**January 1, 2010-May 9, 2014**	**After HCV areas identified**
Image date used	**13/8/2002**	**13/2/2006**	**14/10/2007**	**22/12/2009**	**19/2/2017**
Remnant forest	342.59	380.90	1058.85	480.06	1307.02
Woody weed regrowth	1259.07	1270.65	1069.87	1760.04	1710.27
Scrublands	1267.32	1954.18	1295.02	2792.34	1843.56
Grasslands	7374.08	6311.64	5594.52	5216.48	5193.44
Open lands	355.16	144.87	509.54	340.82	478.81
Open water	54.61	72.07	45.04	63.08	119.72
No Data	0	518.51	1079.97	0	0
Totals	**10652.82**	**10652.82**	**10652.82**	**10652.82**	**10652.82**

3.5.2.5. Corporate and non-corporate clearance divided into vegetation coefficient from specific period of time - *in hectares*

3.5.2.5.1. Summary process for determining corporate and non-corporate clearance

This assessment has occurred on customary land in an area where there has been no oil palm establishment or land clearing to date. Due to the above-mentioned reasons, the following sections are deemed to be *not applicable* and will not be reported n as part of this analysis;

- Section 3.8.2. RaCP vegetation coefficients not applicable for this assessment
- Section 3.9. Environmental remediation reporting not applicable as no land clearing or oil palm establishment has occurred in this landscape.
- Section 3.10. RaCP vegetation coefficients not applicable for this assessment
- Section 3.11. No compensation liability for this assessment as no land clearing or oil palm establishment has occurred in this landscape.

It should be noted that the 1.65 ha difference in total area seen between Section 3.5 and Section 3.7 is not a mistake, but rather a result of rasterizing the feature dataset and constraining the change detection analysis (section 3.7) to a 30m x 30m grid. An example of this can be seen below in Figure 24.

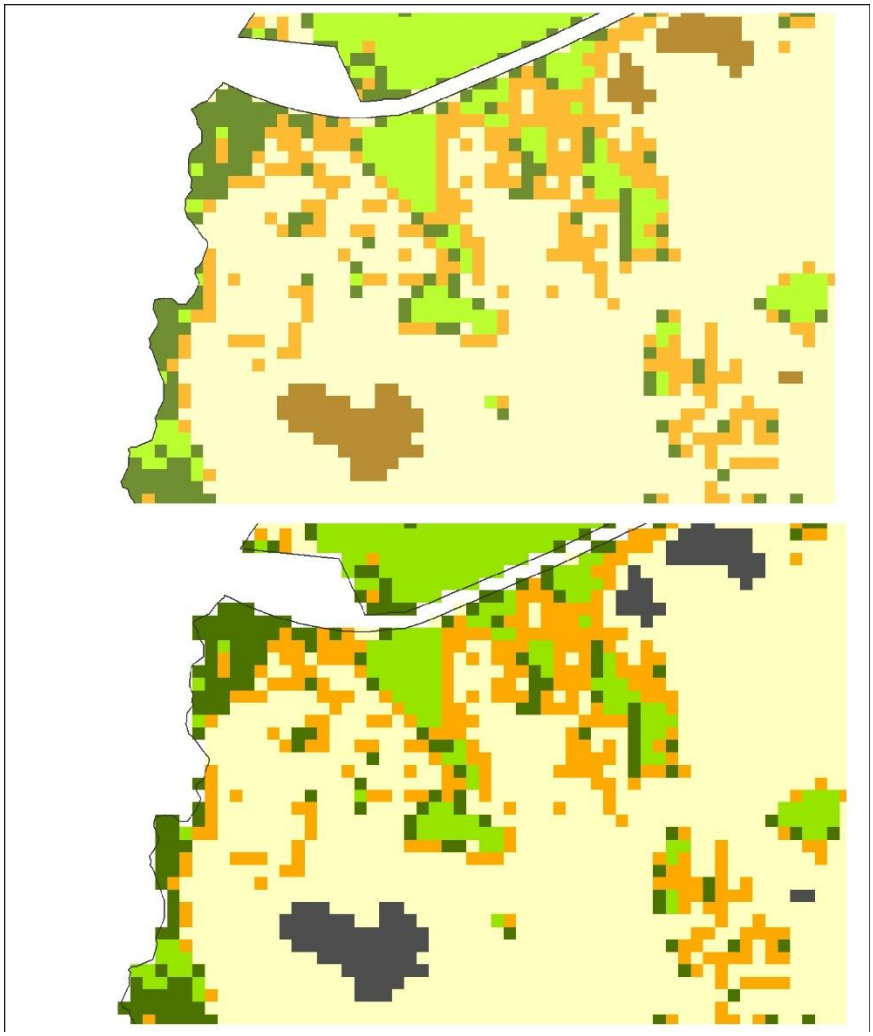
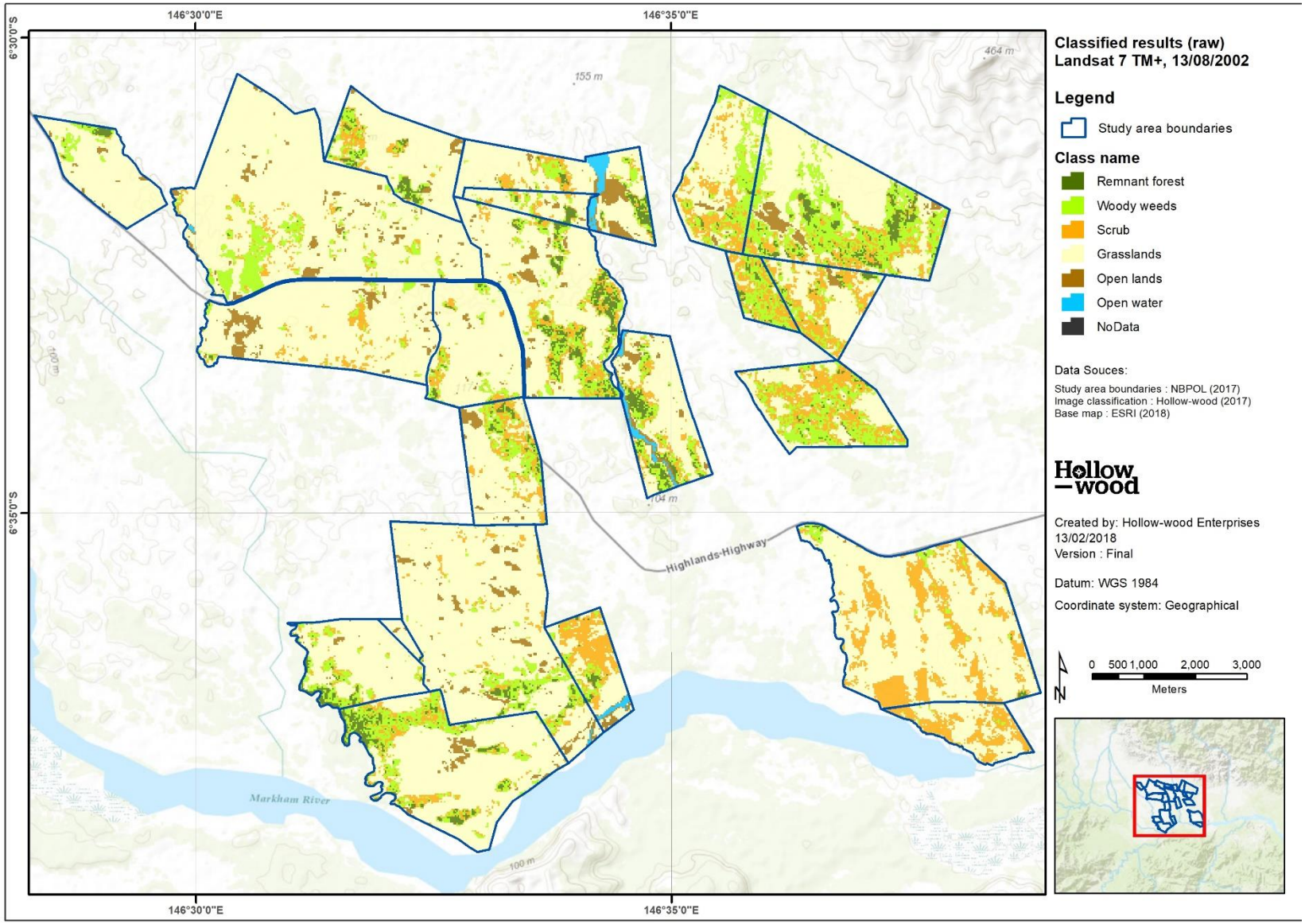


Figure 24. Rasterised land cover data showing pixels over and under the study area boundaries, explaining the 1.65ha difference between Section 3.5 and Section 3.7. Vector dataset in image above and rasterised dataset in image below.

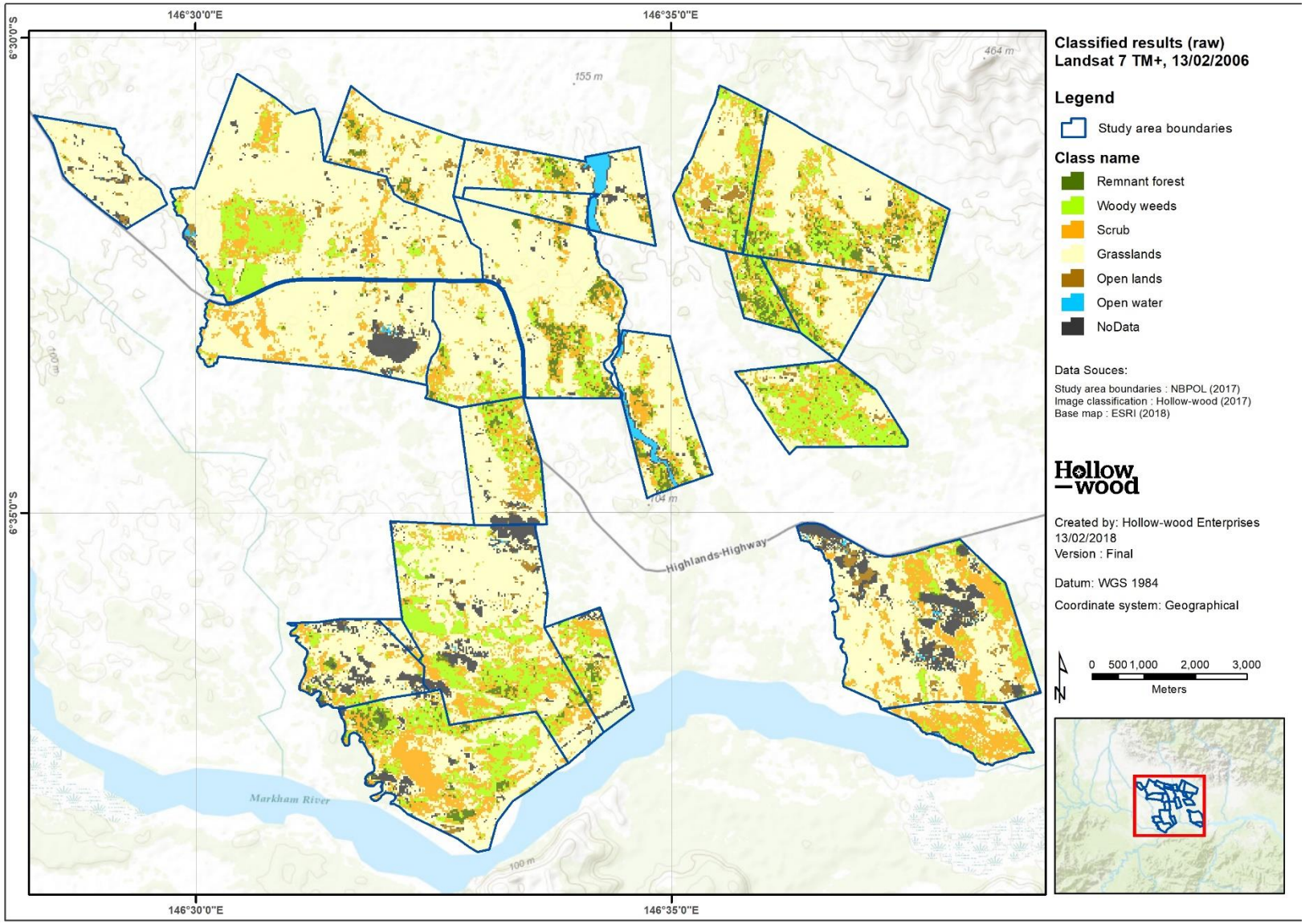
3.5.2.6. Non-corporate change detection. Updated 5th Oct 2018								
	Land cover class	Post HCV assessment (2017)						
		Remnant forest	Woody weeds	Scrub	Grasslands	Open lands	Open water	**Total**
Between January 01 2009 and May 2014	Remnant native forest	178.02	62.82	56.61	168.12	7.29	8.1	**480.96**
	Woody weeds regrowth	274.77	1087.38	262.08	117.99	13.59	4.41	**1760.22**
	Scrublands	550.53	343.8	630.72	1181.7	61.65	23.04	**2791.44**
	Grasslands	288.54	210.51	843.93	3493.62	337.77	44.19	**5218.56**
	Open lands	16.29	6.66	49.86	219.78	37.89	10.17	**340.65**
	Open water	0.18	0	0.09	12.69	20.07	29.61	**62.64**

	Total	**1308.33**	**1711.17**	**1843.29**	**5193.9**	**478.26**	**119.52**	**10654.47**

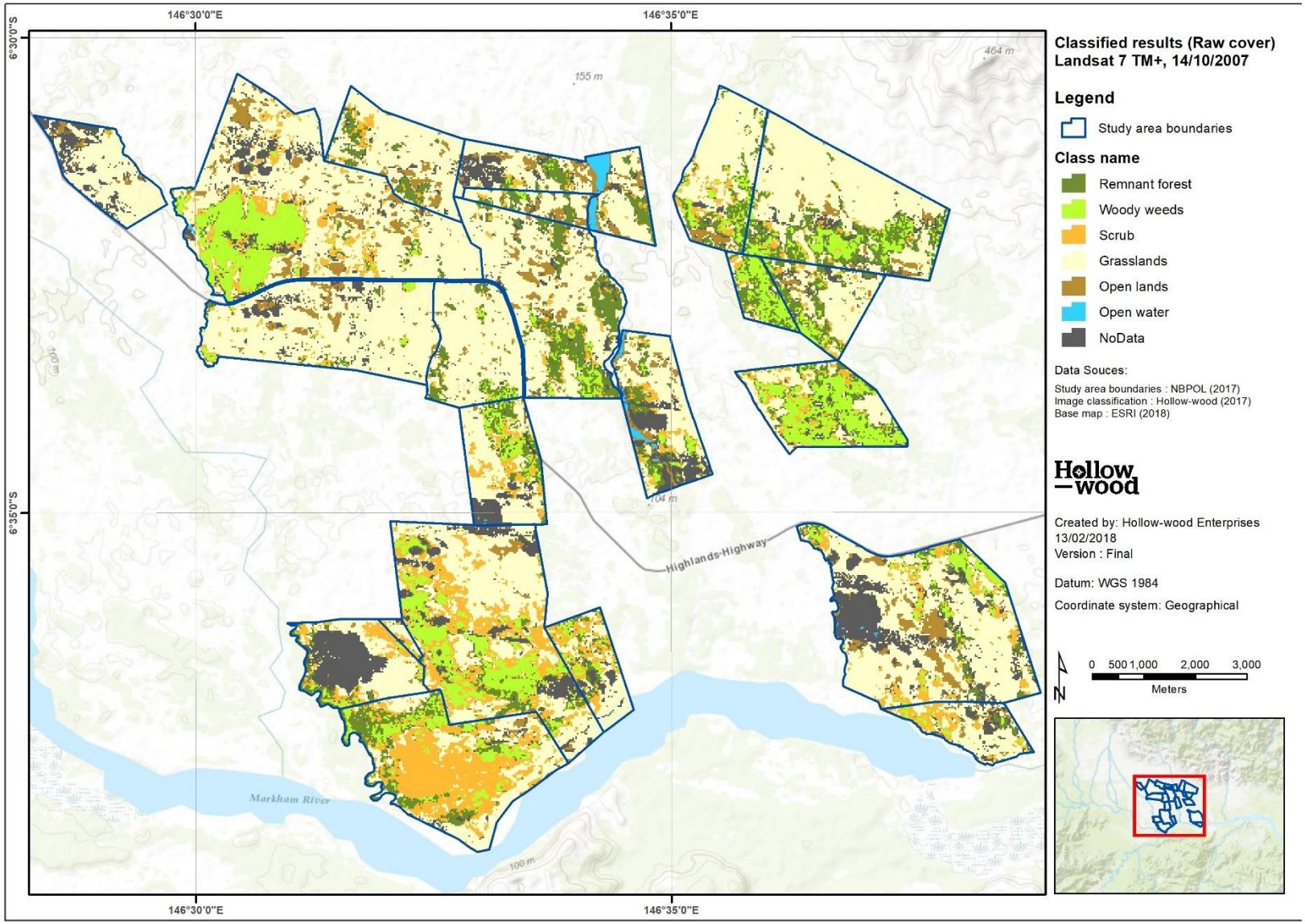
3.5.2.7. Raw and processed land cover maps
3.5.2.7.1. Raw land cover maps ***(prior division into the according vegetation coefficients for each of clearance period and additional cut-off periods)***
See Maps 10 to 14
3.5.2.7.2. Processed land cover maps ***(after division into the according vegetation coefficients (1.0, 0.7, 0.4, 0) for each of clearance period and additional cut-off periods)***
Not applicable


146°30'0"E
146°35'0"E
6°30'0"S
6°35'0"S
155 m
464 m
104 m
100 m
Highlands-Highway
Markham River
Classified results (raw)
Landsat 7 TM+, 13/08/2002
Legend
Study area boundaries
Class name
Remnant forest
Woody weeds
Scrub
Grasslands
Open lands
Open water
NoData
Data Souces:
Study area boundaries : NBPOL (2017)
Image classification : Hollow-wood (2017)
Base map : ESRI (2018)
Hollow-wood
Created by: Hollow-wood Enterprises
13/02/2018
Version : Final
Datum: WGS 1984
Coordinate system: Geographical
N
0 500 1,000 2,000 3,000
Meters

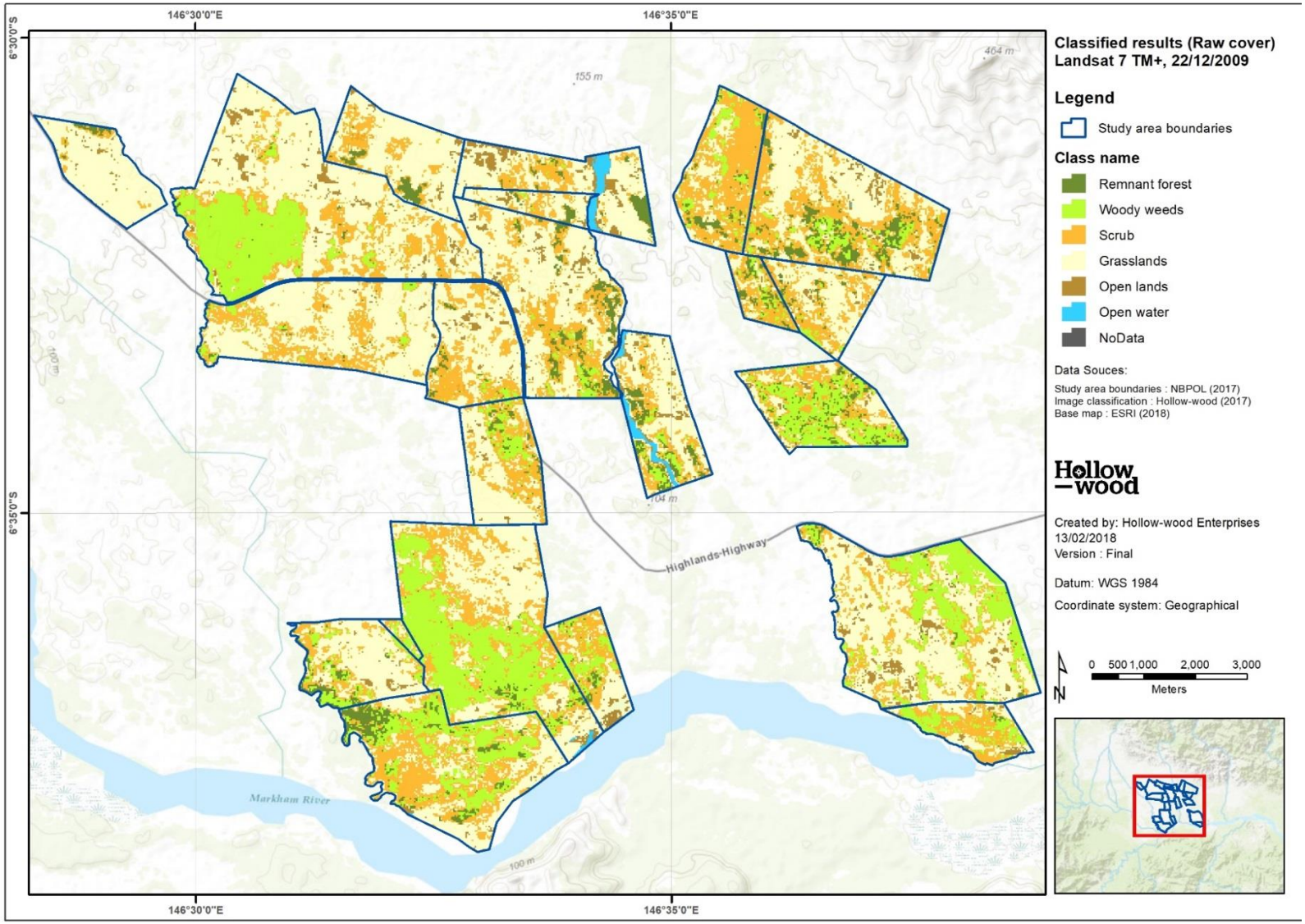
Map 16. Land cover across the study area before November 2005. Inamgery from August 2002.



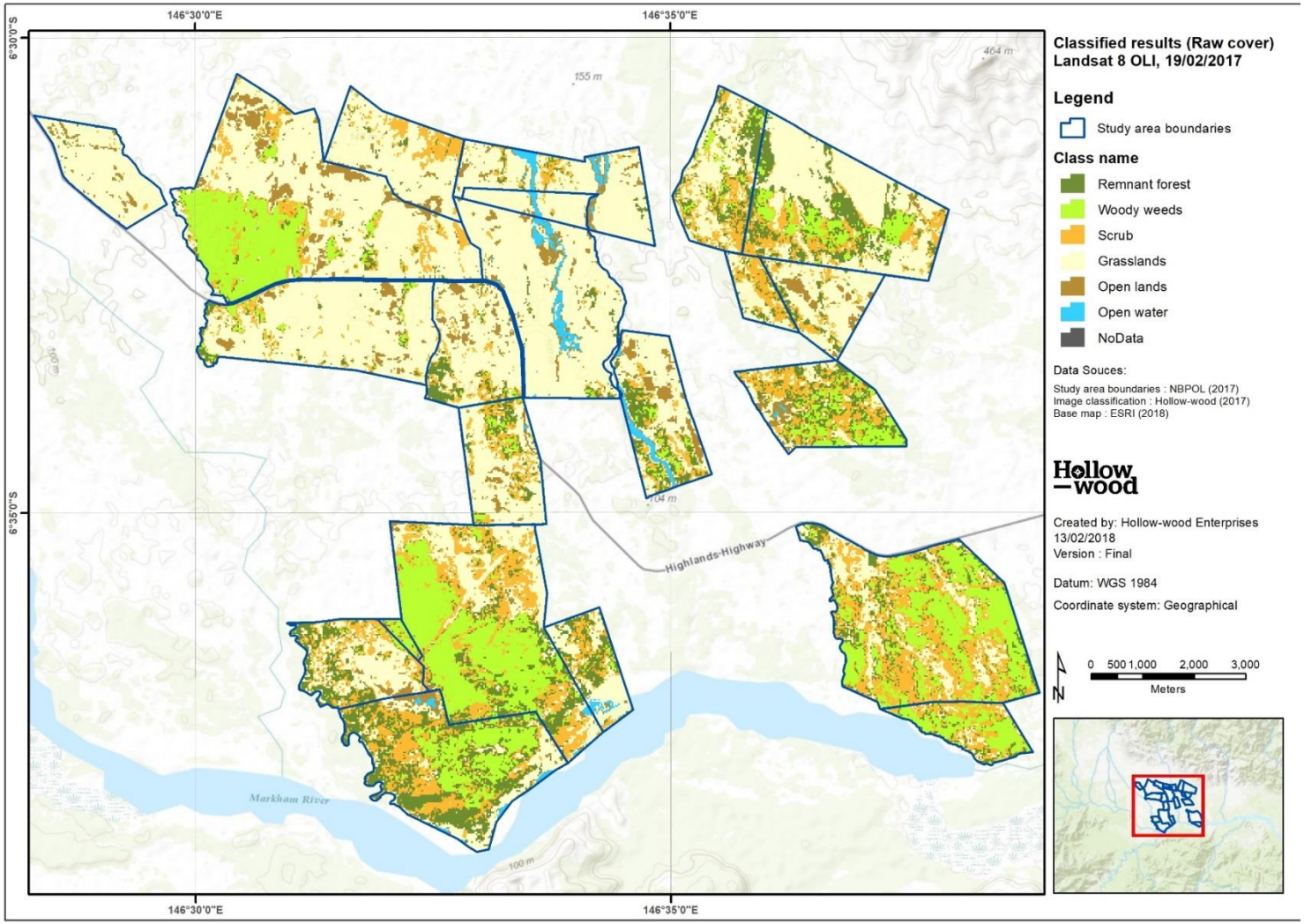
Map 17. Land cover across the study area between 1/11/2005 and 31/11/2007. Imagery captured 13/02/2006



Map 18. Land cover across the study area between 1/12/2007 and the 31/12/2009. Imagery captured on the 14/10/2007.



Map 19. Land cover across the study area between the 01/01/2010 and the 14/05/2014. Imagery captured on the 22/12/2009.



Map 20. Land cover across the study area after both the 14 /05/2010 and after the most recent HCV assessment in 2016. Imager y captured on 19/02/2017.

3.5.2.8. Environmental remediation - *the loss of areas where oil palm establishment is prohibited*					
Period of land clearance	**Riparian buffer**	**Steep slope**	**Peat**	**….**	**Total**
After May 9, 2014	n/a	n/a	n/a	n/a	n/a
Jan 1, 2010 to May 9, 2014	n/a	n/a	n/a	n/a	n/a
Dec 1, 2007 to Dec 31, 2009	n/a	n/a	n/a	n/a	n/a
Nov 1, 2005 to Nov 30, 2007	n/a	n/a	n/a	n/a	n/a
Total (sum of row)	n/a	n/a	n/a	n/a	n/a

3.5.2.9. LUCA result before multiplying with vegetation coefficient					
Land cover class	**Vegetation Coefficient**	**Nov 1, 2005 to Nov 30, 2007**	**Dec 1, 2007 to Dec 31, 2009**	**Jan 1, 2010 to May 9, 2014**	**After May 9, 2014**
One or more land cover classes which fulfill the criterion of vegetation coefficient 1.0	**1.0**	n/a	n/a	n/a	n/a
One or more land cover classes which fulfill the criterion of vegetation coefficient 0.7	**0.7**	n/a	n/a	n/a	n/a
One or more land cover classes which fulfill the criterion of vegetation coefficient 0.4	**0.4**	n/a	n/a	n/a	n/a
One or more land cover classes which fulfill the criterion of vegetation coefficient 0.0	**0**	n/a	n/a	n/a	n/a
Total (sum of rows)		n/a	n/a	n/a	n/a

3.5.2.10. Final compensation liability *(see Remediation and Compensation Procedures November 2015, page 15, Table 3 determining conservation liability)*		
Period of land clearance	**Land controlled by a non-member at time of clearance**	**Land controlled by an RSPO member at the time of clearance. This includes land acquired from other RSPO members**
After May 9, 2014	n/a	n/a
January 1, 2010 to May 9, 2014	n/a	n/a
December 1, 2007 to December 31, 2009	n/a	n/a
November 1, 2005 to November 30, 2007	n/a	n/a
Total (sum of rows and columns)	n/a	

3.6 FPIC process

3.6.1 Identification legal, customary or user rights

All proposed new developments have undergone extensive participation with the legal customary land owners. All of the land under consideration is privately owned, there are no government granted concessions in Papua New Guinea and as such the identification of genuine land owners is a requirement to ensure the security of the long term investment. All of the new development have resulted from voluntary and unsolicited expressions of interest by the traditional landowners. The long standing presence of NBPOL in this landscape and the employment of local citizens familiar with the land owners of the areas including those being proposed by them for development has facilitated the identification of the rightful land owners.

3.6.2 Documentary evidence of FPIC process

The fulfilment of FPIC requirements have been further ascertained and reinforced through the carrying out of the SEIA, HCV and HCS all of which incorporate best practices such as participatory mapping as part of their methodology. All the original expressions of interest, meeting attendance records of awareness meetings, and land use planning maps signed off by clan leaders are available for verification by the CB.

4.0 Summary of Management Plans

4.1 Team responsible for developing management plans

The management plans are developed by RAI Management based upon the recommendations of the assessments done and summarized within this document. The following detail the roles and responsibility of each Management team.

General Manager RAI- Authorizes the Management plan. Ensures budgetary requirements are met as necessary to implement the management plan. Structures lease agreements to make protection requirements a condition of HCVMA lands leased to RAI. Supports Management team as necessary to resolve any issues met during the implementation of the Management Plan.

Field Manager RAI- Implements the operational components of the Management Plan. Ensures all Field Department employees and Contractors are inducted to the requirements of the Management Plan. Monitors and enforces requirements of the Management Plan.

Sustainability Manager RAI- Trains all Field Management Staff on the requirements of the Management Plan. Provides initial and regular awareness to all land owning communities as required. Audits the implementation of the Management Plan by the Field Department.

4.2 Elements to be included in management plans

4.2.1.Social and Environmental Impact Management Plan

The following social impact management plan is derived from the SEIA report recommendations and is relevant to impacts and mitigation measures identified in that reports These recommendations will be incorporated into the a RAI Social and Environmental Management Plan whose coordination is responsibility of the Sustainability Department.

Table 27 Social Impact Management Plan (updated on 5 Oct 2018)

No	Aspect/Activity	Potential Impact/s	Mitigation measure/s	Performance indicator/s	Monitoring period/ frequency	Responsibility	Time Frame
A	**PRE-DEVELOPMENT SITE EVALUATION AND LAND LEASE ARRANGEMENT**						
1	Letter of Interest (LoI) from landowners (LOs).	Resistance by some LOs against the proposal to enter into Zifasing oil palm project (ZOPP) development venture with RAIL.	• Ascertain that the LoI genuinely reflects the collective intention of all the landowners. • Ensure that LOs are not coerced or unduly influenced in giving up their land for ZOPP.	• Confirmation meeting held with the community. • Confirmation interviews held with individual members of the community representing the demographic cross-section of the community. • FPIC	During ILG registration and negotiation on mini-estate (ME) and lease-lease-back (LLB) agreement.	• Lands Officer (LandsO) • Project Manager – New Development (PM-ND) • Sustainability Manager (SM)	Completed
2	Awareness on RSPO in ILG community	Misunderstanding of RSPO and its ultimate objective to protect the environment and improve the welfare of the community.	• Carry out RSPO awareness in each intending ILG community. • Invite relevant Provincial Government officials and local	• RSPO awareness held in each intending ILG community with the attendance of relevant Provincial	Ideally prior to the start of feasibility and related investigations.	• PM-ND • SM	Completed and Ongoing

No	Aspect/Activity	Potential Impact/s	Mitigation measure/s	Performance indicator/s	Monitoring period/ frequency	Responsibility	Time Frame
			NGO representatives.	Government and local NGO representatives.			
3	Notification to CEPA	CEPA unaware of the project and may not be prepared to satisfactorily deal with potential complaints/concerns relating to environmental degradation.	• Formally notify CEPA of planned ME development as per Environment Act 2000. • Comply with official response from CEPA.	• Timely notification to CEPA. • Compliance with official response from CEPA.	Ideally prior to completion of land lease acquisition as well as HCV, HCS and SEI assessments.	• PM-ND • SM	Completed
4	Notification and input from (i) relevant Morobe Provincial Government Divisions including Planning, Lands, Agriculture and Environment, (ii) host LLGs and (iii) local environment NGOs.	Oil palm project development incompatible with provincial and district development plans. • Environment NGOs may claim lack of transparency.	Keep relevant government authorities as well as local NGOs informed and seek their input into the proposed oil palm project.	Submission of regular written updates and maintenance of effective dialogue with relevant officials.	Quarterly	• LandsO • PM-ND	Completed
5	Land boundary surveys and site assessments.	• Some LOs not happy with land allocation. • Clan boundaries disputed by neighbouring clans	• Ascertain that all LOs agree with allocation of land for ZOPP. • Confirm that clan boundaries are recognised by other clans.	Endorsement of land allocated for ME development by all LOs and neighbouring clans.	Prior to the start of negotiation on ME and LLB agreement.	LandsO PM-ND	Completed & ongoing
6	Compilation of ILG genealogy and related documents for registration of ILG.	• Some ILG members are not included. • Disputes over eligibility for membership may arise.	• Ensure all LOs actively participate in the study and all documents are compiled in time.	• Assessment of ILG genealogy in accordance with RSPO guidelines and the ILG Act. • Timely submission of relevant documents for	Prior to the start of negotiation on ME and LLB agreement.	• LandsO • PM-ND	Ongoing

No	Aspect/Activity	Potential Impact/s	Mitigation measure/s	Performance indicator/s	Monitoring period/ frequency	Responsibility	Time Frame
				registration of ILG.			
7	Assessment of HCV and HCS	Not carried out as per RSPO guidelines.	Ensure accredited and competent assessors are engaged and the assessments involve the LOs.	• Assessment of HCV and HCS in accordance with RSPO guidelines. • Timely submission of HCV report and HCS report.	Prior to the start of negotiation on ME and LLB agreement.	• PM-ND • SM	Completed
8	Negotiation of ME and LLB Agreement as per the ILG Act.	• Land use agreement not understood by all LOs. • Members of the ILG community not given the opportunity to hear from existing ME landowners. • Some LOs unwilling to proceed with establishment of ME. • LO terms and conditions not adequately accommodated in the agreement.	• Ascertain that LOs are kept informed on the progress of the negotiations. • Facilitate discussions between intending and current ME landowners.	• LOs are kept informed on the progress of the negotiations.	During negotiation on ME and LLB agreement.	• LandsO • PM-ND • SM	Ongoing
9	Finalisation and signing of ME and Lease Agreement.	LOs not fully aware of terms and conditions of the agreement before signing it.	Ascertain that LOs are aware of terms and conditions of the agreement before signing it.	LOs are aware of terms and conditions of the agreement before signing it. This should be verified by the Ward Councillor and two local pastors.	During and up to the signing of the ME and Lease agreement.	• LandsO • PM-ND • SM	Aug-Oct 2018
10	Census of pre-project establishment ILG household socio-economic situation including the following aspects:	Omission of households in the census.	Ensure all ILG households are covered in the survey.	All ILG households are covered in the survey.	Prior to the start of site preparation and then every three years during the lease period.	PM-ND SM	Jan-March 2019 & ongoing

No	Aspect/Activity	Potential Impact/s	Mitigation measure/s	Performance indicator/s	Monitoring period/ frequency	Responsibility	Time Frame
	• Type of house • Population • Demography • Education and skills • Economic activity • Income • Nutrition • Water supply • Sanitation • Health						
11	Pre-development water quality analysis of surface and groundwater within and at the periphery of the project area.	The absence of baseline water quality data will not help RAI deal effectively with subsequent water contamination allegations.	Carry out pre-development water quality monitoring.	Pre-development water quality monitoring carried out.	Before start of site preparation.	• PM-ND	Sept-Nov 2018
B	**SITE PREPARATION, PLANTING OF OIL PALM AND INSTALLATION OF WO3RKERS ACCOMMODATION, PLANTATION AND MILL INFRASTRUCTURE**						
1	Detailed survey of entire lease area and demarcation of buffer zones, oil palm plots, access roads, drainage, as well as workers accommodation, plantation related and mill infrastructure.	Buffer zones not appropriately demarcated.	Ensure buffer zones are appropriately demarcated.	Buffer zones are appropriately demarcated.	Before site preparation, then monthly through to start of operation phase and six monthly thereafter.	LandsO PM-ND TSD (Technical Services Division)	Completed
		Oil palm plots, access roads, drainage, as well as workers accommodation, plantation, and mill infrastructure not sited to minimize environmental degradation.	Ensure plantation and mill infrastructure are positioned so that environmental impacts are minimised.	Plantation and mill infrastructure are positioned so that environmental impact is minimal.	Before site preparation, then monthly through to start of operation phase and six monthly thereafter.	LandsO PM-ND TSD	Nov-Dec 2018 onwards

No	Aspect/Activity	Potential Impact/s	Mitigation measure/s	Performance indicator/s	Monitoring period/ frequency	Responsibility	Time Frame
2	Direct employment and contractual engagement for site preparation, construction of roads and drainage, oil palm planting as well as installation of workers accommodation, plantation and mill infrastructure.	Priority for employment and contractual work not given to nearby villagers.	Give priority for employment and contractual work to nearby villagers. .	Priority for employment and contractual work given to nearby villagers.	Prior to start of site preparation.	PM-ND SM TSD	Nov-Dec 2018 onwards
		Employees not advised of their terms and conditions of employment, not adequately trained and not provided with appropriate PPE.	Advise all employees of their terms and conditions of employment, train them and provide appropriate PPE	All employees advised of their terms and conditions of employment, trained and provided with appropriate PPE.	Prior to start of site preparation.	• PM-ND • SM	Oct 2018 onwards
3	Reforestation where necessary of buffer zones.	Some buffer zones not reforested where necessary.	Ensure buffer areas are reforested where necessary.	Buffer zones not reforested as required.	Before site preparation, then monthly through to start of routine operation phase and six monthly thereafter	• PM-ND • SM • TSD	Nov-Dec 2018 onwards
		Clear and legible signage in English and Tok Pisin not erected alongside buffer zones.	Install sufficient, clear and legible signage in English and Tok Pisin on restrictions within the buffer zones.	Sufficient, clear and legible signage in English and Tok Pisin on restrictions within the buffer zones and conservation reserves installed.	Before site preparation, then monthly through to start of routine operation phase and six monthly thereafter	• PM-ND • SM	Nov-Dec 2018 onwards

No	Aspect/Activity	Potential Impact/s	Mitigation measure/s	Performance indicator/s	Monitoring period/ frequency	Responsibility	Time Frame
		Enhancement of local flora in the buffer zones.	Enhance variety of local plant species in each buffer zone.	Inventory of local plant species in each buffer zone is enhanced.	Before site preparation and then six monthly thereafter	• PM-ND • SM	Nov-Dec 2018 onwards
		Reduced soil erosion and siltation of nearby surface water bodies.	Monitor soil erosion and siltation reduction capacity of buffer zones.	Soil erosion and siltation management capacity of buffer zones are monitored for continuous improvement.	Before site preparation and then six monthly thereafter.	• PM-ND • SM	Nov-Dec 2018 onwards
4	Removal of vegetation as demarcated in preparation of oil palm plots as well as construction of access roads and drainage, of workers accommodation, plantation and mill infrastructure.	Significant variation in local hydrology.	Contour landscape to local natural drainage.	Minimum net deviation from local natural drainage.	Weekly	• PM-ND • SM • TSD	Nov-Dec 2018 onwards
		Increased soil erosion and siltation of surface water	Restrict vegetation clearance to pre-designated areas.	Minimum unwarranted vegetation removed.	Weekly	• PM-ND • SM • TSD	Nov-Dec 2018 onwards
			Where appropriate, use the removed vegetation as flow impediment structures and silt traps.	Removed vegetation effectively used to impede flow and retain silt.			Nov-Dec 2018 onwards
			Incorporate other silt regulation mechanisms and devices such as silt	Other cost-effective silt management methods successfully applied.			Nov-Dec 2018 onwards

No	Aspect/Activity	Potential Impact/s	Mitigation measure/s	Performance indicator/s	Monitoring period/ frequency	Responsibility	Time Frame
			sumps and artificial silt barriers.				
			Where required stockpile topsoil on a zero to very low gradient site for subsequent re-use.	Topsoil strategically stored for later re-use.			Nov-Dec 2018 onwards
		Elevated noise level in nearby communities.	Ensure noise generating machinery and equipment are in good working condition prior to being brought on site;	Noise generating machinery and equipment are in good working condition prior to being brought on site.	Weekly	• PM-ND • SM	Nov-Dec 2018 onwards
			Ensure regular maintenance of all noise generating machinery and equipment.	Regular maintenance of all noise generating machinery and equipment.			Nov-Dec 2018 onwards
			Carry out pre-start machinery and equipment check before every shift work.	Pre-start machinery and equipment check carried out before every shift work.			Nov-Dec 2018 onwards
		Contamination of soil and water by accidental hydrocarbon spillage.	Ensure that machinery and equipment are in good working condition prior to arrival on site.	Machinery and equipment are in good working condition prior to being brought on site.	Weekly	• PM-ND • SM	Nov-Dec 2018 onwards

No	Aspect/Activity	Potential Impact/s	Mitigation measure/s	Performance indicator/s	Monitoring period/ frequency	Responsibility	Time Frame
			Ensure regular maintenance of machinery and equipment.	Regular maintenance of all noise generating machinery and equipment.			Nov-Dec 2018 onwards
			Carry out pre-start machinery and equipment before every shift work.	Pre-start machinery and equipment check carried out before every shift work.			Nov-Dec 2018 onwards
		Generation of excess dust from exposed soil surfaces and vehicular movement especially during dry periods	Confine vegetation clearance to pre-designated areas.	Minimum unwarranted vegetation removed.	Weekly	• PM-ND • SM	Nov-Dec 2018 onwards
			Apply water spraying to suppress excessive dust formation	Dust suppression via water spraying applied at an effective frequency.	As required	• PM-ND • SM	Nov-Dec 2018 onwards
5	Management of the various waste-streams generated.	Aesthetic nuisance and habitat destruction. Emission of offensive smoke and odour. Breeding of disease transmission vectors such as rats and flies. Contamination of nearby water bodies.	Segregate waste types and dispose in designated landfill site.	Ensure appropriate management and disposal of wastes.	Weekly.	• PM-ND • SM	Jan 2019 onwards
			Reduce amount of waste produced and reuse or recycle items where possible				Jan 2019 onwards
			Avoid burning of vegetative waste and				Jan 2019 onwards

No	Aspect/Activity	Potential Impact/s	Mitigation measure/s	Performance indicator/s	Monitoring period/ frequency	Responsibility	Time Frame
			use it as mulch or for erosion control.				
			Provide adequate water supply and sanitation facilities for all workers.				Jan 2019 onwards
6	Planting of ground cover on oil palm plots.	Reduced soil erosion and siltation of surface water.	Ensure groundcover planted to improve soil fertility and control erosion.	Groundcover planted to improve soil fertility and control erosion.	Weekly	• PM-ND • SM	Jan 2019 onwards
7	Planting of oil palm seedlings.	Planting on non-designated sites.	Ensure seedlings are planted where they should be.	Seedlings planted as demarcated.	Weekly	• PM-ND • SM	Jan 2019 onwards
C	**OPERATION PHASE**						
1	Application of soil remediation substances and fertilizers.	Improper handling of soil remediation substances and fertilizers resulting in personal injury to workers and contamination of local surface and ground water	Ensure proper application of soil remediation substances and fertilizers.	Application of soil remediation substances and fertilizers by trained persons using the correct procedure.	Monthly	• Plantation Manager for Zifasing Oil Palm Ltd (PlanM) • SM	Jan 2019 onwards

No	Aspect/Activity	Potential Impact/s	Mitigation measure/s	Performance indicator/s	Monitoring period/ frequency	Responsibility	Time Frame
			Carry out periodic water quality monitoring.	Surface and ground water quality monitoring carried out as scheduled.	Quarterly		Jan 2019 onwards
2	Control of weeds	Improper application of herbicides resulting in bodily harm to sprayers and contamination of local surface and groundwater.	Ensure proper application of herbicides.	Application of herbicides by trained persons using the correct PPE and procedure.	Monthly	• PlanM • SM	Jan 2019 onwards
			Carry out periodic surface and ground water quality monitoring	Surface and ground water quality monitoring carried out as scheduled.	Quarterly		Jan 2019 onwards
3	Control of pests	Improper application of pesticides resulting in bodily harm to sprayers and contamination of surface and ground water.	Ensure proper application of pesticides.	Application of pesticides by trained persons using the correct PPE and procedure.	Monthly	• PlanM • SM	Jan 2019 onwards
			Carry out periodic surface and ground water quality monitoring.	Surface and ground water quality monitoring carried out as scheduled.	Quarterly		Jan 2019 onwards

No	Aspect/Activity	Potential Impact/s	Mitigation measure/s	Performance indicator/s	Monitoring period/ frequency	Responsibility	Time Frame
4	Harvesting of FFB	Delayed collection of FFB resulting in build-up of free fatty acids (FFA) and loss in value of the crop. If delay is prolonged the crop will not be milled and will have to be disposed properly.	Ensure timely collection of FFB.	Timely collection of FFB.	Monthly	• PlanM • SM	Jan 2021 onwards
			If necessary, correctly dispose the ruined fruit.	Correct disposal of ruined fruit.			Jan 2021 onwards
5	Processing of FFB	Release of untreated mill stack exhaust material into the atmosphere and mill effluent into the local drainage causing environmental degradation and adversely affecting public health.	Install and maintain appropriate waste management equipment and facilities.	Mill stack emission filter and scrubber plus effluent treatment facility installed and maintained.	Monthly	• Mill Manager (MM) • SM	Jan 2021 onwards
				Mill stack emission and effluent quality standards are not exceeded.	Weekly	• MM • SM	Jan 2019 onwards
				Monitor receiving air and water quality	Quarterly	• MM • SM	Jan 2019 onwards
6	Maintenance of buffer zones and conservation reserves.	Neglected buffer zones not effectively performing their intended functions	Maintain local species variety in the buffer zones and conservation reserves.	Diverse local species in the buffer zones and conservation reserves.	Monthly	• PlanM • SM	Jan 2019 onwards

No	Aspect/Activity	Potential Impact/s	Mitigation measure/s	Performance indicator/s	Monitoring period/ frequency	Responsibility	Time Frame
			Ensure buffer zone signage intact and legible and restrictions are not breached.	Buffer zone signage intact and legible and restrictions enforced.			Jan 2019 onwards
7	Maintenance of roads and drainage	Increased erosion and siltation of local water bodies.	Ensure timely maintenance of access roads and site drainage.	Access roads and drainage in a good condition.	Monthly	• PlanM • SM	Jan 2019 onwards
		Dust generation adversely affecting health and wellbeing of workers and local residents.	Carry out dust suppression during the dry season using water spray trucks.	Dust suppression with water spray carried out during the dry season.			Jan 2019 onwards
8	Management of various other waste streams generated	Aesthetic nuisance and habitat destruction. Emission of offensive smoke and odour. Breeding of disease transmission vectors such as rats and flies. Contamination of nearby water bodies.	Install and maintain appropriate waste management equipment and facilities.	Appropriate waste management equipment and facilities installed and maintained.	Monthly	• PlanM • MM • SM	Jan 2019 onwards
			Segregate waste types and dispose in designated sites.	Waste types, segregated and disposed in designated sites.			Jan 2019 onwards

No	Aspect/Activity	Potential Impact/s	Mitigation measure/s	Performance indicator/s	Monitoring period/ frequency	Responsibility	Time Frame
			Reduce amount of waste produced and reuse or recycle items where possible.	Amount of waste reduced and where feasible items reused or recycled.			Jan 2019 onwards
			Use organic waste as mulch or for composting.	Organic waste used as mulch or for composting.			Jan 2019 onwards
			Provide adequate water supply and sanitation facilities for all workers	Adequate water supply and sanitation facilities provided for all workers			Jan 2019 onwards
9	Employment during operation phase	Priority for employment and business contracts not given to nearby villagers.	Give priority for employment and business contracts to nearby villagers.	Priority for employment and business contracts given to nearby villagers.	Six monthly	• PlanM • MM • SM	Jan 2019 onwards
		Employees are not advised of their terms and conditions of employment, not properly trained and not supplied with appropriate PPE.	Educate employees about the terms and conditions of employment, train them and provide them appropriate PPE.	Employees advised of their terms and conditions of employment, trained and provided appropriate PPE.			Jan 2019 onwards

No	Aspect/Activity	Potential Impact/s	Mitigation measure/s	Performance indicator/s	Monitoring period/ frequency	Responsibility	Time Frame
10	Adaptive management and continual improvement to the operation.	Appropriate remedial actions and changes are not implemented so that the operation, its various stakeholders, the environment and the local economy are negatively affected,	Promptly carry out remedial work as well as make changes that will improve performance and maximise positive outcomes.	Remedial actions and improved practices documented in the Continuous Improvement Plan and implemented.	Continuous	• PlanM • MM • SM	Jan 2019 onwards
11	Contribution where possible to local community infrastructural, socio-economic and integrated sustainable development.	Obvious lack of support to local infrastructural, socio-economic and integrated sustainable development.	Maintain close liaison with local government officials and communities and where possible assist in sustainable development projects.	Close liaison maintained with local government officials and communities and assistance in sustainable development projects provided where possible.	Continuous	• GM – RAIL • PlanM • MM • SM	Jan 2019 onwards

4.2.2. HCV management and monitoring

Table 28 lists the threats to the HCV areas. Because there is a threat to HCV area, HCV management is required in the form of a HCV management area. This table recommends management actions to mitigate these threats. Monitoring recommendations are made, these form a follow-up loop to measure the success, or otherwise, of management and should prompt subsequent review of actions.

These Management and Monitoring Recommendations were initially based on Daemeter's experience with HCV assessments elsewhere. These recommendations were subsequently discussed with NBPOL staff, stakeholders (during stakeholder consultations) and with the owners and government officials (during the public consultations). The recommendations in

Table 28 were refined based on feedback from these groups. These recommendations apply to the community use areas as well as the areas that are leased for oil palm. Daemeter realises these are aspirational recommendations and extremely difficult to implement. However, NBPOL must undertake its *best endeavours*[5] to implement these recommendations.

Table 28. Threat Assessment, Management and Monitoring Recommendations. (updated 5 Oct 2018)

HCV	Threat	Management Recommendation	Monitoring Recommendation	Responsiblity	Time Frame
1	• Conversion of HCV 1 area to gardens • Burning • Hunting	Creation of "Ridge to River" concept where riparian areas and swamps act as corridors and stepping stones. This would be done by maintaining natural vegetation (where it exists). Also planting high standing trees and fruit trees within the buffer areas along the creeks and rivers (which are currently dominated by raintrees). This will increase the viability of these buffer areas to accommodate for bird species that are moving across the landscape. Other trees that are recommended because of their value to megapodes are *Adenanthera novoguinensis.* Agreements with the community about no hunting of birds in the HCV areas.	• Record the areas that are planted with natural forest species (using species that dominate the riparian strips in the RAIL estate). • Undertake bird surveys to see if birds are using these trees during their transit between forest areas.	Sustainability	Prior to plantation establishment (August-Sept 2018)

[5] This term best endeavours requires NBPOL to take "all those steps in their power which are capable of producing the desired results" although it is by no means an absolute obligation and the concept of reasonableness still applies.

HCV	Threat	Management Recommendation	Monitoring Recommendation	Responsiblity	Time Frame
		Awareness raising in villages to discourage random fire lighting. Enforcement of the "No Burn Policy" Provide a sustainable income from oil palm that keeps delivering funds even during droughts so people aren't forced to plunder natural resources to feed themselves.			
2	HCV 2 is absent in this assessment				
3	HCV 3 is absent in this asssessment				
4	• Burning to assist agricultural development within the riparian buffer strip. • Lack of awareness by company employees and contractors about HCV 4, particularly small river riparian buffers and mismanagement of high risk activities within buffer areas (e.g building roads through riparian areas). • People constructing huts and living (permanently or temporarily) and making gardens in riparian areas. • River changing course and destroying riparian areas • Fire – this will stop tree lined riparian strips being established.	• Follow the buffers specified in the RSPO (Table 25) • Prior to development, map all rivers and small watercourses within the development areas. Physically demarcate river buffers, swamps and lakes (which will be HCV areas) with flagging tape prior to land clearing to ensure there is no accidental incursion into these areas by land clearing contractors. • Rivers / lakes /swamps areas and associated buffers marked on NBPOL operational maps. • Planting appropriate species in the buffer areas. (e.g. grasses such as kikuyu grass with a spreading pattern and deep roots, furthermore	• Quarterly monitoring of riparian buffer condition. • Use of adaptive management to evaluate and adjust management and monitoring activities as necessary • Include conditions in the lease agreements that rentals on buffer zones will be withheld if there is an infringement • Undertake water quality monitoring program to include HCV 4 areas identified during this assessment, aiming to measure change in quality from where rivers enter and exit the estate. • Document all stabilisation works (e.g. planting of appropriate grass species) and monitor the effectiveness. • Mapping of the number and size of fires.	Sustainability Plantation	During plantation establishment and ongoing

HCV	Threat	Management Recommendation	Monitoring Recommendation	Responsiblity	Time Frame
		the stems will lay down during floods and protect the soil) • Maintain and establish riparian buffers – this involves : ○ Planting native species in the buffer areas. ○ Ensuring vegetation cover is maintained • Agreeing with the community on allowable use of vegetation in riparian areas. • Awareness raising with the communities to try to discourage them lighting fires. • On-going fire-fighting to put out fires before they get large and uncontrollable.			
5 (internal)	• Continued agricultural expansion putting increased pressure on natural areas. • Drop in the water table caused by oil palms using ground water. This area is on the lower rainfall threshold for OP growth. • Agricultural chemicals in the ground water.	• Ensuring adequate areas are available for the community to garden and collect natural materials (outside the lease area). This has been addressed by developing land use plans. These should not be seen as a fait accompli but something that is constantly revised. • Mapping of clans' lands (not just those areas to be leased) and assisting to have the land included in the ILGs. This is to ensure security	• Monitor against POIG metrics of 0.5 ha of garden land per person available. • Monitoring recommendations for HCV 1 & 4 will overlap with HCV 5 and are not repeated. • Ground water monitoring points should be established along with weather stations. A relationship between rainfall and water table level should be established. Establishing this immediately will enable a baseline to be developed. As the palms grow changes in the water table can be monitored.	Sustainability	Prior to plantation establishment (August-Sept 2018)

HCV	Threat	Management Recommendation	Monitoring Recommendation	Responsiblity	Time Frame
		of the land and right to use the land in the future. • Once disputes are resolved (e.g. Gor) follow the same process for developing a land use plan and having it signed-off by the landowners. • If the palms cause a significant drop in the water table. Additional planting may have to be stopped.			
5 (external)	• Gold Mining operation that will bring settlers into the area and they may build dwellings in the assessment area. Once these illegal occupants have set up houses they are hard to get rid of.	• Planting oil palm is a way of showing "use" and therefore "ownership." Currently it looks like abandoned land and this leaves the door wide open to settlers.	• Rapid eviction of settlers before they get established.	Sustainability	After plantations established (January 2021)
6	• Accidental clearing of cemeteries and other cultural sites by NBPOL staff. • Fires that may burn these sites.	• Demarcation in the field prior to land clearing and planting. Including an appropriate buffer to make sure these areas are not disturbed by operations. • Demarcation on operational maps • Documentation of cultural and historical values • Awareness raising with the communities to try to discourage them lighting fires. • On-going fire-fighting to put out fires before they get large and uncontrollable.	• Checks to make sure enclaved areas are still clearly delineated. • Mapping of the number and size of fires. •	Sustainability	Prior to plantation establishment

Table 29. RSPO PNG guideline on determination of riparian widths and approximate order of streams (RSPO,2017b)

Stream width	**1 - 5 m**	**5 -10 m**	**10 -20 m**	**20 – 40 m**	**40 – 50 m**	**> 50 m**
Buffer width on each side	5 m	10 m	20 m	40 m	50 m	100 m

4.2.3. Soil Management Plan

The following soil management plan is derived from the soil suitability report recommendations and is relevant to all areas identified in that reports. These recommendations will be incorporated into the Plantation Management whose coordination is responsibility of the Field Department.

Table 30 Soil Management Plan

Parameter to be monitored	***Proposed Enhancement / Mitigation Measures***	***Location***	***Measurement***	***Frequency***	***Responsibility***	***Estimated Time-frame for completion of task***
Marginal soils identified in soil suitability study	Compare productivity on similarly classified soils in existing plantations	*All*	GIS Map OMP Data	*Once*	*Field Manager*	*January 2019*
Soil management	Apply soil amendments as deemed necessary based on the above recommendation	*TBD*	Field inspection	*Ongoing*	*Field Manager*	*June 2019*

4.2.4 GHG Management Plan

The following soil management plan is derived from the GHG report recommendations and is relevant to all areas identified in that reports. These recommendations will be incorporated into the Plantation Management whose coordination is responsibility of the Field Department.

Table 31 GHG Management Plan

(Updated 5 Oct 2018)

Parameter to be monitored	*Proposed Enhancement / Mitigation Measures*	*Location*	*Measurement*	*Frequency*	*Responsibility*	*Estimated Time-frame for completion of task*
Mitigate net GHG emissions associated with oil palm cultivation	Implementation of the High Carbon Stock Approach prior to development. No conversion of HCSA vegetation with carbon stocks greater than that contained in Scrub	*All areas to be leased*	GIS Map	*Once*	*Sustainability Manager* *Field Manager*	*Completed*
Enhancement of Carbon Stocks	All HCV/HCS areas to be leased to company to be managed as conservation areas allow for carbon sequestration.	*All areas to be leased*	GIS Map Field inspection	*Quarterly*	*Sustainability Manager* *Field Manager*	Dec 2018
	Awareness to be carried out on the importance of maintaining HCV/HCS areas identified. Fund raising, ie/ through HCSA, for funding into the conservation of these areas	*All areas to be leased*	GIS Map Field inspection	*Annual*	*Sustainability Manager* *Field Manager*	Dec 2018
	Monthly monitoring of all conservation areas within areas leased to NBPOL. Enforcement of incursions (ie/gardening) through consultation with communities, removal of crops and if that is not effective enforcement through stop payments of lease payments over conservation areas.	*All areas to be leased*	Field Inspections	*Annual*	*Sustainability Manager* *Field Manager*	Dec 2018

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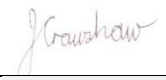
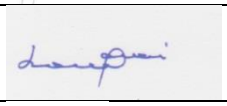
6. Internal responsibility

6.1 Formal signing off (with date) by assessors and grower.

The following assessors formally accept our interpretation of their findings and management recommendation as summarised in this report:

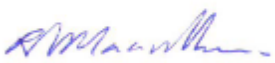
Assessment	Name of Lead Assessor	Signature
High Conservation Value Assessment	Jules Crawshaw	
Social Environmental Impact Assessment	Narua Lovai	
Soil Suitability Study	John Palolen	
Land Use Change Analysis	Michael Hansby	
Carbon Stock Assessment	Michael Hansby	
Greenhouse Gas Analysis	Michael Hansby	

6.2 Statement of acceptance of responsibility for assessments and formal signing off of management plans.

This document is the public summary of the integrated SEIA, HCV & HCS management for new developments at Zifasing and Tararan by Ramu Agri Industries and has been approved by management.

Ruari Macwilliams: General Manager **Date: 5/10/2018**

Signature:



Bob Wilson: Project Manager New Development **Date: 5/10/2018**

Signature:

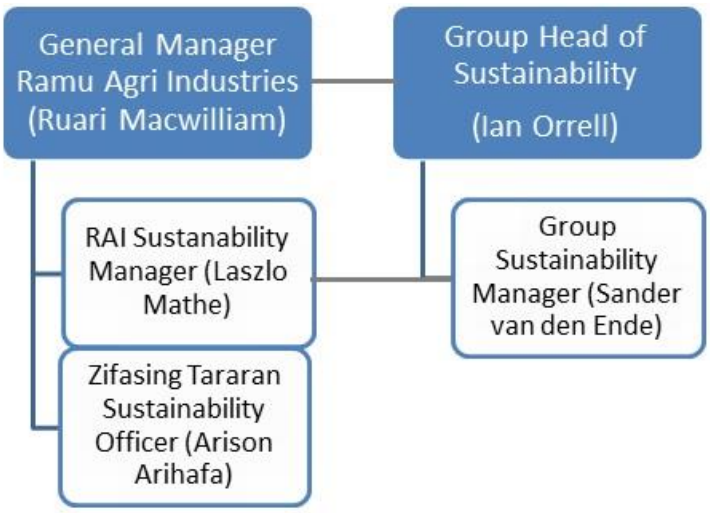
Arison Arihafa: Sustainability Officer **Date: 5/10/2018**

Signature:

6.3 Organisational information and contact persons.

Updated 5 Oct 2018

Zifasing Organizational Chart



All Management Plan commitments are authorized by the General Manager of Ramu Agri-industries Ltd (RAI). The implementation of the Management Plans is the responsibility of the Zifasing Sustainability Officer. Note that the Zifasing Sustainability Officer works closely with the ZIfasing New Development Manager (not included in org chart) to ensure compliance. Monitoring and technical back stopping and support are provided by the RAI Sustainability Manager and the Group Sustainability Manager.

Contact Persons:

For RSPO Matters:

Sander van den Ende: Sustainability Group Manager, New Britain Palm Oil Limited
Email: svdende@nbpol.com.sg

Arison Arihafa: Sustainability Officer, Ramu Agri Industries Limited
Email: aarihafa@rai.com.pg

For Operational, Legal and Financial Matters:

Ruari Macwilliam: General Manager, Ramu Agri Industries Limited
Email: rmacwilliam@rai.com.pg

Annex 1 Maps of Individual Net Potential Development Areas