Environmental Impact Assessment

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SRI: Mahaweli Water Security Investment Program

North Western Province (NWP)

Prepared by Mahaweli Consultancy Bureau (Pvt) Ltd. for the Asian Development Bank.

EIA STUDY OF THE PROPOSED NORTH WESTERN PROVINCE (NWP) CANAL PROJECT

DRAFT FINAL REPORT

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Abbreviation and Acronyms

AMDP	-	Accelerated Mahaweli Development Project
BW	-	Bed Width
CEA	-	Central Environmental Authority
CECB	-	Central Engineering and Consultancy Bureau
CI	-	Cropping Intensity
CKD	-	Chronic Kidney Disease
Cumecs	-	Cubic Meters per second
DS	-	Divisional Secretary
DWLC	-	Department of Wildlife Conservation
EC	-	Electrical Conductivity
EIA	-	Environmental Impact Assessment
EP	-	Eastern Province
FD	-	Forest Department
FSL	-	Full Supply Level
FR	-	Forest Reserve
GN	-	Grama Niladhari
GSMB	-	Geological Survey and Mines Bureau
GWH	-	Giga Watt Hours
GWT	-	Ground Water Table
Ha	-	Hectares
Km	-	Kilometer
ID	-	Irrigation Department
LB	-	Left Bank
m	-	Meters
MASL	-	Mahaweli Authority of Sri Lanka
MCB	-	Mahaweli Consultancy Bureau

MCM	-	Million Cubic Meters
MI&WRM	-	Ministry of Irrigation and Water Resources Management
MMDE	-	Ministry of Mahaweli Development and Environment
MW	-	Mega Watts
NAAQS	-	National Air Quality Standards
NBRO	-	National Building Research Organization
NCP	-	North Central Province
NCPCP	-	North Central Province Canal Project
NP	-	Northern Province
NWP	-	North Western Province
NWPC	-	North Western Province Canal
OFC	-	Other Field Crops
RB	-	Right Bank
SAR	-	Sodium Adsorption Ratio
TDS	-	Total Dissolved Solids
UEC	-	Upper Elahera Canal
UNDP	-	United Nations Development Programme

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EXECUTIVE SUMMARY

1. This EIA report assesses environmental and social impacts of the proposed North Western Province Canal (NWPC) Project. The project areas include Hakwatuna Oya Irrigation System in the Deduru Oya River Basin and medium and small irrigation systems in the Upper Mi Oya Basin in the North Western Province (NWP). The NWP Canal is interlinked with the North Central Province Canal Program (NCPCP). The NCPCP comprises two phases: (i). The construction of the Upper Elehera Canal (UEC) which will divert water from the Moragahakanda Reservoir to the North Central Province (NCP); and (ii) the North Central Province Canal which will transfer water from NCP to the Northern Province. Once the UEC canal is constructed areas currently supplied by the Bowatenna tunnel will receive water from the UEC canal, hence water savings can be diverted to the NWP, through the NWPC. A separate report assesses the environmental impacts of the UEC canal project.

2. The proposed NWPC originates from a point about 1 km downstream of the outlet of the Bowatenna tunnel at Lenadora in Matale District. A contour canal will transfer water to water scarce systems in NWP. On the way, the transfer canal will supply water to Wemedilla and then to Dewahuwa reservoirs. The transfer canal will go through the Kahalla Pallekele Sanctuary in Kurunegala District, and Maha Kirula and Maha Kitula Reservoirs which will serve as storage reservoirs. The Mahakithula reservoir will enable the transfer of water to Hakwatuna Oya Reservoir. The diverted water will be stored in existing and new reservoirs in the Kurunegala District and distributed to tanks in the Hakwatuna Oya Basin and Upper Mi Oya basin according to irrigation and drinking water demands benefitting 80,000 families in 393 Grama Niladhari (GN) Divisions located in 5 Divisional Secretary Divisions.

3. The project will be implemented in two stages, namely:
Stage 1 - Nalanda – Wemedilla - Devahuwa feeder Canal - Hakwatuna Oya Diversion

Stage 2- Diversion of Mahaweli water to Mi Oya Basin from downstream of existing Bowatenna Irrigation Tunnel (refer Fig 1-2)

4. The new irrigation conveyance canal to divert the Mahaweli water to Upper Mi Oya and Daduru Oya-Hakwatuna Oya basins would traverse through 41 villages in 31 Grama Niladari Divisions in 5 DS divisions of Matale and Kurunegala Districts. The canal trace will be 78.6 km long, out of which 12.4 km run through lands belong to the Wildlife and Forest conservation Departments; the balance 66.2 km will traverse through human settlements. The project layout, location maps are included in this report. The project will build infrastructure including a large number of waterways and supporting structures such as road crossings and bridges, diversion weirs, aqueducts, sluices, spills, tunnels and railway crossings. The estimated cost of the project is Rs 14.45 billion. The investment will be financed by the Asian Development Bank and the Government of Sri Lanka.

5. The economic analysis considered the project lifespan as 50 years, and expects benefits to accrue from the 4th year when some of new irrigation activities are scheduled to commence. By the 8th year, the construction investment will be completed and annual net income will be increased to the maximum level of Rs. 2,045 million. Economic and financial analysis shows that the project is economically viable, as economic internal rate return is calculated at 13.6%.

6. The project will be implemented by the Ministry of Mahaweli Development and Environment (MMDE). In view of the potential environmental and social impacts of the project, an environmental impact assessment is required. This assessment has been conducted by paying attention to the safeguard requirements of the Central Environmental Authority and ADB's Safeguard Policy Statement (2009). Methodologies adopted included a comprehensive literature review of previous hydrological, topographic, geological and environmental studies conducted in the dry zone, fresh field surveys on ecological, physical and social environment, impact prediction and analysis. Discussions were held with stakeholder including the communities who will be affected, the government officials, and other key informants and stakeholders.

7. The project is in compliance with the overall development vision of Government of Sri Lanka, which is articulated in Mahinda Chinthana.

8. The legal environment within which the project will be implemented is governed by several Acts and Ordinances, the most relevant in this case are the:

- Mahaweli Authority of Sri Lanka Act No. 23 of 1979
- Soil Conservation Act No. 25 of 1951 and No. 29 of 1953 and amended by Act No. 24 of 1996
- Irrigation Ordinance No. 32 of 1946, Act No.1 of 1951 and No. 48 of 1968, Law No. 37 of 1973

9. The national legal environment safeguard requirements are given in the following two key regulatory frameworks:

- National Environment Act (NEA) No 47 of 1980 as amended by act No 56 of 1988 and act No 53 of 2000
- EIA regulations gazetted under NEA (Government Gazette Extraordinary No.772/72 dated 24 June 1993 and in several subsequent amendments)

10. All relevant policies, acts, regulations and guidelines that are relevant to the project have been analyzed and interpreted in the report.

11. The project is in conformity with other development initiatives in the North Western Province. There is no water resource development project in the Upper Mi Oya Basin yet. During the implementation of the project, the Irrigation Department will bring officials, beneficiaries of affected major and medium irrigation schemes together and appoint a joint management system (Committee) to address administrative and technical requirements of the project, decisions and execute. The project will have several beneficial social and environmental

impacts in the long run. Nevertheless, there are some significant adverse social and environmental impacts for which mitigation measures have been described.

12. In terms of hydrological changes, following observations have been made:

- Deduru Oya basin: The diversions will have a positive impact on Deduru Oya basin through water transfer to Hakwatuna Oya reservoir. The cropping intensity (CI) of Hakwatuna Oya irrigation scheme would be increased from 1.5 to 1.8.
- Kala Oya Basin: The diversions will have a positive impact on Kala Oya Basin through water transfer to Wemedilla and Devahuwa Reservoirs. The CI of both reservoirs would be increased from 1.8 to 2.0.
- Mi Oya Basin: The diversions will have a positive impact on Mi Oya Basin through water transfer to Mahakithula and Mahakirura Reservoirs and about 4000 ha of minor tank cascade systems will be benefited with increased CI from 1.0 to 1.5
- Maintenance of the minimum storage of 1/3 capacity in the tanks (even during the dry seasons) will have an environmental benefit to the wild animals. It will enable the maintenance of a comparatively high groundwater level during dry periods, which helps improving groundwater quality, and minimize drought effects on forests.

13. In terms of ecological impacts, it was observed that, a major part of the proposed canal traverses through human modified habitats such as home gardens, paddy fields, agricultural and abandoned lands, inundation of several natural habitats such as scrub, dry-mixed evergreen forests, degraded dry-mixed evergreen forest, degraded teak plantation, and riverine forests causing the habitat degradation, fragmentation and loss of habitats. It is also observed that the rich biodiversity repositories, especially the terrestrial habitats such as riverine forest, dry-mixed evergreen forests, disturbed dry-mixed evergreen forests and scrublands will be affected due to the proposed reservoirs and the canal.

14. In terms of fauna, it was observed that since the two proposed tanks, *Maha Kithula* and *Maha Kirula* (combined area is 342 ha) will inundate forest, scrub forest and teak planted areas within the Kahalla-Pallekele Sanctuary, which includes loss of habitats as well as blockage of movement paths for animals, especially large charismatic species such as Asian Elephant, Sloth bear, threatened and endemic reptiles. Since the only wildlife reserve that is present in the project direct impact zone is the Kahalla-Pallekele Sanctuary, and that no other sanctuary than this is found such as Nature Reserves, National Parks, Elephant Corridors, Forest Reserves or Protected Wetlands the project will have a moderate impact on the Kahalla-Pallekele sanctuary.

15. The EIA was conducted on a wider corridor (30 m strip) to identify social environment as well as flora and fauna in project areas. The resettlement survey, conducted recently, confined its scope to a narrower corridor where the center line of the diversion canal is passing. The number of households that will be physically displaced is 22. In addition 480 households will lose some of their lands to the project. A detailed Resettlement Implementation Plan closely following the Resettlement Framework of the Program will be formulated to address land acquisition, compensation, income restoration and relocation issues of the affected persons. The project aims to augment eight major, medium and minor tanks located within 3 river basins in 7 DS divisions through construction of the proposed canal by which enabling cultivation in

both yala & maha seasons and easy access to domestic water. This would directly and indirectly benefit the people living in and around the area in various ways and the project can be considered a multipurpose development project.

16. The Project Area and the areas in close proximity are of special archaeological importance, being located in areas related with folktales to Anuradhapura, Kurunegala and Yapahuva ancient Kingdoms. Some highly respected and worshipped Buddhist temples and ancient ruins are also situated in close proximity. The ancient concept of Tank, Stupa, village & Temple still remains the major philosophy and is well respected and practiced. The elders in the Project community are considering this heritage with reverence and devotion and also share the view that the protecting and transferring this legacy to the future generation is their responsibility.

17. The Environmental Management Plan has taken note of the said impacts and proposes mitigation actions. An environmental Monitoring plan has also been developed and it will be used by the project developer and contractors during the project life cycle to report the progress of the project. A grievance redress mechanism has been recommended in order to resolve issues arising from the construction stage and operational stage.

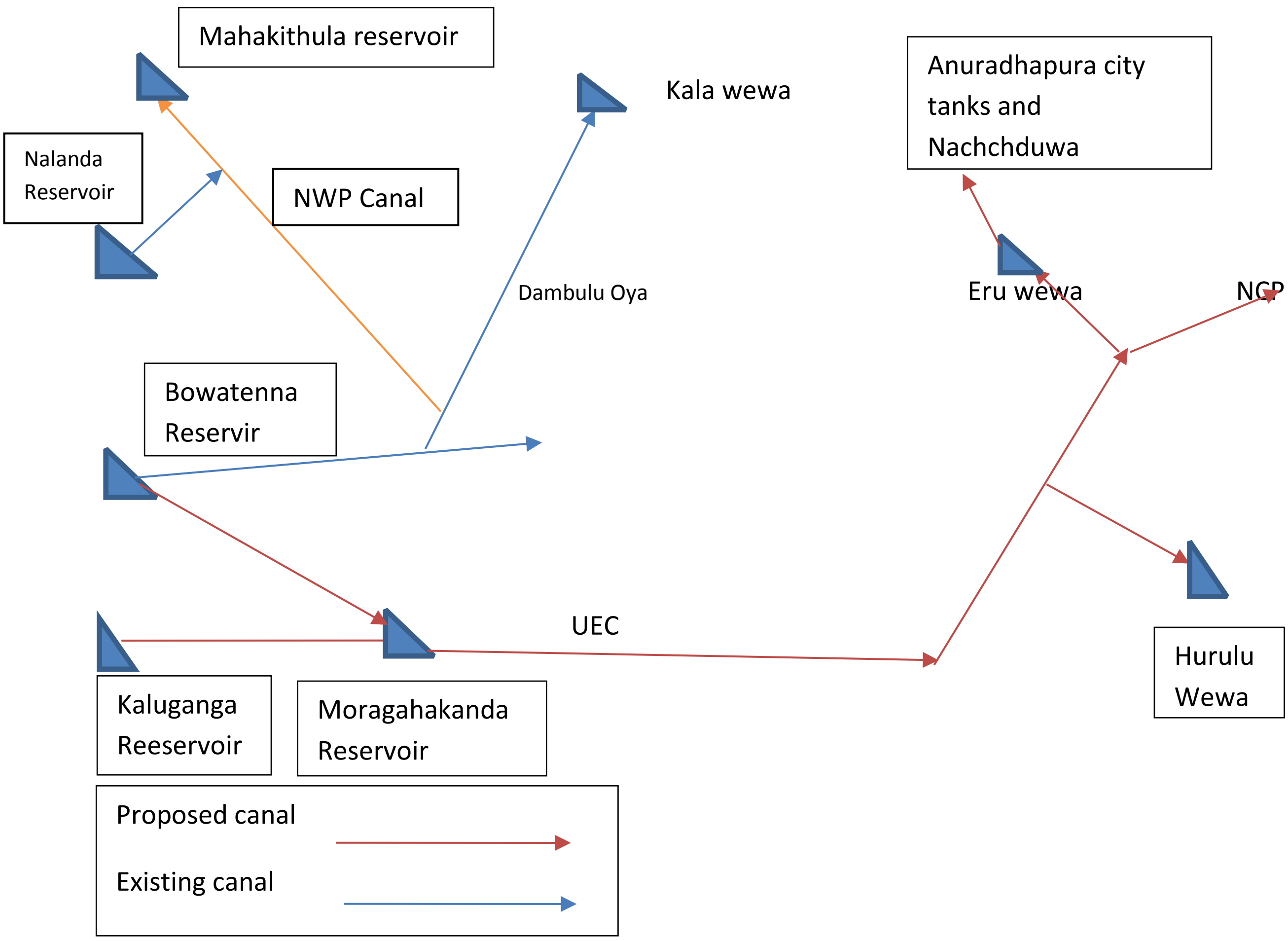
18. The project is important in view of the paucity of irrigation waters demanded by the farmers in the North Western Province. This will contribute to increased cropping intensity and will enhance country’s food production and well-being of the people. All the environmental and social impacts can be mitigated through careful implementation of the EMP. Therefore the project is recommended to be implemented.

CHAPTER 1

1. INTRODUCTION

1.1 Background of the Project

19. The Moragahakanda and Kaluganga Reservoirs and the North Central Province Canal program (NCPC) are the components of the Mahaweli Master Plan that awaited development. Their development, it was envisaged, would meet the growing water demands of North Central Province (NCP), Northern Province (NP), Eastern Province (EP) and North Western Province (NWP). However, the irrigation water resources of the Moragahakanda and Kaluganga Reservoirs may not meet this expectation. As a response to this situation, the Ministry of Mahweli Development and Environment[1] (MMDE) initiated a water resources utilization study in the Mahaweli Basin. The study revealed that the water resources in several major tributaries of Mahaweli can be further developed to provide irrigation water to NCPC's targeted areas. Further studies identified the optimum routes to transfer such water resources to NWP, NCP and NP. The Upper Elahera Canal is one of the alternatives that have been evaluated as technically feasible and economically viable to transfer irrigation water to the target areas in NCP and NP under the NCPC Project.



[1] This Ministry was previously named as the Ministry of Irrigation and Water Resources Management. In January 2015 it was renamed as the Ministry of Mahaweli Development and Environment.

Figure 1-1 Schematic Diagram - water issues from UEC and NWP Canals

20. The proposed Upper Elahera Canal (UEC) would deliver 285 MCM of water to Huruluwewa, Nachchaduwa and Anuradhapura city. The current demand of 125 MCM of irrigation water to Huruluwewa, Nachchaduwa and Anuradhapura city is being supplied through the Bowatenna Tunnel. The UEC would replace the irrigation water supply from the Bowatenna Tunnel to Hurulu wewa, thereby providing 100 MCM in water savings which can be transferred to NWP canal which is the subject of this EIA. The total volume of water to be conveyed through the NWP canal is 130 MCM and the deficit will be met from water from Nalanda Reservoir (30 MCM).

21. In 2011, the then Ministry of Irrigation and Water Resources Management (MI&WRM) and Mahaweli Authority of Sri Lanka (MASL) conducted a pre-feasibility study to examine the possibility of reviving the North Western Province Canal Project (NWPCP) to provide water to Hakwatuna Oya reservoir in the Deduru Oya Basin and minor reservoir systems (cascades) and medium level reservoirs in the Mi Oya basin in NWP.

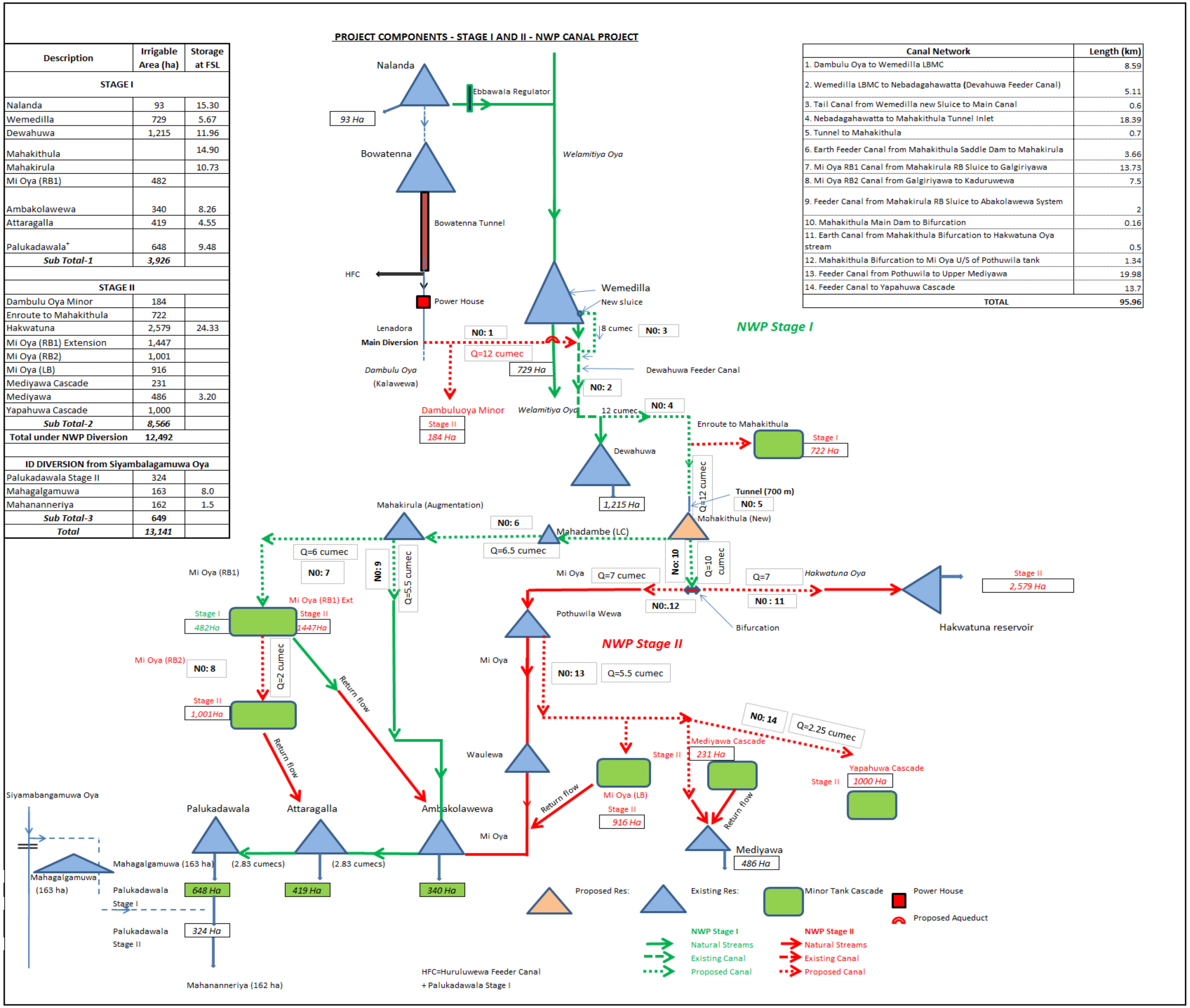
22. The detailed water assessment study under the pre-feasibility study has revealed that about 100 MCM could annually be re-allocated to the proposed NWP areas if the volume of water that is being diverted to the Nachchaduwa wewa and Anuradhapura city reservoirs is provided through the proposed UEC. The 100 MCM of water can be transferred to NWP through the proposed diversion canal that will start in Lenadora at the outlet of Bowatenna tunnel. Additional 30 MCM of water could be transferred to this canal form the Nalanda Reservoir once repairs to the Nalanda Reservoir dam are completed[2]. This volume of water will be transferred through Wemedilla Reservoir. The total volume of water that could be diverted to NWP would then be 130 MCM.

23. The land that will be fed by the proposed project experiences water shortages which thwarts optimum cropping intensity and disturbs the water supply reliability. The cropping intensity (CI) of village reservoirs is less than 0.9 or 90%. In 2003, the Central Engineering Consultancy Bureau (CECB) conducted a study to examine the feasibility of diverting water from the Mahaweli River to the Hakwatuna Oya Basin and Upper Mi Oya Basin from the Bowatenna Reservoir. Based on the study and the pre-feasibility study of NCPC, in 2011, MI&WRM completed the feasibility studies of the proposed project.

24. The proposed diversion canal starts at a diversion weir that will be built across the Dambulu Oya below the Bowatenna Tunnel outlet. The diversion canal will flow 76.5 km to Hakwatuna Oya sub-basin (A sub-basin of Deduru Oya) and Upper M Oya Basin. Under the NWP project, two reservoirs, namely, the Mahakitula Reservoir (15 MCM) and the Mahakirula Reservoir (10 MCM) will be built in the Kahalla Pallekele Sanctuary. The water stored in these reservoirs will be released to the Hakwatuna Oya sub basin and Upper Mediyawa Basin. (see Fig 1-2)

[2] The Nalanda reservoir is currently being rehabilitated under a World Bank funded project and completion is expected by December 2014

PROJECT COMPONENTS - STAGE I AND II - NWP CANAL PROJECT



Description	Irrigable Area (ha)	Storage at FSL
STAGE I		
Nalanda	93	15.30
Wemedilla	729	5.67
Dewahuwa	1,215	11.96
Mahakithula		14.90
Mahakirula		10.73
Mi Oya (RB1)	482	
Ambakolawewa	340	8.26
Attaragalla	419	4.55
Palukadawala[+]	648	9.48
Sub Total-1	***3,926***	
STAGE II		
Dambulu Oya Minor	184	
Enroute to Mahakithula	722	
Hakwatuna	2,579	24.33
Mi Oya (RB1) Extension	1,447	
Mi Oya (RB2)	1,001	
Mi Oya (LB)	916	
Mediyawa Cascade	231	
Mediyawa	486	3.20
Yapahuwa Cascade	1,000	
Sub Total-2	***8,566***	
Total under NWP Diversion	**12,492**	
ID DIVERSION from Siyambalagamuwa Oya		
Palukadawala Stage II	324	
Mahagalgamuwa	163	8.0
Mahananneriya	162	1.5
Sub Total-3	**649**	
Total	***13,141***	

Canal Network	Length (km)
1. Dambulu Oya to Wemedilla LBMC	8.59
2. Wemedilla LBMC to Nebadagahawatta (Devahuwa Feeder Canal)	5.11
3. Tail Canal from Wemedilla new Sluice to Main Canal	0.6
4. Nebadagahawatta to Mahakithula Tunnel Inlet	18.39
5. Tunnel to Mahakithula	0.7
6. Earth Feeder Canal from Mahakithula Saddle Dam to Mahakirula	3.66
7. Mi Oya RB1 Canal from Mahakirula RB Sluice to Galgiriyawa	13.73
8. Mi Oya RB2 Canal from Galgiriyawa to Kaduruwewa	7.5
9. Feeder Canal from Mahakirula RB Sluice to Abakolawewa System	2
10. Mahakithula Main Dam to Bifurcation	0.16
11. Earth Canal from Mahakithula Bifurcation to Hakwatuna Oya stream	0.5
12. Mahakithula Bifurcation to Mi Oya U/S of Pothuwila tank	1.34
13. Feeder Canal from Pothuwila to Upper Mediyawa	19.98
14. Feeder Canal to Yapahuwa Cascade	13.7
TOTAL	**95.96**

Figure 1-2 Project components - stage I and II

1.2 The Objectives and Justification of the Proposed Project

25. The NWP canal which is the focus of this study is a part of NCPCP where it will be possible to divert water to NWP with the saving of water presently used in Mahaweli system. With the construction of UEC canal some areas presently supplied by the Bowatenna Tunnel will receive water from the new UEC canal. The Hakwatuna oya Irrigation System and village tank systems in Hakwatuna oya basin and upper Mi Oya river basin are performing under capacity due to shortage of water. The average cropping intensity (CI) of these village tanks is about 0.9. Therefore, there is a need to increase the water availability to these areas. This is a long felt need by the people of this area.

26. The subproject has been designed to augment water quantities of major, medium and minor reservoirs enabling the cultivation of 12,000 ha of land and to increase average CI from 1.2 to 1.7. The CI of village tanks is less than 0.9 and this is expected to increase to 1.4.

27. The project consists of:

- Construction of 78.6 km of transfer canals
- Construction of Mahakithula Reservoir with capacity of 14.9 MCM and, restoration of Mahakirula Reservoir (10.7 MCM) to store and regulate the diverted flow.
- Refurbishment of Dewahuwa Feeder Canal

28. The NCP Canal Pre-Feasibility Study notes that this diversion is possible only if diversion to Mahaweli systems IH and MH is made from Upper Elahera Canal, as planned in original UNDP study. The rationale of the studies carried out on the proposed NCP Canal Project is to supply the water demands in major, medium and minor irrigation schemes northern part of NCP, southern part of NP, Upper Mi Oya and Deduru Oya basins in NWP which were experiencing acute water shortage of water.

29. The key objective of the proposed NWP project are:

- To divert Mahaweli water to Hakwatuna Oya Reservoir and to medium and small reservoir cascades in the Mi Oya Basin
- To increase average cropping intensity (CI) from 1.2 to 1.7 in a command area of 12,000 ha (in village tanks the CI is usually less than 0.9) and
- To provide for drinking water requirements Polpithigama DS area.

30. The proposed diversion originates from a point about 1 km downstream of the outlet of existing Bowatenna Irrigation tunnel at Lenadora in Matale District. A contour canal will transfer water to water scarce systems in the NWP. On the way, the transfer canal will supply water to Wemedilla and then to Dewahuwa reservoirs. The transfer canal will go through the Kahalla Pallekele sanctuary in Kurunegala District, and Maha Kirula and Maha Kitula (to be restored) will serve as storages.
31. Mahakithula reservoir will enable transfer of water to Hakwatuna Oya reservoir. Water is stored in existing and new reservoirs in Kurunegala District and distributed to tanks in Hakwatuna Oya basin

and upper Mi Oya basin according to irrigation and drinking water demands. The proposed project will benefit 80,000 families in 393 Grama Niladhari (GN) Divisions in 7 Divisional Secretary Division

32. Additional source of water was a long-term need of the people of the area due to low Cropping Intensity (CI) of tanks in the area. The major reservoir in the project area is the Hakwatuna Oya Reservoir and its CI has fallen from 2 to 1.5 in recent years because of diminishing annual inflows. Under the proposed diversions, the benefitted area is about 12,000 hectares with Devahuwa, Wemedilla and Hakwatuna Oya irrigation schemes achieving cropping intensities around 1.8-2.0 and other major schemes such as Abakolawewa, Attaragalla, Palukadawala, Mediyawa achieving cropping intensities around 1.8 and minor schemes benefitted with cropping intensities around 1. Refer Fig 2-3 for the layout map of the project.

33. The cropping intensity (CI) of minor tank cascades is about 0.9 at present. The CI of major and medium reservoirs is range from 1.04 to 1.5 in Kurunegala District. It is proposed to increase the CI of minor reservoirs to 1.5 and up to 1.8 in major and medium reservoirs. In addition, the diverted water will supply up to 3.5 MCM annually for drinking and industrial water demand in the area. The proposed subproject will convey about 130 MCM annually from the Mahaweli Basin through a trans-basin diversion canal and the diverted water will be stored in the existing Hakwatuna Oya Reservoir (capacity 24.3 MCM) and restored Mahakithula (14.9 MCM) and Mahakirula (10.7 MCM). The subproject will also provide additional irrigation water and drinking water to the area.

34. Alternative subproject proposals were considered during prefeasibility phase. The chosen subproject is the most feasible proposal from investment and environmental sustainability points of view. The subproject will directly and indirectly benefit 80,000 households. Details of the subproject alternatives considered are described in chapter 2.

35. The direct benefits of the proposed subproject are increased agricultural production including additional income from coconut cultivation, livestock and fisheries under minor reservoirs and the provision of water for domestic use. At present, almost all paddy lands under minor reservoirs are cultivated only one season - Maha season (December to March) because of the water shortage. After the completion of the subproject, village reservoirs will provide water to cultivate at least 50% the irrigable area with paddy and OFC during Yala season. The increased availability of a water source to supply domestic pipe borne water would enhance the living standards of beneficiary households.

36. The proposed diversion can cater the domestic drinking and industrial demands up to 3.5 MCM, which is the predicted demand by the year 2025. The economic analysis considered the project lifespan to be 30 years and the benefits to accrue from the 4th year when part of new irrigation activities is scheduled to commence. From the 6th year, the construction investment will be completed and annual net income will be increased to its maximum level of Rs. 2,045 million. Economic and financial analysis shows that the Project is economically viable, as economic internal rate return is 15.9%.

1.3 The objectives of the EIA report

37. The Ministry of Mahaweli Development and Environment (MMDE) conducted the project feasibility study. The study found that the subproject is technically feasible and economically viable. This Environmental Impact Assessment (EIA) has been carried out to achieve the following objectives:

- Identify and evaluate the potential environmental impacts of the proposed interventions.
- Recommend appropriate mitigation measures to avoid, minimize, remedy or compensate predicted negative impacts.
- Highlight cumulative/composite impacts of other similar projects in the region.
- Assess environmental costs and include them in the economic analysis, cost benefit analysis, IRR/ERR evaluation and sensitivity analysis.
- Identify places of archeological interest and artifacts in the areas of construction and inundation and proposed appropriate actions to protect them.
- Provide a site-specific Environmental Monitoring and Management Plan (EMP) with adequate options in terms of mitigation measures, project alternatives and a monitoring plan to achieve overall environmental sustainability of the subproject.
- Analyze and discuss any alterations to the approved subproject as per the approved TOR.

38. The EIA was conducted in compliance with the TOR provided by Central Environmental Authority by incorporating requirements stipulated by ADB according to their Safeguards Policy Statement 2009 (SPS, 2009).

1.4 EIA Methodology

39. The EIA has been carried out in keeping with the requirement stipulated by the Central Environmental Authority in its Terms of Reference. It stipulates procedures to be followed as well as areas of investigations following specific methods. The section below details the specific methodology that was followed by the EIA Team which was responsible for the respective investigation areas. However, the methodologies are further explained in detail in the respective chapters as well.

1.4.1 Literature review & preparation of maps

40. EIA studies already undertaken for similar projects (Moragahakanda- Kaluganga Project, Uma Oya, Project, Veheragala Project, Rambukkan Oya Project, Moragolla Project, etc,) were reviewed. Following data and information covering the subproject sites and their surrounding areas have been collected:

- Topographic maps on 1:50,000 scale, 1:10,000 scale (Hard copies)
- Topographic maps on 1:50,000 scale, 1:10,000 scale (Digital copies)
- Aerial Photographs (1:40,000 and 1:10,000 scales)
- Satellite Images (Google, TM7)
- Geological maps (both hard and soft copies) (1:100,000 & 1:50,000 scale) were obtained from Geological and Survey Mine Bureau
- 1:10,000 to 1:1,000 scale maps to prepare the Technical Proposal for NWPCP
- Geological reports on the subproject area and its surrounding areas

- Drill Hole data (obtained from NWP Canal Office)
- Water pressure testing, Observations of core samples and geological logging
- Permeability tests and standard penetration (SPT) tests in drill holes
- Testing results of soil samples obtained from test pits.

41. Report of the prefeasibility study of North Central Province Canal project and Feasibility study of North Western Province Canal project were also reviewed and necessary information was used during EIA report preparation.

1.4.2 Technical Approach and Methodology.

42. Technical approach and methodologies followed by the technical teams have been as follows:

- The EIA study team studied the project concepts and its objectives and discussed them with the Consultants who prepared the Feasibility Report, officials of Irrigation Department and MMDE.
- Hydrological and meteorological data and maps were obtained from relevant organizations and were studied before field studies.
- The EIA study team visited the project areas and proposed project sites.
- Project impact areas such as dam sites (Mahakithula and Mahakirula) and canal locations were identified using the GIS technology.
- Defined and assessed and ranked significant impacts using Leopold matrix.
- Devised mitigations measures using cost effective and socially acceptable methodologies
- Detailed EMP was prepared as part of EIA Report.
- Developed a monitoring plan to indicate monitoring frequencies, responsible institutions and locations
- Estimated the cost of impacts mitigation and monitoring.
- Carried out extended economic analysis of project with 50 years return period
- Environmental and social impacts of the subproject were identified.
- Reporting procedures and feedback mechanisms to inform relevant institutions about the progress and effectiveness of mitigatory measures and their monitoring are included in the EIA.

1.4.3 Assessment Methodology

43. The primary method of assessment of significance of environmental and social risks and impacts was the customized Leopold matrix. Once the significance of impacts was screened, they were further assessed. The EIA study team used the environment standards prescribed by CEA as the baseline in assessing the subproject impacts on physical and biotechnical environment.

A. Biological Environment (Habitats & Flora)

44. Survey of habitats/ distribution of flora to assess subproject impacts and to propose mitigation actions and environmental monitoring programme (section 3.2, 4, 5 and 9 of the TOR given by the

CEA). A survey was carried out to identify major habitats / vegetation formations, populations and communities of flora (terrestrial and aquatic) in and around the subproject sites and to assess possible impacts on habitats and flora. The survey area was confined to the specific locations and immediate surroundings directly affected by the proposed subproject activities (e.g. two proposed dams and the impounding area of the Maha kithula and Maha kirula wewa, 700 m tunnel, irrigation canals, and proposed environmental improvement of Kahalla- Pallekele Wildlife Reserve). In addition, a survey of habitats and flora was carried out in the areas where indirect impacts of the subproject were expected (e.g. quarries, refuse disposal areas, work camps, temporary access roads).

45. As there are no records of habitats and flora in the subproject areas, the EIA study team examined the areas using scientific field sampling methods. Flora in different habitats varied according to their climatic zone, geology of the area, soil types, and the microclimate of the specific site.

46. Plant species found in all habitats of the subproject areas were recorded by walking along transects to assess the plant diversity. In addition, several transects were marked in representative habitats and 5x100 m plots/ quadrats were demarcated to enumerate flora/ populations and plant communities. Land use maps (1:50,000 or 1:10,000) were used as base maps for the EIA study.

47. Vascular plant species were recorded on a plot-by-plot basis (10 m x 5 m) within every quadrant (100 m x 5 m) of a transect. The number, estimated height (with the exception of climbers) and DBH (diameter at breast height) of individuals exceeding 5 cm DBH were also recorded. If the felling of trees required for subproject activities, a list of species and their diameter (>30 cm DBH) was prepared. Each herbaceous species within a quadrat was recorded and individuals are not counted. Additional species encountered along the transect, between quadrats, were also recorded. Any other additional species encountered elsewhere within the protected area are also recorded.

48. The conservation status of the species was determined according to the Red List (2012) of Sri Lanka. Name of the plant family, species name, local name of plant, life form, taxonomic status (Endemic, Indigenous, Introduced), and conservation status (threatened, endangered etc.) of species found in all habitats of the proposed subproject area were compiled.

49. The observed flora species identified using published descriptions and taxonomic keys provided by Dassanayake and Fosberg- Handbook to the Flora of Ceylon (1980 - 1991), Dassanayake et al. (1994 - 1995), Dassanayake and Clayton (1996 - 1999) and Senaratna (2001). Anticipated impacts of the subproject on habitats, populations and communities of plants especially on ecologically sensitive habitats, endemic and threatened plant species (Critically endangered (CR), Endangered (EN) and Vulnerable (VU)) were studied, and mitigation actions have been proposed.

B. Methodology for Faunal Survey

50. Information was gathered from the Irrigation Department regarding the nature of the project, its activities and benefits. Furthermore, available data on the project were reviewed. Information on fauna found in the project area was collected from publications and field investigations. An inventory of the fauna present in the subproject site was compiled using the following methodology.

51. The subproject area was stratified to sampling units based on habitat types defined by the botanist and the sites identified for various project activities such as the inundation area of reservoir

sites, borrowing sites, canal traces and the command area. Sampling within each selected sampling unit was carried out using standard techniques. The line transect method is the main method used. It was used to sample mobile species such as birds, butterflies and large mammals. Each line transect was designed within each sampling unit in a manner to capture the maximum possible environmental gradient present. Each transect line was geo-referenced using a hand held GPS. Direct observations and verifiable indirect observations such as nests, droppings, footprints, and calls were recorded. Where direct observation was possible, the identity and number of individuals were recorded. Quadrate sampling method was used for the less mobile species such as amphibians and reptiles. An 8 m x 8 m quadrate was marked and blocked with a plastic sheet to prevent animals from escaping. Then the area within the quadrate was examined and the type of species present and their densities were recorded. After that the location of each sampling quadrate was geo-referenced.

52. The animal classification, nomenclature, endemism and local names used as per D'abrera (1998), Fonseka (1998), Pethiyagoda (1991), Dutta and Manamendra-Arachchi, (1996), De Silva (1996); Pethiyagoda & Manamendra-Arachchi, (1998), Inskipp et al (1996), and Corbet and Hill (1992).

53. Aquatic fauna was surveyed using various sampling gears such as cast nets, fine meshed drag nets, hand nets and scoop nets. Baits were also be used to bring the hidden species into exposure. Furthermore, interviews were conducted with fishermen in the area to collect information on different fish species present in the subproject area. Baseline data on current fishing practices and fishery resources in the impact zone of the subproject were documented using available literature, field observations, interviews and inspection of fish catches of the fisherman utilizing this area for fishing. Aquatic amphibians and reptiles were recorded by direct observations. The amphibians usually occupy the surface layer of the water and also inhabit the area closer to the shore and therefore easy to spot from the edge of the water body. Aquatic birds were sampled using the line transect method where the line transect is laid along the shore line and recording birds observed. Both direct observations and indirect observations were recorded.

<u>Survey of existing natural habitats</u>

54. The different types of natural habitats present in the study site were designated according to the classification developed by the ecologist (Habitats/ Flora).

<u>Determination of conservation and taxonomic status:</u>

55. The conservation status of the species was determined according to the Red List (2012) of Sri Lanka. The endemism and commercial importance were determined based on the published information on these species.

C. Methodology to Study Sociological Aspects of Human Settlement

56. A sociological study was conducted to collect socioeconomic data in the subproject area. The main objective of the study was to identify adverse project impacts on communities, if any, and to propose measures to avoid or at least to mitigate such impacts including occupational safety of the project implementing staff. Based on the TOR guidelines, the sociological study area was limited to the proposed canal traces.

57. During the canal trace design, every attempt was taken to avoid homesteads. The canal trace has been revised several times to reduce environmental and social impacts of the canal. Because of these adjustments to the canal trace, the land area and number of households affected by the Project have been substantially reduced. According to the Resettlement Census of 2014, the total number of physically displaced households is 22 who reside in 08 GNDs. Added to them are the 70 households who will be economically displaced. Their economic displacement is partial, as only a strip of land will be taken from each affected land allotment. This allotment will be less than 10 percent of the total land.

58. Sample surveys were organized with the support of Grama Sevaka (Village level government officer in charge of administration) and the identified groups were interviewed by Development Assistants. About 280 households were interviewed and their views were incorporated into the EIA. Secondary data were collected from Divisional secretaries, Irrigation Offices, Offices of Wild Life Conservation etc. Secondary data was mostly population statistics, irrigable areas and details of wildlife reserves.

59. Consultations were undertaken with project affected persons. Special attention was paid during the field information survey to gather detailed information on families expressed their agreement to evacuate on the condition of allocation of suitable lands from an adjoining area as well as a reasonable payment of compensation for their deprived properties.

60. In addition, small group discussions were organized by respective Grama Niladaris with the patronage of Divisional Secretaries of Dambulla, Galewela, Polpithigama and Mahava DS divisions which would be affected by the proposed Project. These discussions were attended by officers of Irrigation Department, Economic Development Officers and Grama niladaris of DS divisions and officers of Mahaweli Consultancy Bureau. Even representatives of ADB participated in the small group discussions held in Pannampitiya & Lenadora South GNDs. (Photographic evidence of these meetings are provided in the Annex VI-III.

D. Mitigation and monitoring of Environmental impacts:

61. Based on the main project activities and the data collected on the characteristics of the natural ecosystems that would be affected by such activities, an Impact Matrix was developed paying attention to the vulnerability of the resource, the degree of influence of the activity on the resource, magnitude and duration of potential damages. An analysis was also prepared on the possible on-site as well as off-site impacts of the subproject during its construction and operation phases.

62. A risk assessment was carried out to assess the sensitivity and vulnerability of each of the natural ecosystems to potential risks that might arise during the construction and operation phases of the proposed water resources development project. Based on the risk assessment an Environmental Management Plan was proposed to avoid or minimize the identified significant risks and impacts. Furthermore, a Contingency Plan was also prepared to assess and monitor ecological impacts of accidents. Performance monitoring plan was prepared with indicators, recommended monitoring frequencies for each parameter, and a budget.

1.5 Policy, Legal and Administrative Framework of the Project

Policy Environment

63. The GOSL's priority on irrigated agricultural development has been re-emphasized by the President's vision for the future of Sri Lanka - Mahinda Chinthana[3]which states "The performance of many irrigation schemes has not yet reached its threshold over the last few years. Therefore, the returns on investments in most schemes remain low and inconsistent. Improving the performance of available systems has therefore become a felt need. In view of this, the future of the irrigation sector has been set out in a way to promote agriculture productivity by increasing the availability of new water resources and enhancing the present level of water use and conveyance efficiencies to an optimal level."

64. According to the government policy, projects aimed at country's irrigation potential receive priority. "A number of new projects will also been undertaken to provide water for agriculture and other water uses. Among them, Gin/Nilwala Diversion Project, System B (Maduru Oya) RB Development Project, Malwatu Oya Diversion Project, System L (Weli Oya) Development Project and Construction of the NCP Canal are given high priority. These projects will also be undertaken in parallel to the on-going projects and are expected to be completed by 2018"[4]

Policy with regard to land acquisition and Involuntary Resettlement

65. The Land Acquisition Act No. 9 of 1950 governs the process of acquiring land for state use in Sri Lanka. As usually done in all National development programs the land acquisition under NWP Water Diversion Project also would be done within the framework of the Land Acquisition act of 1950 with its amendments (LAA). In terms of LAA, compensation was determined based on the market value of a property. The value of property depends on the current condition of the property, location, use etc. and the current market prices. Since this is a specialized field, the Government Valuation Department has been tasked with determining the market value of acquired land.

66. Land acquisition new regulations were issued (1596/12) in 2009 to decree that compensation should be based on market value as well as value to owner. Although Land acquisition and compensation is done according to the terms stipulated in LAA there had been no mention regarding the process of resettlement in LAA.

67. Taking into consideration the consequences of not having provisions for involuntary resettlement the cabinet of ministers adopted the National Involuntary Resettlement Policy (NIRP) in year 2000. It introduced the hitherto unknown concept of replacement value to the Sri Lankan lexicon. The objective of NIRP is to assist those affected by land acquisitions to be resettled as soon and effectively as possible, while avoiding impoverishment resulting from the acquisition process. The policy requires implementing agencies to submit detailed Resettlement Action Plans (RAPs) for all projects displacing people and requires project authorities to pay compensation for land at replacement value.

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[3]Mahinda Chinthana – Vision for the future, Department of National Planning – 2010 page 36
[4]Mahinda chinthana Vision for the future, Department of National Planning -2010 page 37

68. The NIRP specifically states that impoverishment should not take place as a result of compulsory land acquisition and that people 'who do not have documented title to land should receive fair and just treatment'. The policy also assigns specific institutional responsibilities to the Ministry of Land and Land Development, the Central Environmental Authority, and Project Implementing Agencies. In acquiring land for the project, the executive agency will apply LAA, NIRP and LAA Regulations of 2009.

Legal Environment

69. There are a number of legislative and regulatory instruments in Sri Lanka that address social, environmental and economic consideration of development project in both general and specific terms. Among these are the 1978 Constitution of Democratic Socialist Republic of Sri Lanka and a number of Acts and Regulations introduced by the government from time to time. The Acts and Regulations of particular relevance to the proposed NWP Canal Project are as follows;

- Mahaweli Authority of Sri Lanka Act No. 23 of 1979
- Soil Conservation Act No. 25 of 1951 and No. 29 of 1953 and amended by Act No. 24 of 1996
- Irrigation Ordinance No. 32 of 1946, Act No.1 of 1951 and No. 48 of 1968, Law No. 37 of 1973
- The Land Acquisition Act No 9, 1950 and subsequent amendments
- The Urban Development Authority Act No. 41 of 1978
- The Municipal Council (MC) Act No. 19 of 1987 & Urban Council (UC) Act No. 18 of 1987
- The Irrigation Ordinance (Chapter 453)
- The Antiquities Ordinance, No.9 of 1940 (now Act) and the subsequent amendments, particularly the Antiquities (Amendment) Act No. 24 of 1998 is the primary Act.

70. In terms of protecting and managing environment and natural resources, the constitution of the Democratic Socialist Republic of Sri Lanka under chapter VI: Directive Principles of State policy and Fundamental duties in section 27-14 and in section 28-f proclaims;

"The state shall protect, preserve and improve the environment for the benefit of the community". "The duty and obligation of every person in Sri Lanka to protect nature and conserve its riches".

71. These two statements show the commitment of the state and obligations of the citizens. Other Environmental Acts and Ordinances having a bearing on the project are:

- National Environment Act (NEA) No 47 of 1980 as amended by act No 56 of 1988 and act No 53 of 2000
- Provincial Environmental Statue No. 12 of 1990 of the North Western Province.
- EIA regulations gazetted under NEA (Government Gazette Extraordinary No.772/72 dated 24 June 1993 and in several subsequent amendments)
- Environmental Protection License (EPL) regulations gazetted under NEA (Government
- Gazette Extraordinary No. 1533/16 dated 25 January 2008)
- Environmental Standards stipulated under NEA:
- Wastewater Discharge Standards- Gazette Notification No. 1534/18 dated 01/02/2008;
- National Environmental (Noise Control) Regulations 1996 - Gazette Notification no.
- 924/12 dated 23.05.1996
- Interim standards on Air Blast Over Pressure and Ground Vibration
- Mines and Minerals Act No. 33 of 1992
- Fauna and Flora Protection Ordinance as amended by Act No. 49 of 1993 and subsequent amends.

- Antiquities Ordinance No. 09 of 1940 (Chapter 188) (As amended)
- Forest Ordinance of 1907 and subsequent amendments

72. Forest Ordinance No. 16 of 1907 (Chapter 451) (As amended)

The Forest Ordinance of 1907 has been amended by Act numbers 13 of 1966, 56 of 1979, 13 of 1982, 84 of 1988, 23 of 1995 and 65 of 2009. It is cited as the 'Forest Conservation Ordinance' according to the Act No. 65 of 2009. The four categories of forests protected by the Forest Conservation Ordinance are Conservation Forest, Reserved Forest, Village Forest and Other forests except for Conservation, Reserved and Village forests.

73. Conservation forest is any specified area of state land declared by an Order published under section 3A of the Ordinance in the Gazette by the Minister in charge of the subject.

74. Reserved forest is any specified area of state lands declared by an Order published under section 3 of the Ordinance in the Gazette by the Minister in charge of the subject. According to the interpretation under section 78 "reserved forest" includes forest plantations and chenas with planted trees. Apart from that any forest declared as a reserved forest under any law before the enactment of the Forest Ordinance No. 16 of 1907 is considered to be a reserved forest.

75. Village forest is a specified area of state land declared by an Order published under section 3 of the Ordinance in the Gazette by the Minister in charge of the subject for the benefit of any village community or a group of village communities.

76. Other forest (except for conservation, reserved, and village forests) need not be declared with specified boundaries, and they are all other state forests which have not been declared as conservation forests, reserved forests or village forests and therefore several interpretations have to be associated to better understand an 'other forest'.

77. Conservation forests, reserved forests and village forests can be declared under the Forest Ordinance. Provisions to protect and manage them and 'other forests' (not declared under the Forest Ordinance) are provided in the Ordinance. Acts prohibited in conservation forests are given in Section 6, in reserved forest in Section 7, in village forest in Section 14, in forest other than conservation, reserved forest or village forest in Section 20. Punishments, for doing such things are also indicated in the Forest Ordinance.

Flora and Fauna Protection Ordinance

78. EIA provisions are also included in the Fauna and Flora Protection Ordinance (FFPO) Amended Act No. 49 of 1993. According to this Act, any development activity of any description what so ever proposed to be established within one mile from the boundary of any National Reserve, is required to be subjected to EIA/IEE, and written approval should be obtained from the Director General, Department of Wildlife Conservation prior to implementation of such projects. Since the project will result in the inundation of ca. 342 ha of a sanctuary (Kahalla-Pallekele Sanctuary) declared under the FFPO, the views and concerns of the DWC should be given due consideration.

79. The protected areas are classified as: (i) Sanctuaries (Sanctuaries ensure the protection of wildlife of private lands which are outside the state claim. Therefore sanctuaries may include private lands and permits are not required to enter) (ii) Strict Nature Reserves (An area of land deemed to be dedicated to species of animals and plants to thrive on with the least disturbance for the purposes of ensuring the survival of threatened species in their natural habitat facilitating appropriate scientific research. Strict Natural Reserves are protected as pure natural system. Therefore human activities are not allowed in the Strict Natural Reserves. But research activities could be carried out under direct supervision of DWC, , (iii) national parks (public are permitted to enter national parks to observe and study wildlife under rules and regulations introduced to protect wildlife and their habitats, and (iv) Nature reserves (Wildlife viewing and studying is restricted in these areas. Similar to Strict nature reserves scientific researchers are encouraged under the supervision of Department of Wildlife Conservation staff. These areas differ from strict nature reserves by allowing traditional human activities to continue.)

The classification of the protected areas declared under the FFPO is as follows:

(i) **Strict Nature Reserves:** An area of land deemed to be dedicated to species of animals and plants to thrive on with the least disturbance for the purposes of ensuring the survival of threatened species in their natural habitat facilitating appropriate scientific research. Strict Natural Reserves are protected as pure natural system. Therefore human activities are not allowed in the Strict Natural Reserves. But research activities could be carried out under direct supervision of DWC. **According to the IUCN system of classifying protected areas [1], a Strict Nature Reserve is a Category Ia protected area**.

(ii) **National Parks**: Public are permitted to enter national parks to observe and study wildlife under rules and regulations introduced to protect wildlife and their habitats. **According to the IUCN system of classifying protected areas, a National Park is a Category II protected area**.

(iii) **Nature Reserves:** Wildlife viewing and studying is restricted in these areas. Similar to Strict nature reserves scientific researches are encouraged under the supervision of Department of Wildlife Conservation staff. These areas differ from strict nature reserves by allowing traditional human activities to continue. **According to the IUCN system of classifying protected areas, a Nature Reserve is a Category IV protected area**.

(iv) **Sanctuaries**: Sanctuaries ensure the protection of wildlife in private lands which are outside the state claim. Therefore sanctuaries may include private lands and permits are not required to enter) **According to the IUCN system of classifying protected areas, a Sanctuary is a Category VI protected area**.

NEA No 47 of 1980 and its amendments

80. The National Environmental Act No. 47 of 1980 (NEA) is the basic national charter for protection and management of the environment. The NEA has been amended twice to make improvements and to respond to the needs of the time; National Environmental (Amended) Act No 56 of 1988; and National Environmental (Amended) Act No 53 of 2000.

81. There are two main regulatory provisions in the NEA through which impacts on the environment from the process of development are assessed, mitigated and managed. These are:

a. The environmental Impact Assessment (EIA) procedure for major development projects. Regulations pertaining to this process are published in Government Gazette Extraordinary No.772/72 dated 24 June 1993 and in several subsequent amendments.
b. The Environmental Protection License (EPL) procedure for the control of pollution. Regulations pertaining to this process are published in Government Gazette Extraordinary No. 1533/16 dated 25 January 2008.

Environmental Impact Assessment

82. The provision relating to EIA is contained in Part IV C of the National Environmental Act. The procedure stipulated in the Act for the approval of projects provides for the submission of two types of reports; Initial Environmental Examination (IEE) report and Environmental Impact Assessment (EIA) report. Such reports are required in respect of "prescribed projects" included in a Schedule in an Order published by the Minister of Environment in terms of section 23 Z of the act in the Gazette Extra Ordinary No. 772/22 dated 24th June 1993.

83. Any project or undertaking irrespective of its magnitude, if located partly or wholly within an Environmental Sensitive Area, will become a prescribed project requiring approval under the EIA regulations; hence the requirement for EIA in the case of this project. Proposed NWP Canal Project is a prescribed project as per the provisions of the above Gazette and conducting an EIA is the appropriate process.

84. The EIA process is implemented through designated Project Approving Agencies (PAAs). The PAAs are line ministries and agencies that are directly connected with a prescribed project. They are responsible for administration of the EIA process under the NEA. Determination of the appropriate PAA will be based on the following unranked criteria:

85. As the proposed NWP Canal Project is located in an area under the jurisdiction of the Ministry of Irrigation and Water Resources Development, it was designated as Project Proponent (PP) while CEA is the appropriate Project Approving Agency (PAA) for this project. In order for a project to be approved, the project proponent should submit an Environmental Impact Assessment (EIA) report. Once an EIA report is submitted, there is mandatory period of 30 days during which the public can inspect the document and comment on the report. Further, a public hearing may be held to provide an opportunity to any member of the public to voice their concerns. A decision whether to approve the project will be made by the PAA only after public consultation is done and major issues are resolved.

Environmental Protection License (EPL)

86. The Environmental Protection License (EPL) is a regulatory / legal tool under the provisions of the National Environmental Act. The EPL procedure has been introduced to prevent or minimize the release of discharges and emissions into the environment from industrial activities in compliance

with national discharge and emission standards , to provide guidance on pollution control for polluting processes and to encourage the use of pollution abatement technology such as cleaner production, waste minimization etc.

87. There are several activities associated with construction of the proposed NWP canal project that come under the provisions of this regulation and the Contractors are responsible for obtaining the Environmental Protection License (EPL) in each case. The prescribed activities are: bulk petroleum liquid or liquefied petroleum gas storage or filling facilities; asphalt processing plants; concrete batching plants; mechanized mining activities; granite crushing (metal crushing) plants; incinerators; wastewater treatment plants; solid waste dumping yards, and toxic or hazardous waste treatment or disposal facilities.

Institutional Framework that deal with the implementation of environmental safeguards

88. The national organization that has the mandate to implement the provisions under NEA and to protect and take measures to safeguard the environment is the Central Environmental Authority. Its functions are decentralized for IEE approvals, and currently operate in nine Provincial Offices and nine District Offices thought the country.

89. The following key national agencies with a mandate for environmental management and protections are also relevant to the activities of NWPCP.

- Forest Department,
- Department of Wildlife Conservation,
- Department of Archeology,
- Disaster Management Center
- Geological Survey and Mines Bureau.
- National Building Research Organization

90. They have their regional offices and technical staff to cater to and monitor the environmental safeguards as per the policies and regulatory provisions governing them.

91. In addition there are several national agencies which have the mandate for environmental protection and ensure environmental safeguards as well. They are Urban Development Authority (UDA), Water Supply and Drainage Board (NWS&DB), Road Development Authority (RDA), Department of Agriculture, Department of Agrarian Services and Irrigation Department (ID).

92. The Local Authorities (LA) also have provisions under their respective Acts and Ordinances to safeguards and provide environmental services and maintain environmental cleanliness for the convenience of the public in their respective areas. The Municipal Council (MC) Act No. 19 of 1987 and Urban Council (UC) Act No. 18 of 1987 provide for the establishment of MCs and UCs with a view to provide greater opportunities for the people to participate effectively in the decision making process relating to administrative and development activities at a local level and it specify the powers, functions and duties of such LAs and provide for matters connected therewith or incidental thereto. These Acts cover public health, drainage, latrines, unhealthy buildings, conservancy and scavenging, nuisance etc

Antiquities Ordinance:

93. An Archeological Impact Assessment (AIA) for new projects is required under section 47 and 43A of the Antiquities Ordinance. (Extraordinary gazette no 1154/14 dated 4th October 2000.)

Multinational Agreements

94. Sri Lanka has acceded or ratified around 40 Multilateral Environmental Agreements (MEA). The MEAs that are relevant to this project are shown in Table 1-1.

Table 1-1 Project relevant international environmental agreements

Agreement	Ratification Date	Objectives
Atmosphere		
United Nations Framework Convention on Climate Change (UNFCCC 1992)	23 November 1993	Stabilization of greenhouse gas (GHG) concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climatic systems
Kyoto Protocol (1997)	3 October 2002	The Annex 1 parties (Developed Countries) to reduce their collective emissions of greenhouse gases by at least 5% of the 1990 level by the period 2008 –2012.
Biodiversity		
International Plant Protection Convention (1951)	12 February 1952	To maintain and increase international co-operation in controlling pests and diseases of plants and plant products, and in preventing their introduction and spread across national boundaries
Plant Protection Agreement for Asia and Pacific Region (1956)	27 February 1956	To prevent the introduction into and spread within the region of destructive plants
Convention on the conservation of Migratory Species (CMS-1979)	6 June 1990	To protect those species of wild animals which migrate across or outside national boundaries
Convention on Biological Diversity (CBD-1992)	23 March 1994	Conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources, including appropriate access to genetic resources and by appropriate transfer of relevant technologies and appropriate funding
Land		
United Nations Convention to Combat Desertification (UNCCD- 1994)		To combat desertification and to mitigate the effects of drought in countries experiencing serious droughts and/ or desertification with the final aim being to prevent land degradation in the hyper arid, arid, and semi-arid, dry sub humid areas in the countries that are parties of the Convention

1.6 ADBs requirements:

95. ADB uses a classification system to reflect the significance of a project's potential environmental impacts. A project's category is determined by the category of its most environmentally sensitive component, including direct, indirect, cumulative, and induced impacts in the project's area of influence. Each proposed project is scrutinized as to its type, location, scale, and sensitivity and the magnitude of its potential environmental impacts. Projects are assigned to one of the following four categories based on ADB's Safeguard Policy Statement (2009)

96. Category A: Projects with potential for significant adverse environmental impacts which are irreversible, diverse, or unprecedented. An environmental impact assessment (EIA) is required to address significant impacts.

97. Category B: Projects judged to have some adverse environmental impacts, but of a lesser degree and or significance than those of category A projects. An initial environmental examination (IEE) is required to determine whether or not significant environmental impacts warranting an EIA are likely. If an EIA is not needed, the IEE is regarded as the final environmental assessment report.

98. Category C: Projects unlikely to have adverse environmental impacts. No EIA or "IEE is required, although environmental implications are still reviewed.

99. Category F1: Projects are classified as category F1, if they involve a credit line though a financial intermediary. The financial intermediary must apply on environmental management system; otherwise all subprojects will result in insignificant impacts.

100. ADB will disclose the draft EIA on ADB's website 120 days prior to Board consideration

Preliminary approvals needed for the proposed project from state agencies.

101. This project will extend over two provinces, Central and North Western. There are several approvals needed from various government agencies which are listed below.

1. Approval for the EIA study from Central Environmental Authority
2. North Western Provincial Environmental Authority[5] (The North Western Province has passed its statue in 1990 namely the Provincial Environmental Statue No. 12 of 1990. As the subject of environment protection is listed in the concurrence list of the 9th schedule of 13th amendment to the constitution of Sri Lanka) However, as this is an interprovincial river and the project is also an interprovincial project the final approval will be granted by the central government with NWP Environmental Authority as a part of the review/approval committee.
3. Approval from Mahaweli Authority of Sri Lanka.
4. Approval from Department of Agrarian Services.
5. Approval from Archeological Department.
6. Approval from Department of Wildlife Conservation.
7. Approval from Forest Department

[5] NWP Environment Authority has agreed to TOR issued by CEA with ADB amendments.

8. Approval from National Planning Department.
9. Approval from respective Predeshiya Sabhas.
10. Approval from Geological Surveys and Mines Bureau for operating rock and sand quarries.

1.7 Conformity with other development plans in the area.

102. The target area of the project is the Hakwatuna Oya Irrigation System in the Deduru Oya River Basin and medium and small irrigation systems in the Upper Mi Oya Basin. The Deduru Oya Reservoir located in the middle reaches of the basin is under construction. The Hakwatuna Oya Reservoir is upstream of the Deduru oya Reservoir and the proposed NWP canal will have no direct impact on the Deduru Oya project. However, Deduru Oya Reservoir will receive more drainage water from Hakwatuna Oya fields due to increased inflow to Hakwatuna Oya Reservoir from the proposed diversion. There is no water resource development project in the Upper Mi Oya Basin. Refer Fig 2.2 for project location map.

CHAPTER 2

2. DESCRIPTION OF THE PROPOSED PROJECT AND REASONABLE ALTERNATIVES

2.1 Evaluation of Alternatives

103. The EIA study team has studied the following alternative routes of the NWPC:

I. Central Engineering Consultancy Bureau (CECB)'s proposal for transfer route from Bowatenna reservoir through a second Bowatenna Tunnel (8 km in length) to Wemedilla reservoir. Water will be released from Wemedilla to Devahuwa feeder canal. Water from there traverse through a contour canal up to Pothuwila Reservoir is Kurunegala District. Hakwatuna oya and Mediyawa reservoirs also will be fed through a link canal
II. Transfer canal from Devahuwa Reservoir to Mi Oya & Hakwatuna Oya.
III. Transfer canal from Dambulu Oya bypassing Wemedilla reservoir through Devahuwa Feeder Canal to Pothuwila Tank. Diversion from the existing Bowatenna Irrigation Tunnel at a point downstream of the tailrace canal of the mini hydropower station. A new diversion structure will be built across the Dambulu Oya to divert water through a contour canal. The diverted water is stored in two reservoirs (Mahakithula and Mahakirula) and released to target areas at appropriate times through a canal system

I CECB Proposal

104. The CECB's feasibility study of 2003 recommended the transfer of 80 – 100 MCM annually from the Mahaweli System to NWP. The main diversion point of the conveyance route is a new 8 km long, 6 m diameter fully lined tunnel from Bowatenna Reservoir ("Second Bowatenna Tunnel"). It was designed to convey a total discharge of 45 cumec out of which 25 cumec is to meet irrigation water demands of system H, I/H and M/H of Mahaweli System, and 20 cumecs to augment the Upper Mi Oya Basin reservoirs in NWP area and minor reservoirs en-route. (Please refer figure 2.2 in page 18 for Mahaweli Development Areas in relation to proposed developments)

105. The tunnel, with its inlet portal located on the periphery of Bowatenna Reservoir in Wambotuyaya village will traverse in NW direction up to Potawa village in the Welamitiya Oya basin and towards a 6.6 MW power plant generating 37.57 GWH at the outlet portal. Then water will be discharged to an upstream point of Welamitiya Oya which flows to Wemedilla Reservoir. A second power plant with 5.3 MW and 28.3 GWh was proposed below the dam to utilize the elevation difference between Wemedilla reservoir and the Welamitiya Oya below. However, Wemedilla reservoir was finally completed in the year 2007, without incorporating the proposed power station.

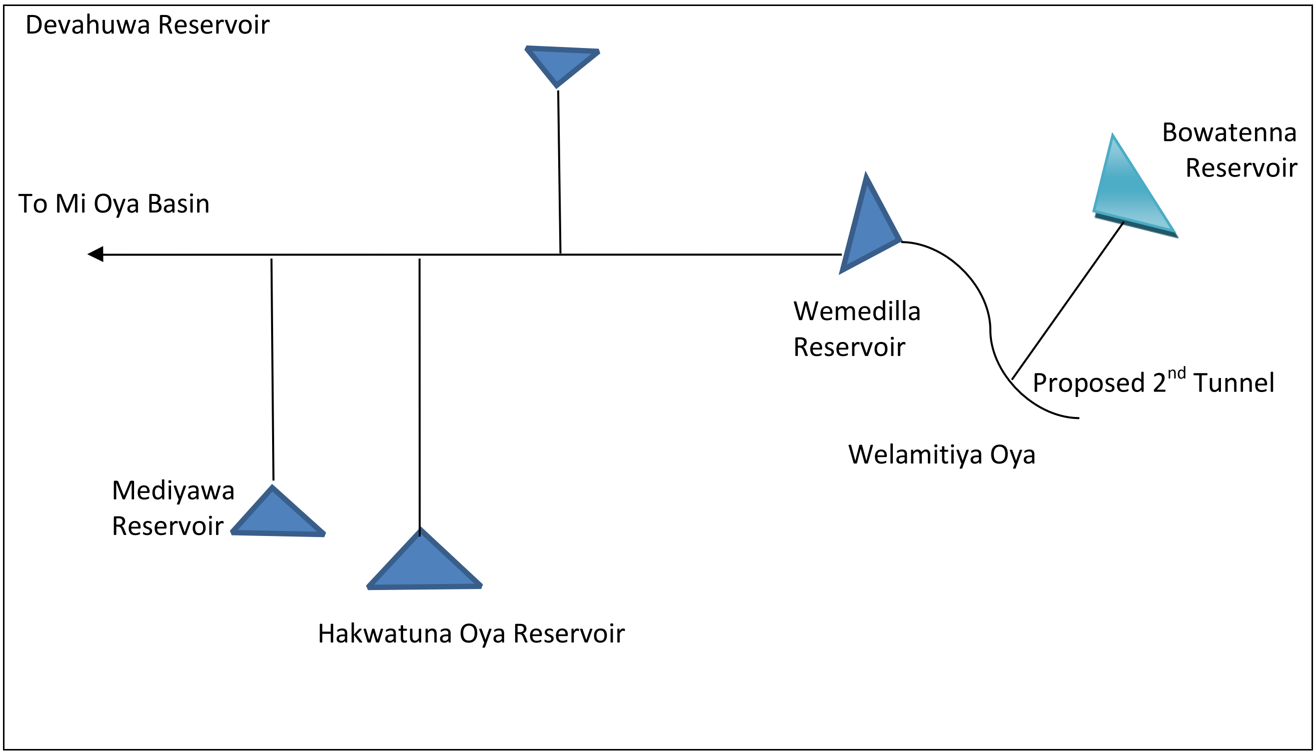


Figure 2-1 Schematic Diagram - CECB proposal

106. The proposed canal to take off from the LB Main Canal sluice and traverses as a contour canal traversing 26.5 km, with a capacity varying from 20 to 8 cumec feeding the Pothuwila Reservoir in the Upper Mi Oya Basin through a 700 m tunnel. Also the Hakwatuna Oya and Mediyawa Reservoirs were to be fed by appropriate diversion / regulator structures and link canals.

107. This Proposal does not provide storage reservoirs, which is required for flexible water management. Water from Bowatenna Reservoir is not available throughout the year due to riparian demands. Thus water can be issued to NWP area only during certain months where the inflow and storage is sufficient to cater for the additional demand in NWP. Therefore, storage reservoirs in the NWP area is an essential feature for a proposal especially in the backdrop of impending climate change.

108. Furthermore, with this proposal, the demand for water from Bowatenna Reservoir is increased, but inflow for such an increased demand is not demonstrated in the water balance study. Therefore this alternative was not considered on the basis that available water resources were inadequate to support this proposal.

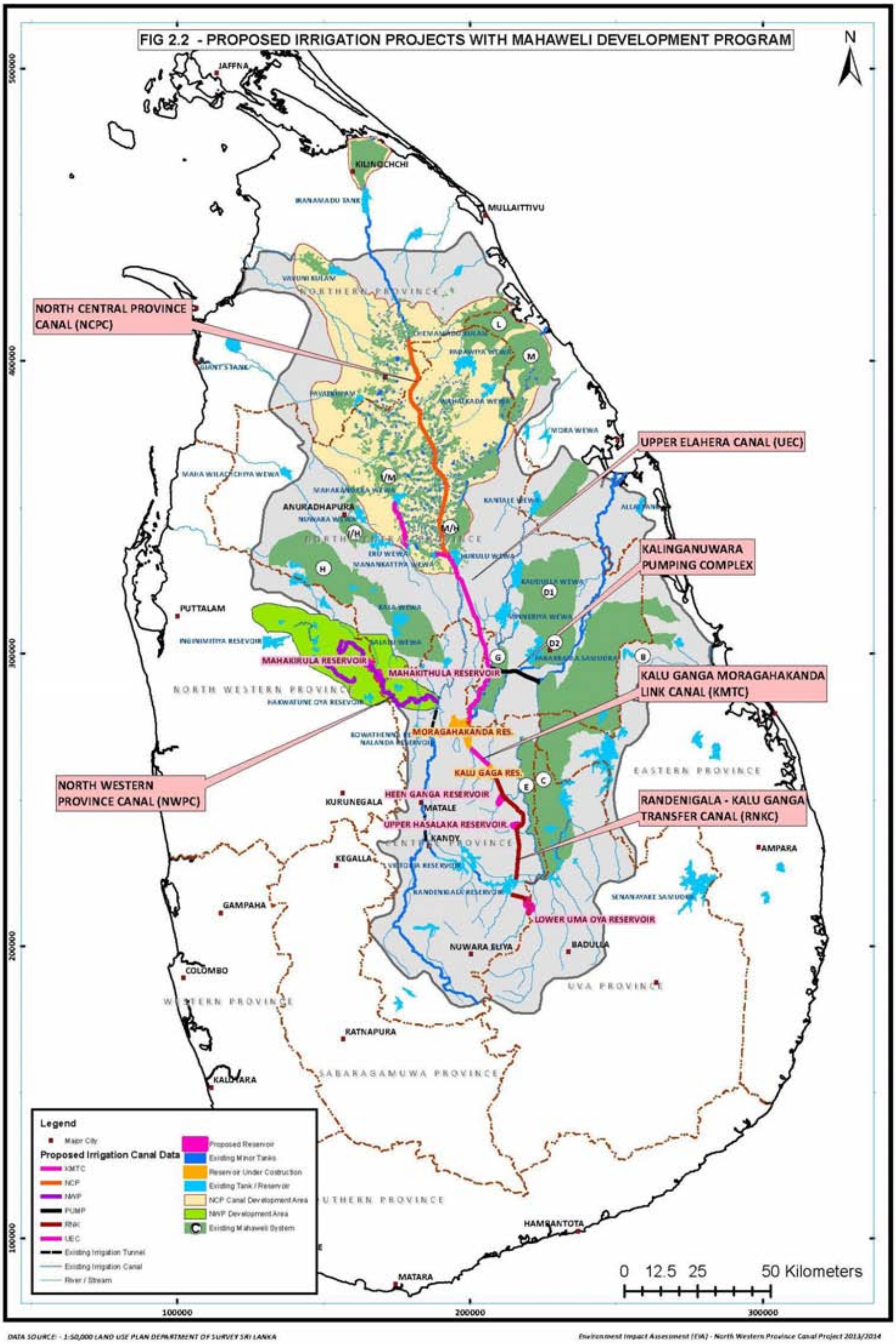


Figure 2-2 Development areas under Mahaweli Development Programme

II Transfer canal from Devahuwa Reservoir to Mi Oya and Hakwatuna Oya

109. During the initial stages of the prefeasibility study the possibility of constructing a transfer canal from Devahuwa reservoir to Upper Mi Oya basin was considered. This proposal was based on the fact that the Wemedilla Reservoir was built to augment the Devahuwa Reservoir through its LB Main Canal, which traverses as a contour canal up to Kalugal Oya, a natural stream draining to Devahuwa reservoir. However, the FSL of Devahuwa reservoir is 182.42 m while the FSL of Mahakithula (a new reservoir proposed in Kahalla Pallekele Sanctuary) is estimated was about 195 m.

110. The main drawbacks of the proposal was that the link canal from Devahuwa to Pothuwila (bypassing Mahakithula reservoir) would involve extensive deep cutting and tunneling, and hence it would not be able to feed the Hakwatuna Oya Reservoir due to topographical restrictions. Hakwatuna Oya Reservoir is the only major reservoir in the target area. Therefore augmenting this reservoir is essential under any water transfer scheme.

III Transfer Canal from Dambulu Oya to Pothuwila Reservoir

111. Under this alternative, the main diversion route starts from the Bowatenna Irrigation Canal at a point downstream of the tailrace canal of a mini hydropower station at Lenadora which is under construction. The main diversion canal traverses 8.1 km towards but bypasses the Wemedilla reservoir and then falls into its LB Main Canal (Devahuwa Feeder Canal) within 100-m downstream of the sluice. It then traverses along the Devahuwa Feeder Canal up to a point just upstream of the 2nd Drop structure located at 13.3 km, and then deviates towards Galewela and continues to traverse towards Kahalla-Pallekelle Forest Reserve and through a 700 m long tunnel to Mahakithula Reservoir which is an abandoned tank in Kahalla Pallekele Sanctuary. It is located at the highest point of the catchment divide separating the Hakwatuna Oya and the Mi Oya basins, and would be a very important regulating reservoir controlling flows to target areas. Two diversion structures were proposed: one in the Mahakithula Reservoir in LB to feed the Hakwatuna Oya Reservoir, and the other in RB to feed the Upper Mi Oya flowing to Pothuwila minor reservoir, where the main diversion canal ends.

112. From Pothuwila Reservoir, a new RB Feeder Canal takes off to feed minor tank cascade in RB Upper Mi Oya, while a new LB sluice conveys water through the Mi Oya to feed the Wavulewa minor reservoir located downstream. There will be a new LB Feeder Canal in Wavulewa Reservoir to feed minor reservoir cascades in the Upper Mediyawa Basin.

113. The length of main diversion canal is 35.4 km, of which the Feeder Canal to RB Upper Mi Oya cascade is 25.9 km and the Feeder Canal to the Upper Mediyawa cascade is 15.5 km.

114. Following table list out both advantages and disadvantages of these the proposals:

Table 2-1 Comparison of alternative proposals

Option	Proposal	Disadvantages	Advantages
01	CECB proposal with 2nd Bowatenna tunnel. This proposal has two power houses. The diversion canal will be a contour canal and supply water to Pothuvila, Hakwatunaoya and Mediyawa tanks.	High cost of 8 km tunnel. No adequate water to transfer As a result, potential power generation is drastically reduced. No storage reservoirs are proposed. But water for diversion is available only during few months. The upper Mi Oya Basin consists of a large number of village tank cascades which need a new water source to increase cropping intensity. But proposal does not cater that requirement. High cost of a new 8 km tunnel makes the total project cost high.	Less land acquisition problems. Less potential for illicit extraction of wate Less damage to existing agricultural lands
02	Transfer canal from Devahuwa tank to Mi Oya and Hakwatuna Oya	Involve extensive deep cutting and tunneling Environmental disadvantages due to deep cuts in the Kahalla Pallekele Sanctuary. Water from Devahuwa does not reach Hakwatuna Oya (a focal point in the target area) due to topographical restrictions	Shorter distance between Devahuwa and target area.
03	Transfer canal from Dambulu Oya to Pothuvila tank	Land acquisition problems envisaged. Potential for unauthorized extraction of water along the route.	Low capital and maintenance cost. The mini hydro power station will be able to utilize 100 MCM earmarked. Minor tanks along its route to Wemedilla depending on the topography will be benefitted. Minor tank cascades in the upper Mi Oya basin can be augmented. Proposal suggests creation of two storage reservoirs (Mahakithula and Mahakirula) which will increase flexibility of water management in the system. These two storage reservoirs are more environmentally sustainable in the face of impending climate change

Evaluation of different diversion routes

115. As described above three options were considered to transfer water to the target area in NWP.

116. The consultants considered the advantages and disadvantages of above three options and recommended option (3) as most viable for following reasons.

117. Low capital and maintenance costs. Under option 1 the proposed new 2nd tunnel from Bowatenna is 8 km long which will impact on capital cost

118. The mini hydropower plant will also be able to utilize the 100 MCM earmarked for diversion to NWP without the burden of high cost of a new tunnel.

119. Some minor tanks can be fed along its route to Wemedilla reservoir, depending on the topography. Minor tank cascades in upper Mi Oya basin which are critically in need of additional water source will receive water.

120. Reservoirs created inside Kahalla Pallekele sanctuary (Makithula and Mahakirula) would act as habitats for wild life in the sanctuary because the fluctuating water level in these reservoirs will create flat grassy lands which are preferred habitats for elephants. (Eg, Minneriya Reservoir has this type of grass land when the water level is low which attracts large herds of elephants).Furthermore, these tanks will supply the water demands of Elephants and other wild animals especially during dry season. This will reduce human elephant conflict.

121. Due to the elevations of tanks in the target area the diversion canal has to be taken on a higher elevation. Considering the topography of the area alternative canal traces were not possible.

2.1.1 No action alternative

122. The target area of this project is upper reaches of Mi Oya basin and Hakwatuna Oya basin (a sub basin of Deduru Oya basin). There are several major and medium reservoirs in these basins and a large number of village tanks situated in cascades. It is found that the average cropping intensity is less than 0.9 for village tanks. This area never received an additional source of water other than inflow from own catchment. Poor farmers of these village tanks requested for an additional source of water to enhance their livelihood for many decades. Their request was voiced through politicians of the district but so far a practical solution was not formulated.

123. If no action alternative is adopted, the livelihood of the people will remain at low levels as at present. Furthermore, they may face further challenges with the effects of climate change. Therefore, this option will not improve the environment as well as the livelihoods of farmers living in the target area, and in the long term it might affect the environmental sustainability because of the stagnant condition of irrigated agriculture in the area.

2.2 The proposed project

2.2.1 Name of the Project and location

124. ‘Diversion of Mahaweli Water to Upper Mi Oya & Hakwatuna Oya Basins in Kurunegala District also referred to as the North Western Province project’

125. The proposed diversion originates from a point about 1 km downstream of the outlet of existing Bowatenna Irrigation tunnel at Lenadora in Mathale District. A contour canal will transfer the diverted water to Kahalla Pallekele sanctuary in Kurunegala District. In fact, the proposed project is a further development of above mentioned proposal described in 2.1 above to allow more storage of water in Kurunegala District. It was revealed in the water balance study that water storage structures such as reservoirs are required. Water storage is further justified with impending climate change. Water will be stored in existing Hakwatuna Oya Reservoir (capacity 24.3 MCM) and new reservoirs in Kurunegala District and distributed to tanks in Hakwatuna Oya basin and upper Mi Oya basin according to irrigation and drinking water demands. Diverted water will be stored in proposed Mahakithula Reservoir (to be restored to store 15 MCM under the project) and Mahakirula Reservoir (to be improved to store 10 MCM under the project).

Alternative locations for storage reservoirs were considered at different locations, final locations were determined based on topography.

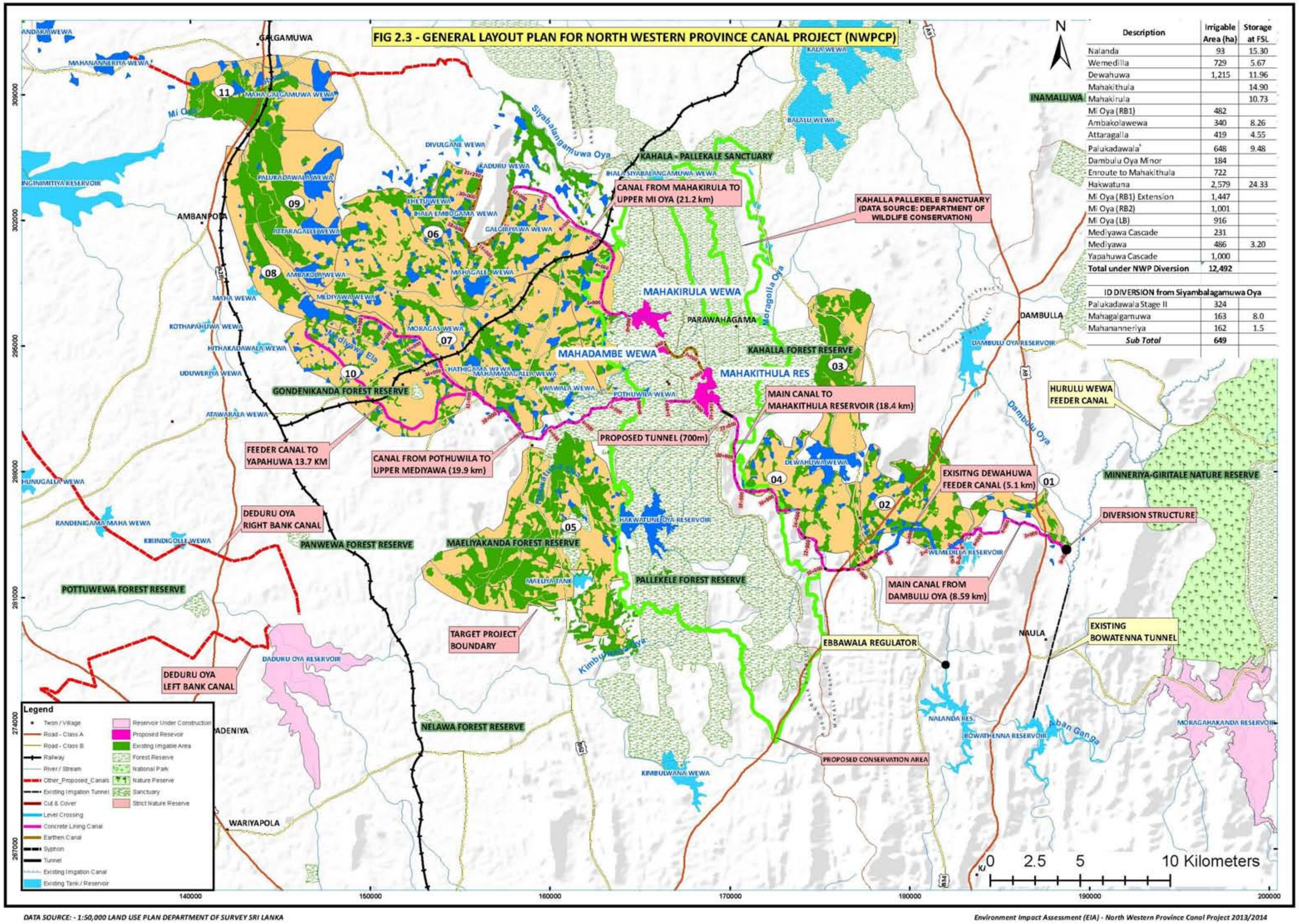


Figure 2-3 General Layout Plan of the Project

2.2.2 Description of components of the project.

126. It is proposed to implement the diversion of water to Mi Oya and Hakwatuna Oya basins in two stages.

Stage 1: Divert about 30 MCM from Nalanda reservoir water to Hakwatuna Oya basin

Stage 2: Diversion of another 100 MCM annually from downstream of Bowatenna irrigation tunnel to Upper Mi Oya irrigation systems once the Moragahakanda and Kaluganga reservoirs and Upper Elahera Canal are completed by 2019.

127. The infrastructure required for each of the stages is indicated below.

Stage 1 - Nalanda – Wemedilla - Devahuwa feeder Canal - Hakwatuna Oya Diversion

Infrastructure Required for Stage 1 Development which is to divert water from Nalanda Reservoir via Wemedilla.

128. Under this stage it is proposed to restore Mahakithula Reservoir located at Upper Mi Oya basin to store water for diversion to Hakwatuna Oya reservoir (2580 ha of command) and balance to minor reservoirs cascade in Mi Oya basin (500 ha of total command). This will include construction of following.

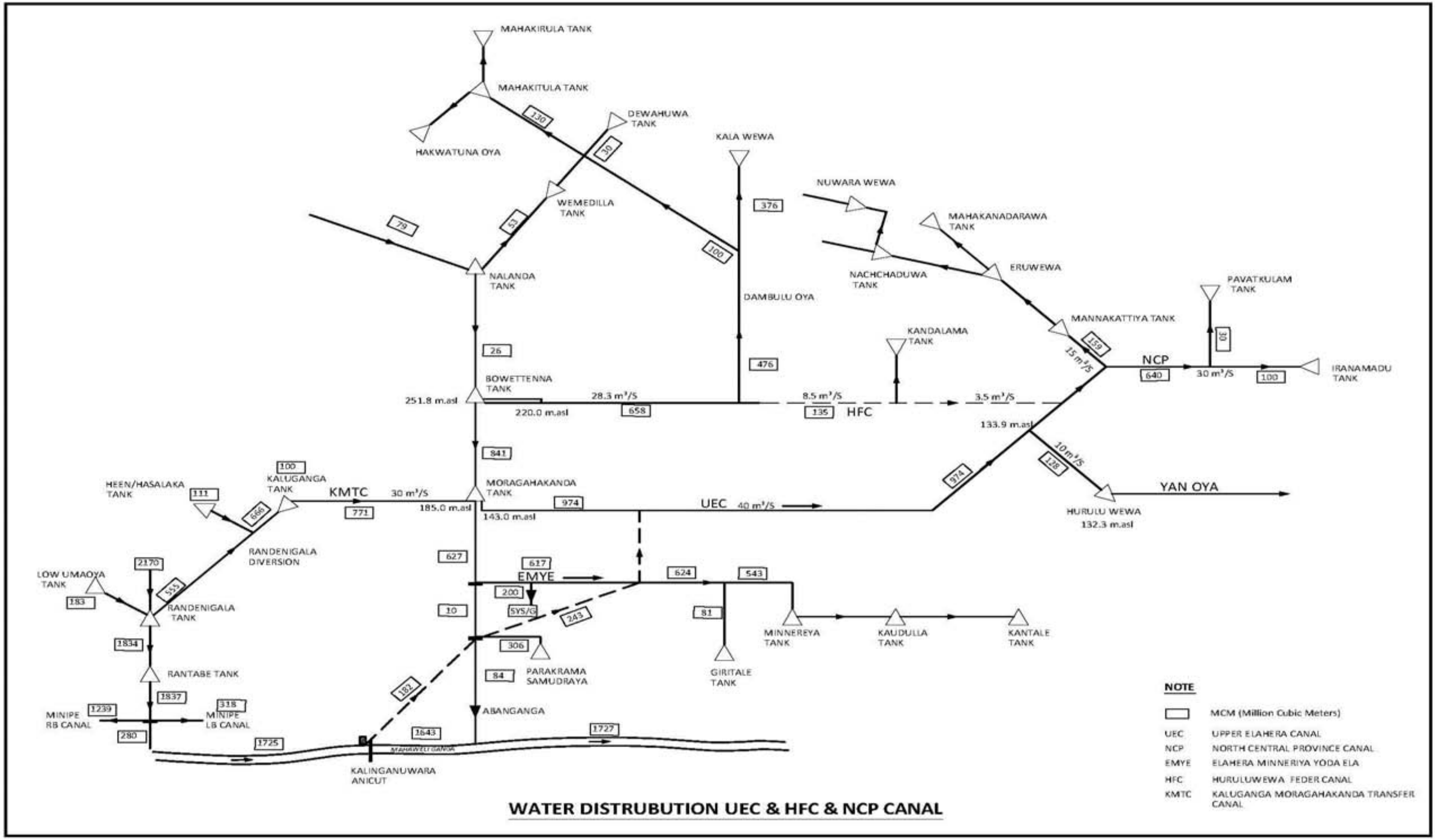


Figure 2-4 Water Distribution Diagram of NWP and Upper Elahera Project

Required infrastructure

1) Construction of a new LB Sluice in Wemedilla reservoir to deliver additional 10 m^3/sec to Devahuwa feeder canal. (The existing LB Main Sluice can only deliver a maximum of 5 cumecs approximately).
2) Improvements to existing Devahuwa feeder Canal for a length of about 5 km to cater for the additional discharge from proposed diversion with a total discharge capacity of 10 m^3/sec. This will be a lined canal with bed width of 3 m. The proposed improvements are; widening of canal bed, increasing bank height and lining along with required improvements to canal structures.
3) New diversion canal of length 18 km from Devahuwa Canal to Upper Mi Oya basin with design discharge of 10 m^3/sec, through a tunnel of length 700 meters in Kahalla-Pallekelle sanctuary in Polpithigama DS area in Kurunegala District. This will be a lined canal.
4) Restoration of ruined Mahakithula Reservoir (15 MCM, dam height 26 m approximately, water spread area 190 ha) inside Kahalla Pallekele sanctuary to create additional storage of 15 MCM required, including the construction of LB Sluice structure to Hakwatuna Oya reservoir, RB Sluice to release water upper Mi Oya cascades of minor tanks, a Mid Sluice to Pothuwila wewa via Mi Oya to feed downstream and the Spill structure to discharge towards Mi Oya. Mahakithula wewa is a breached and abandoned tank in Kahalla Pallekele sanctuary. Restoration works of Mahakithulwewa will include complete restoration of this ruined Reservoir where only traces of a reservoir and remnants of structures remain.
5) A new 1 km long link canal from Mahakithula Reservoir to fall into a major tributary of Maha Dambe Wewa, which will be improved as a level crossing in the route to Maha Kithula. This is an earthen canal with a conveyance capacity of 5.5 m^3/s inside the sanctuary.
6) A new ½ km long link canal from Maha Dambe to Maha Kirula wewa located inside Kahalla-Pallekelle wildlife sanctuary. This link canal will also be an earthen canal.
7) Improvements to existing Maha Kirula Wewa to have an active storage of about 10 MCM. This tank will have a water spread area of 152 ha after improvements. The existing water spread is 7.2 ha. The dam height will be increased from 6 m to 23 m.
8) New diversion canal (Upper Mi Oya) of length 22 km from Maha Kirula tank to provide water to minor tank system in Ehetu Wewa DS area. This canal will be a lined canal with design capacity of 4 m^3/sec at the off take from Mahakirula Tank. Another new lined canal of capacity of 9 m^3/sec will commence from Mahakithula tank to feed Hakwatuna oya natural stream and finally to Hakwatuna oya reservoir.

Stage 2 - Diversion of Mahaweli water to Mi Oya Basin from downstream of existing Bowatenna Irrigation Tunnel

129. Stage 2 developments, as indicated below, could be achieved after completion of Moragahakanda-Kalu Ganga complex with Upper Elahera Canal to transfer irrigation demand of Hurulu Wewa, Nachchaduwa and Nuwara Wewa through UEC. Under NWP it is earmarked to feed about 9,000 ha Under Stage 2 involving minor tanks en-route from Bowatenna to Mahakithula Reservoir, Mediyawa cascade, and balance minor tank cascade in upper Mi Oya basin, Ambakolawewa, Attaragalla and Palukadawala reservoirs.

Required infrastructure

1) New diversion weir across Dambulu Oya and a lined canal of length 8.0 km (capacity 10 m^3/sec) from downstream of Bowatenna tunnel diversion at Dambulu Oya near Lenadora to divert 100 MCM annually to connect to existing Devahuwa Feeder Canal (Wemedilla Left Bank Main Canal).

2) New diversion canal of length 3 km from Mahakithula to Pothuwila Wewa.

3) Improvements to Pothuwila Wewa, including a new LB Sluice structure to feed Waulewa Wewa downstream via Mi Oya.

4) Improvements to Kaduru Wewa tank in Ehetu Wewa Pradeshiya Sabha area. The design team does not propose specific structural improvements.

5) Improvements to Waulewa tank in Polpithigama DS area, including a new LB Sluice structure.

6) New diversion canal of length 15 km with 4 cumec capacity from Waulewa Wewa to feed Mediyawa Wewa and minor tank cascade en-route. This canal will be a lined canal with 1.5 m bed width.

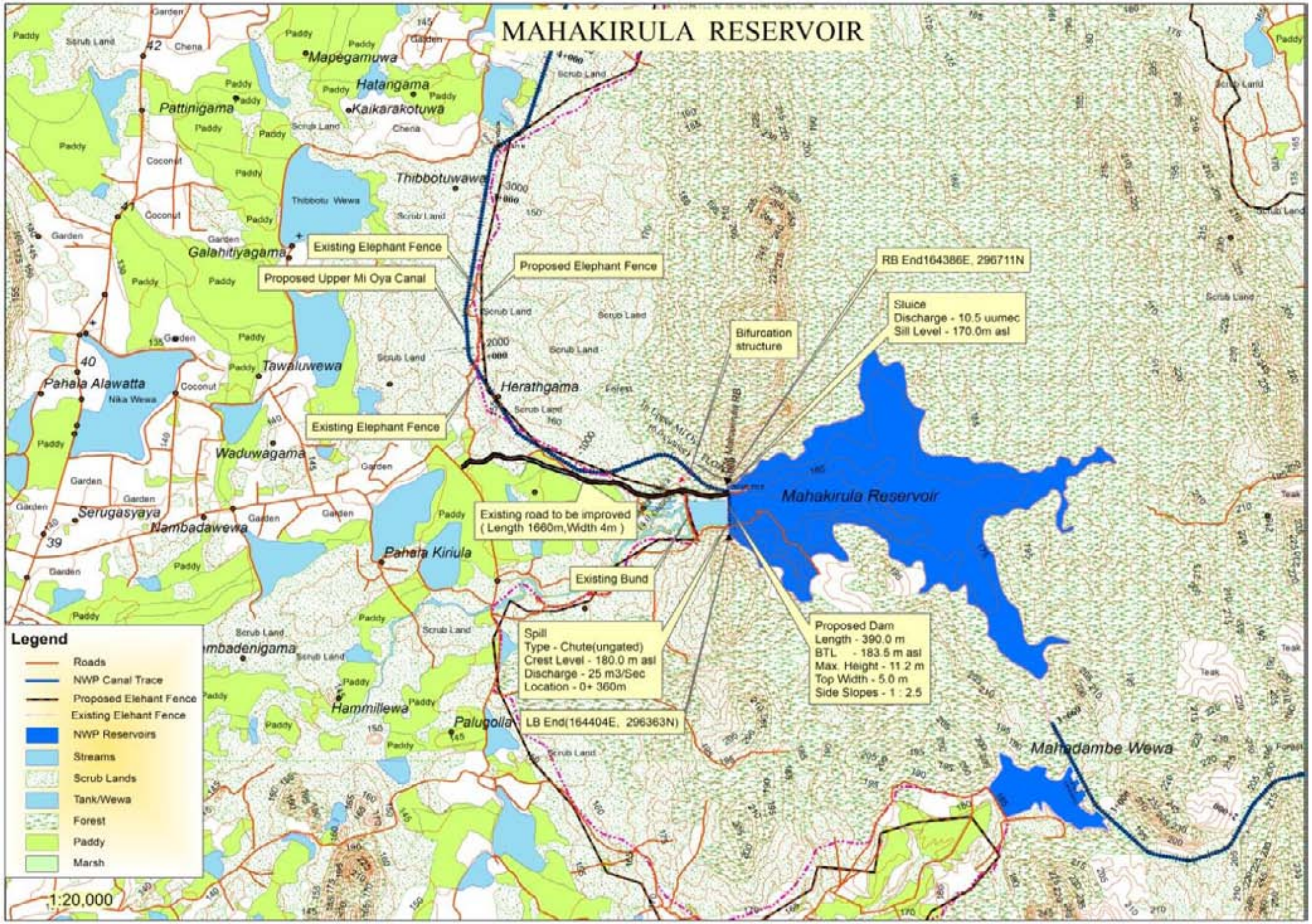


Figure 2-5 Mahakirula Reservoir and landuse

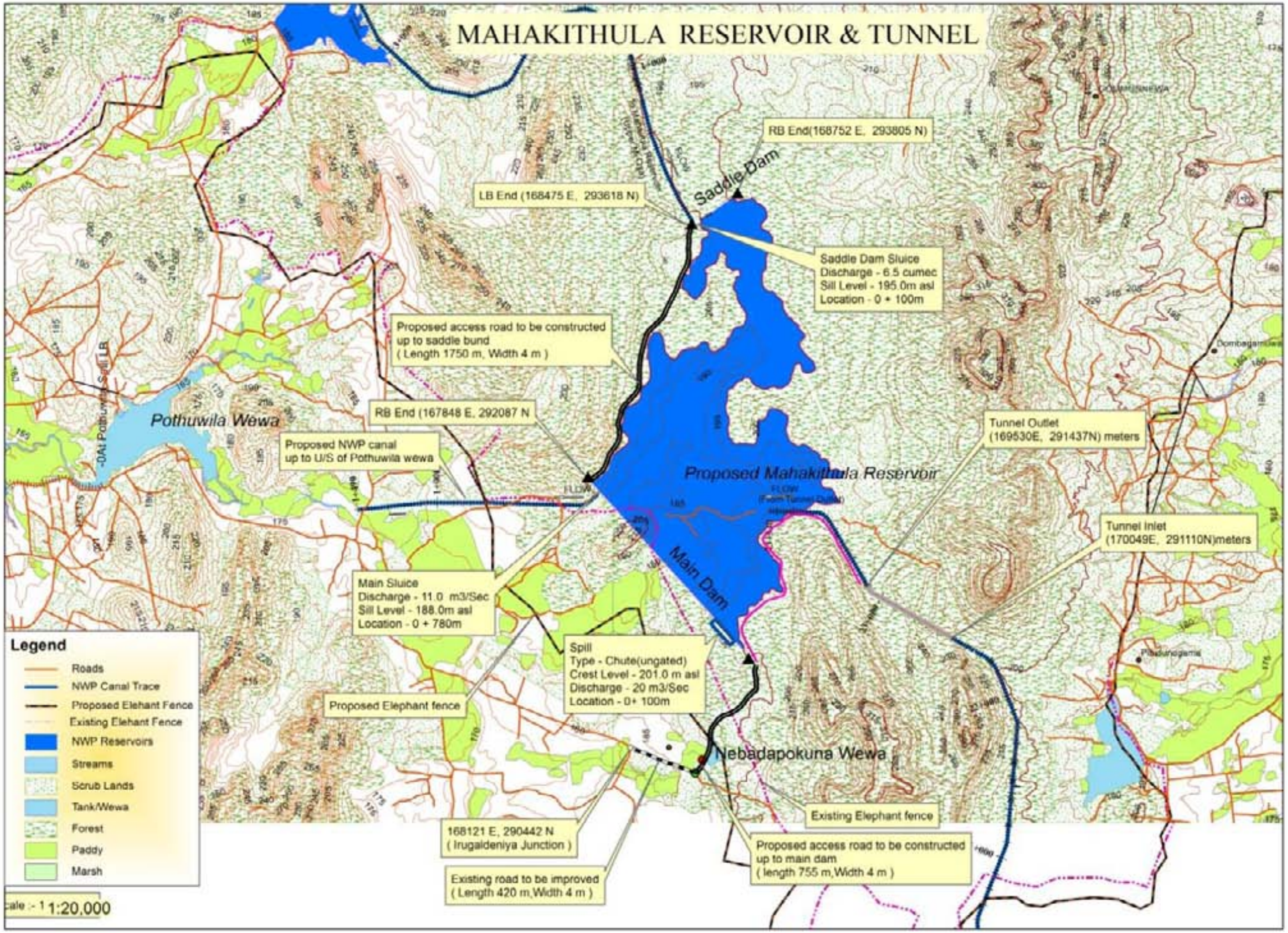


Figure 2-6 Mahakithula Reservoir and Tunnel

Summary of structures involved in the project

130. There are 122 concrete structures that will be necessary for the proposed diversion as shown below:

Type of Structure	Nos
Road crossings and Bridges	52
Turn out structures	41
Diversion Weirs	1
Intake structures	1
Level crossing structures	10
Aqueducts	6
Sluices	5
Spills	2
Drainage crossings	2
Railway Crossings	1
Tunnels	1
Total	122

2.2.3 Reservations

131. The proposed project involves large number of canals of varying discharge capacity and several reservoirs spread over a large area. For the proper maintenance of canals required reservations have to be kept as per the regulations of the Irrigation Department. The table 2.2 shows the reservations to be kept for canals and reservoirs and Table 2.3 shows reservations for streams and rivers.

Table 2-2 Reservations for canals

	Item	Total reservation		Reservation from center line of canal on side of O&M Road	
		Feet	metres	Feet	meters
1	Main canal of bed width (BW) equal or more than 12 ft. (3.7m)	132	40	80	25
2	Main canal of BW equal or more than 8 ft (2.4m) but less than 12 ft	121	40	70	20
3	Main canal of BW less than 8 ft	99	30	60	18

4	Branch canal	66	20	40	12
5	Distributary canal	44	14	32	10
6	Field canal	33	10	24	8
7	Roadway of 12 ft. (3.7m) width	33	10		
8	Roadway of 18 ft (5.5m) width	44	14		
10	**Reservoirs/Tanks**				
	Downstream of bund (dam)	4 times of height of the bund from toe-line			
	Tank bed	All areas falling below Bund Top Level contour			

Source: Irrigation Department circular no 10/1986

Table 2-3 Reservations for streams and rivers

	Stream/River size	Reservation from each bank	
		feet	meters
1	Small - Bed width less than 15 ft	66	20
2	Medium - Bed width between 15-50 ft	128	40
3	Main rivers – Bed width more than 50 ft.	198	60

Source: Government land regulations no 9912 dated 15/10/1948

2.2.4 Methodology of Construction

132. The main components of this project are: (i) construction of a diversion canal from Lenadora (Downstream of Bowatenna tunnel) to convey water to Mahakithula tank in Kahalla Pallekele sanctuary in Kurunegala District., (ii) Construction of Mahakithula tank, link canal from Mahakithula tank to existing Mahakirula tank, (iii) rehabilitation of Mahakirula tank and distribution canal system to Hakwatuna oya basin and Mi Oya basin with appurtenant structures. This project involves restoration of Mahakithula Reservoir (capacity 15 MCM) and rehabilitation of Mahakirula Reservoir (Capacity 11 MCM) in Kahalla Pallekele sanctuary. The project will also involve construction of 77 km of canals of varying sizes. There is a short tunnel of about 700 meters in Kahalla Pallekele sanctuary. There is no power generation involved. Following construction methodologies will be involved:

Site preparation including land clearing:

133. Generally, land clearing is the first operation after the setting out of site. Land clearing is an operation that has an impact on the environment especially in an erodible environment. Proper

measures have to be taken during rainy periods to avoid soil erosion from exposed surfaces. In fact, it is not advisable to commence a construction during northeast monsoon period (from November to February). This is a major consideration to be followed in construction planning.

134. In the construction of earthen dams, core trench is an important feature and this is an excavation of trapezoidal section. It is important to have proper pumping and drainage facilities in construction of earthen dams, especially during core trench excavation and back filling. It is advisable to do core trench in several sections with a phased out programme, and with standard construction methods such as compaction of soil in layers in specified thickness. In planning of core trenches for dams it is important to obtain technical inputs from qualified professionals both from contractors' side and technical consultants. The stability of side slopes is important for safety of workers in the core trench. Rainy periods especially in the monsoons should be avoided in construction planning.

135. The project also has a long canal traversing through several divisional secretariats to convey water to the target area. Excavation of this canal will involve rock blasting at different locations. Blasting operations should be carried out under the supervision of rock blasting experts to minimize damage to other properties. It is noted that the certain reaches of the canal traverses through populated areas. Construction operations in such areas require special attention for the safety of children and adults living in the vicinity.

136. Another important factor to be considered in deep excavations is the stability of excavated faces. It is the responsibility of the site engineer to decide on adequate shoring and protection work to ensure the safety and stability of excavations.

137. Within the wildlife reserve, the use of heavy machinery and other human activities should meet the monitoring standards of Department of Wildlife Conservation in order to make minimum disturbance to wildlife.

Facility Construction

138. Two main reservoirs (Mahakirula and Mahakithula) will be within the Kahalla Pallekele sanctuary which is totally under the jurisdiction of the DWC and it is proposed to use tank beds as borrow areas. The top soil of borrow areas will be excavated and preserved in the tank bed area. It may be reused in the downstream of tank bunds before turf laying as a protective measure to arrest erosion. As the dam axes are found inside the sanctuary, a prior approval from the Department of Wildlife Conservation will be necessary to carry out the activities. Heavy machinery will be used in the construction work in the sanctuary. Type of machinery allowed in the sanctuary should be specified in the contract specifications. Adequate draining facilities must be provided in the dam site to avoid water logging of sites.

139. The construction of canals through two districts namely Kurunegala and Mathale will involve many construction sites. In the preliminary planning under feasibility stage it is proposed to offer the canal construction from diversion point in Dambulu Oya to Mahakithula tank under 3 contract packages.

140. The canal in this reach traverses through several villages and prior to initiating construction 68 number of families living within the canal trace will need to be relocated. This is an operation which has to be carefully planned and executed to avoid public complaints. When the canal construction is in progress, adequate safety measures recommended by safety expert have to be provided by the contractor and executing agency to prevent accidents like children falling to the excavations.

141. When the canal is traversing through the sanctuary side slopes of the canal have to be designed to avoid wild animals falling in to canal. Another important aspect that will be necessary is not to disturb the migratory paths and patterns of wild animals. The design team has proposed to cover deep sections with concrete cover and then earth fill on concrete. Furthermore, canal sections for animal crossings have been designed. The details of canal sections (open canal and cut and cover sections) and lengths are given in Annexure VI-I.

Access Roads

142. One of the main features of this project is the long water conveyance canal form Dambulu Oya to Mahakithula Tank in Kurunegala District. There will be an operation and maintenance road along the canal which will be a gravel road. Villagers will be allowed to use it as an access road except the part of road that traverses through the sanctuary. The section of the road traversing through the sanctuary will be used by Departmental Staff for routine maintenance work. Where the canal passes through human settlements villagers will need bridges across the canal. Location of these bridges will be finalized only after the discussions with beneficiaries during the detailed design stage.

Along the tank bunds there will be road on top of the bund and along the downstream toe for operation and maintenance purposes.

Following access roads have been planned during construction phase of two reservoirs (Mahakithula and Mahakirula) and tunnel.

Herathgama – Mahakithula	-	2.2 km
Herathgama – Pothuwila	-	2.6 km
Pothuwila – Mahadambe	-	2.4 km
Pothuwila – Mahakithula	-	4.6 km
Mahakithula – Tunnel site	-	4.2 km

Materials to be used in the construction

143. The major quantities of materials needed for the project are given the following table. The most predominant material is earth as the construction involves two major tanks and a diversion canal and main canals.

144. Earth for the construction of dams will predominantly be obtained from the borrow areas located in the tank beds, which will be inundated when the reservoirs will be impounded. For canals earth cut and fill sections will be designed as cut material will be used as fill material when the quality of earth is suitable. Any excess material will be dumped along the canal trace temporarily. These materials will be allowed to be transported by the nearby residents for their earth fills. The experience of the Irrigation Department in the construction of Deduru Oya project is that all excess material was used by the residents and schools in the vicinity for construction.

145. Rock quarries have been identified by the material investigation team to establish rock quarries. Identified quarries are depicted on the attached project map. Other materials such as cement, reinforcements and steel gates will be procured from reputed suppliers as per government regulations or as agreed in the contract documents.

Table 2-4 Major Quantities

Major Quantities involved in the Project			
Description	Unit	Quantity	Source
Canal from Dambulu oya to Wemedilla **Stage II**			
Earth and rock excavation	m3	197,657	Canal base
Earth filling and compaction	m3	148,725	Excavated material from canal excavation and borrow areas if the quality of excavated material is not recommended.
Turfing canal banks	m2	31,193	Nearby borrow sites
Concreting	m3	22,620	Aggregates from quarry sites/local purchase
Rip rap protection	m3	1,479	Boulders from quarry site
Canal from Wemedilla to Nebadagahawatta **Stage I**			
Earth and rock excavation	m3	86,777	Canal base

Earth filling and compaction	m3	42,651	Excavated material from canal excavation
Turfing canal banks	m2	41,778	Nearby burrow sites
Concreting	m3	13,166	Aggregates from quarry sites/local purchase
Rip rap protection	m3	241	Rock quarries and excavated rock
Canal from Nebadagahawatta to Mahakithula **Stage I**			
Earth and rock excavation	m3	2,107,193	
Earth filling and compaction	m3	30,035	Excavated material from canal excavation and burrow areas
Turfing canal banks	m2	1,241	Nearby burrow sites
Concreting	m3	35,535	Aggregates from quarry sites/local purchase
Tunnel Section **Stage I**			
Rock excavation	m^3	9,721	Tunnel
Concreting	m^3	1,753	Aggregates from quarry sites/local purchase
Mahakithula Main Dam **Stage I**			
Main dam			
Earth and rock excavation in	m3	121,210	dam axis

foundation			
Earth fill	m3	878,800	Excavated suitable material and borrow sites
construction of clay core	m3	277,593	designated areas of construction drawings
Rip rap protection	m3	36,384	Excavated rock in the dam and rock quarries
Graded aggregate	m3	311	Rock quarries and local purchase
sand and gravel fill	m3	22,326	Local purchase
Turfing slopes	m2	29,420	Tank bed and burrow areas
Concrete	m3	35,535	Aggregates from quarry sites/local purchase
Mahakithula Saddle dam Major Quantities **Stage I**			
Saddle Dam			
Earth and rock excavation	m3	18,327	
Earth fill	m3	93,382	Suitable excavated material and reservoir bed
construction of clay core	m3	27,393	Designated areas in the dam axis
Rip rap protection	m3	6,770	Excavated rock in the dam and rock quarries
Graded aggregate	m3	3,385	Rock quarries and local purchase
sand and gravel fill	m3	5,219	Local purchase
Turfing slopes	m2	5,352	Tank bed and burrow areas
Concreting	m3	40,039	Aggregates from quarry sites/local purchase
Canal from Mahakithula to Mahakirula **Stage I**			
Earth and rock excavation	m3	257,528	

Concreting	m3	3,952	Aggregates from quarry sites/local purchase
Canal from Mahakirula to upper Mi oya **Stage I**			
Earth and rock excavation	m3	609,916	
Earth filling and compaction	m3	3,001	Excavated material from canal excavation and burrow areas
Concreting	m3	18,363	Aggregates from quarry sites/local purchase
Mahakirula Reservoir Major Quantities **Stage I**			
Main dam			
Earth and rock excavation	m3	32,345	dam axis
Earth fill	m3	265,736	Suitable excavated material and reservoir bed
construction of clay core	m3	84,264	Excavated rock in the dam and rock quarries
Rip rap protection	m3	9,419	Excavated rock in the dam and rock quarries
Graded aggregate	m3	4,709	Local purchase
sand and gravel fill	m3	6,789	Local purchase
Turfing slopes	m2	7,649	Tank bed and burrow areas
Mi Oya Main Canal from Galgiriyawa to Kaduruwewa , Main Canal from Mahakithula Bifurcation to Mi Oya , and Feeder Canal from Wavulawa to Upper Mediyawa **Stage II**			
Earth excavation	m3	1,307,100	Canal trace
Rock excavation	m3	110,711	Canal trace
Earth Fill	m3	61,542	Excavated material from canal excavation and

			burrow areas
Turfing	m2	10,742	Nearby burrow sites
Concreting	m3	33,668	Aggregates from quarry sites/local purchase

Table 2-5 Reservoir Parameters

Parameter	Mahakithula Reservoir main dam	Mahakithula Reservoir saddle dam	Mahakirula Reservoir
Maximum height (m)	26.4	11.2	23.8
Material	Homogenous earth fill	Homogenous earth fill	Homogenous earth fill
Inundation area at FSL (ha)	190		152
Storage capacity (MCM)	14.9		10.7

Table 2-6 Land use of potential borrow sites

No	Component	Land use of potential borrow sites
1	Canal from Dambulu Oya to Wemedilla	Earth –Nearby unused lands Turf – From coconut estates Aggregate – From rock quarries
2	Canal from Wemedilla to Nebadagahawatta	No earth is required Turf – From coconut estates and paddy fields Aggregate – From rock quarries
3	Canal from Nebadagahawatta to Mahakithula	No earth required. Turf – From coconut lands and bare lands Aggregate – From rock quarries
4	Mahakithula main and saddle dams	Earth – From degraded teak plantation in tank bed. Turf – From bear lands and coconut lands Aggregate – From rock quarries and tunnel excavations
5	Mahakirula dam	Earth – From degraded teak plantation in tank bed. Turf – From bear lands and coconut lands Aggregate – From rock quarries
6	Canal from Mahakirula to upper Mi Oya	No earth is required Turf – From coconut estates and paddy fields Aggregate – From rock quarries
7	Mi Oya Main Canal from Galgiriyawa to Kaduruwewa ,	No earth is required Turf – From coconut estates and paddy fields

	Main Canal from Mahakithula Bifurcation to Mi Oya , and Feeder Canal from Wavulawa to Upper Mediyawa	Aggregate – From rock quarries and excess rock excavated in the canals.

2.2.5 Methodology of Operation

146. In major and medium irrigation schemes, reservoirs are managed by the Irrigation Department. However, a joint management system (Committee) is implemented in the irrigation system where government officials and farmer organization representatives collectively make decisions and execute. Apart from seasonal issues, there will be social and environmental releases. The amount of such release will be discussed between officials and stakeholders depending on the current flow and the amount of water reserved in the reservoir. Assessments of impacts on natural rivers are discussed in Chapter 4.

147. There are cascades of village reservoirs in the Hakwatuna Oya and Upper Mi Oya basins. These reservoirs supply irrigation water and water for domestic use. These reservoirs also keep the ground water table at a shallow elevation to feed domestic wells.

148. The water distribution schedules must be designed to cater the need of these reservoirs. As per the available cultivation data, Maha season (wet period of the year from December to March) is managed with water collected from the catchment, and additional irrigation water supply is required during the Yala cultivation season. It is reported that the average cropping intensity of village schemes in these basins is 0.9. The project envisages increasing it to 1.4. In major and medium schemes the CI will be increased to about 2.0. See table 4.7.

149. Seasonal water issues will be based on the deficit requirements of the village reservoir cascades which will be collectively decided with respective farmer organizations. Maintenance and repairs of the diversion canal and major reservoirs will be the responsibility of Irrigation Department. The irrigation Department will prepare a maintenance schedule each year and ensure timely execution. However, decisions will be transparent to other agencies such as farmer organizations that are benefitting from the diversion through joint management committees.

2.2.6 Project Cost, Investment and Funding Sources

150. The total estimated cost of the project cost Rs 12.85 billion. The investment will be financed through a loan from the Asian Development Bank and the Government of Sri Lanka

Implementation Programme
NWP Canal Project

Stage	Package No.		Project Component	2015	2016	2017	2018	2019	2020
Stage I	1	a	Wemedilla tank new sluice (8 cumec)						
		b	Tail canal from new sluice to Wemedilla LBMC (0.60 km)						
		c	Improvements to Wemedilla LBMC up to Nebadagahawatta (5.25km)						
	2	a	Extension of Wemedilla LBMC from Nebadagahawatta to Mahakithula Tunnel inlet (5.25 - 23.10 km.)						
	3	a	700 m long Inlet Tunnel to Mahakithula Tank						
		b	Mahakithula tank and downstream Bifurcation						
		c	Mahakirula Tank and downstream Bifurcation						
		d	Feeder Canal from Mahakithula to Mahakirula (3.66 km)						
		e	Mahakirula Tank to Mi Oya RB1 Canal (13.73 km)						
Stage II	4		Dambulu Oya diversion structure and main canal to Wemedilla LBMC (8.68 km)						
	5		Mi Oya RB 2 Canal (extension of RB1) (7.5 km)						
	6		Upper Mediyawa Feeder Canal from Pothuwila tank (19.9 km)						
	7		Yapahuwa Canal (13.7 km) from Upper Mediyawa Feeder Canal						

CHAPTER 3

3. DESCRIPTION OF EXISTING ENVIRONMENT

3.1 Physical Environment and Topography

151. The proposed NWP canal starts from a point in Dambulu Oya (in the Mahaweli Basin), downstream of Bowatenna tunnel outlet. The exact point of diversion is about 1 km downstream of the tunnel outlet. A new diversion weir will be built at this location. The diversion canal starting from this weir will travel on an approximate contour and crosses Kahalla Pallekele sanctuary in Kurunegala District. Water will be stored in the proposed Mahakihtula reservoir (restored) and rehabilitated Mahakirula reservoir, and released to upper Mi Oya and Hakwatuna Oya (a sub basin of Deduru Oya basin) basins.

152. The project area lies in the central and north western provinces and forms part of the strongly dissected northern spine of the central highlands. The topography is rugged and rises to over 760 m in Knuckles range. The area lies across central drainage divide separating Kala Oya, Mi Oya and Deduru Oya drainage basins from the broad low lying Mahaweli Basin.

153. Direct project benefit area lies in Kurunegala District. The benefit area falls within two river basins namely Deduru Oya and Mi Oya. Hakwatuna Oya sub basin, which will directly benefit from the project, is a sub basin of Deduru Oya basin. As shown in the climatic zones map appearing below, Kurunegala District falls within intermediate and dry zones. The project benefit area lies both in intermediate and dry zones.

154. As evident from drought related crop losses map in Figure 3.1 below, Kurunegala District suffers high to moderate losses. Therefore, a reliable supply of irrigation water is a need for the District.

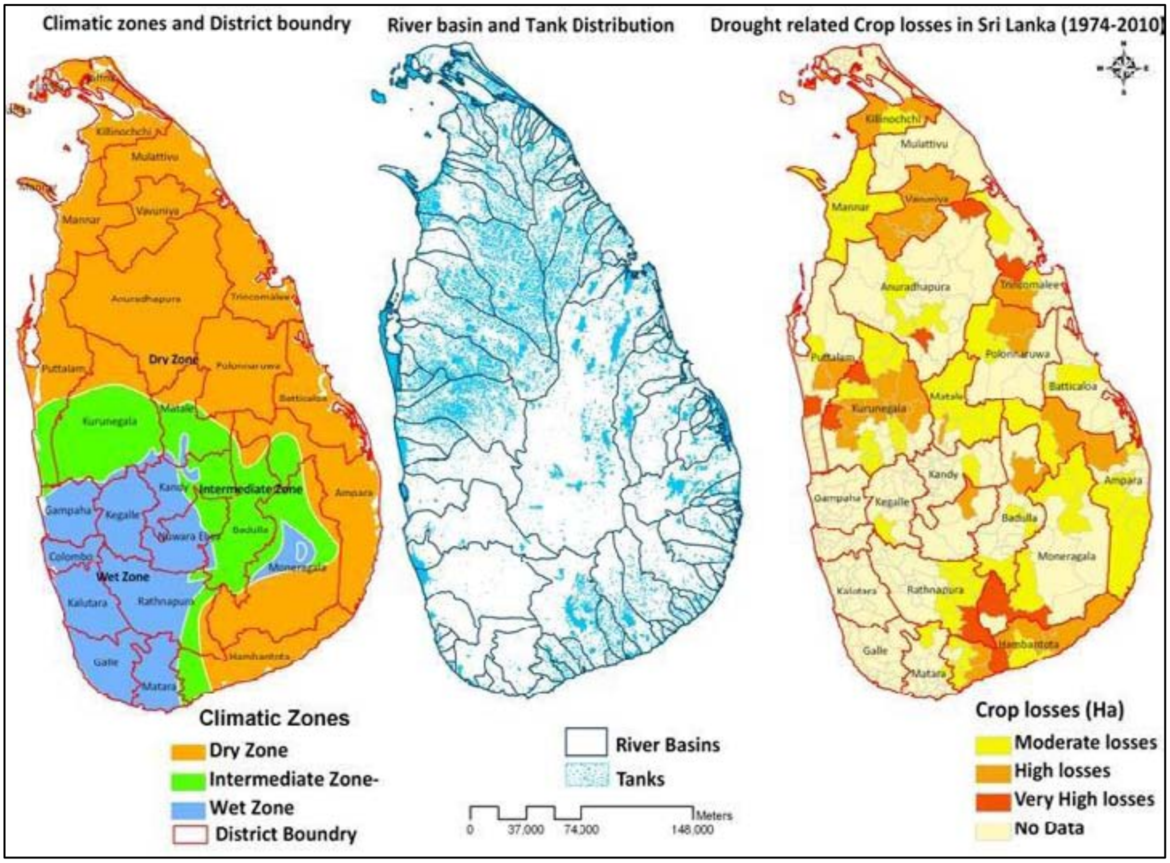


Figure 3-1 Climatic Zones, River Basins, Reservoirs and Drought related crop losses

155. Three major climatic zones, river basins and tank distribution and drought related crop losses; Source: Dept. of Agriculture, Irrigation Dept. and Desinventar (www.desinventar.lk)

3.1.1 Geology and Soils

156. The project area covers from west to east, the wanni and associated complexes; the highland complex; and the Wijayan complex. Approximately half of the project area is underlain by rocks of the highland complex, with the wanni complex present in the western part and the Wijayan only in the extreme eastern part.

157. The proposed NWP canal takes off Dambulu oya near Bowatenna tunnel outlet at Lenodara. The geological map of the proposed diversion is given in the Figure 3.2. The 1stKm of the canal lies within high calcite marble area geologically and then falls into orthogenesis, crosses a fault at 5+300 Km continues up to 7+200 Km in the same Geological area. From there on canal crosses Granatic Gneiss, massive quartzo – feldspainic Gneiss up to 7+950 Km and then passes through narrow pure quartz vein from 7+950 Km to 8+050 Km continues up to 8+500 Km over Garnet-Sillimante-biotote Gneiss Geological area. From there on, the canal falls into existing Devahuwa feeder canal.

158. Devahuwa feeder canal lies within Hornblende-biotote Gneissic area up to 4 Km while passing through quartz patch from 3 Km to 3+150Km. From 4+00 Km up to 6+500 Km canal passes over Biotote-

hornblende Gneissic area and then again crosses Hornblende – Gneissic area up to 8+100m then passes over quartzofeldspathic area while crossing the narrow patches of quartzite from 9+150m to 9+250 Km and again from 9+550Km to 9+900Km. Then the canal passes over Hornblende Gneissic area from 9+900 km to 10+800 km and then again enters quartzofeldspathic Gneissic area continue up to 11+900 Km, then passing narrow patches of quartzite and Granatic Gneiss enters again Hornblende Gneissic area at 12+200 Km, continues up to 13+300 Km and enters Biotite hornblende - Gneissic area continues up to 15+000 Km and then crossing a narrow patches of quartzite and again enters Hornblende Gneissic area at 15+150 Km and continues up to 16+750 Km and enters impure quartzite area continue up to 17+450 Km and then enters Charnokite biotite Gneiss and continue up to 22+450 Km then again enters Hornblende Gneissic area.

159. At 23+617 Km the canal enters proposed Mahakithula wewa Reservoir, from Mahakithula wewa Reservoir a diversion canal to Mahakirula wewa stretches over 4.42 Km while passing Mahadambe wewa. In this 4.42 Km the canal passes over Garneliferrous Quarozofeldspathic Gneiss area which is heavily weathered to iron rich deposits containing Kaolin. Moreover within this reach canal crosses three quartzite patches. It can also be noted that the canal passes shear zonesat the chainages 3+500km, 8+500km where existing Devahuwa Feeder canal takes off Wemedilla wewa.

160. Due consideration need to be given to tunnel (Pothuvila) lying from 22+450 km to 22+800km. which is geologically most important. As revealed from the preliminary investigations the tunnel axis starting from low elevation and runs through a hillock with maximum elevation of 20-22m and at the central part is composed of wedge shaped quartzite with maximum thickness of 15m that coincides with the crest of the ridge.

161. The start and end locations of the tunnel trace indicate the presence of bedrock presumably gt-bt-Gneissic rock. It can be deduced that the existence of quartzite material is due to its weather resistant nature compared to other rock types. Also at the proposed inlet and outlet portal areas of the tunneled section no fracture free bedrock has been observed in the preliminary investigations. These important geological features will have to be given due consideration in the case of design and framing the proposals for treatment.

162. However, it is vital to carryout detailed geological investigation at the tunnel trace prior to detailed design. Depending on the outcome of detailed investigations it may be necessary to strengthen the weak areas by Shot-creting, Grouting, Anchor bolting and lining etc. The proper design and treatments would eventually reduce the leakage into the tunnel and from the tunnel and thereby reduces the undue lowering of Ground water table in that area. This way the flora and fauna of the area would not be adversely affected.

163. The dam site of the Mahakirula Reservoirs on weather resistant quartzite as revealed from the geophysical investigation. Mahakitula dam axis mainly consists of quartzite material and the rest is a weathered profile with gradual weathering down to a bed rock GT-BT gneissic rock. Mahadambe being an existing small reservoir proposed to be extended & lying in between Mahakitula and Mahakuriula

also mainly consists of quartzite materials and quartzite formations are observed at high elevated ground.

164. High amounts of water seepage are evident through formations close to the spill. This requires further investigation to finalize the design & foundation treatments. The proposed dam axis runs across existing Mahakirulawewa, the area which is mainly composed of quartzite materials and leakages are observed at the dam which would have cropped up from the fractured quartzite formation existing underneath the dam axis. Hence, more investigations are required during detailed design.

165. All three sites mentioned above are within the Kahalla Pallekele sanctuary and, therefore needs due attention geologically to minimize the negative environmental effects such as undue lowering and raising of ground water table and occurrence of landslides due to raised ground water table and unstable slopes. Removing all unstable rock boulders and stabilizing the unstable rock slopes, especially in the event of raised G.W.T. would be necessary to mitigate negative impacts and protect the environment.

Please refer Annexure VI – II for Geology maps.

3.1.2 Climate and Meteorology

166. Monthly rainfall data of the study area from 1971 to 2010 had been collected from Water Management Secretariat, ID and the Meteorological Department, while long term evaporation data of nearby meteorological stations have been used. Standard methods have been used in the case of fill-in and extending the rainfall reference base.

167. A detailed meteorological and hydrological study has been carried out for the NWP area to provide basic data necessary for the planning and design of the infrastructure for the proposed conveyance system. The basic data includes computed long-term inflow series for the existing and proposed irrigation reservoirs and the climatologic and meteorological data for the irrigation systems.

168. Sri Lanka receives rainfall mainly from the North-East and South-West monsoons. The island is divided in to three climatic zones namely, Wet, Intermediate and Dry Zones depending on the amount of rainfall received from the monsoon. The project area lies in the Dry and Intermediate Zones, major part of the rainfall is received during October to January from the N-E monsoon (Maha season) and in April and May during Inter Monsoon period.

169. Six meteorological stations in and around the study area have been selected in the analysis and their monthly average rainfall, and monthly average tank evaporation data are given in the table 3.1

Table 3-1 Rainfall and Evaporation Data

A. Monthly Rainfall in mm

Rainfall	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Nalanda	189	96	91	185	78	44	43	49	79	240	309	301	1,704
Kalawewa	85	52	65	158	68	15	29	28	64	210	252	199	1,225
Millawana	129	72	87	200	114	79	63	63	103	294	346	231	1,780
Galgamuwa	61	46	89	171	95	33	25	25	85	271	254	135	1,289
Pelwehera	128	80	79	192	73	16	25	30	65	242	283	260	1,472
Mediyawa	68	48	83	186	92	29	33	29	66	254	249	138	1,274
NWP	104	66	84	189	95	44	42	40	81	261	286	193	1,486

B. Monthly Evaporation in mm

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Kalawewa	98	104	131	123	137	145	152	155	158	121	101	96	1,521
Batalagoda	93	103	116	100	94	92	93	104	106	95	78	87	1,162
Tabbowa	90	96	121	113	116	120	125	138	130	109	84	82	1,323

Source: NWP Canal Project – Feasibility Report- September 2013

It can be seen from Table 3.1 that rainfall exceeds evaporation during April and October- December. Therefore, in general terms, water storage and distribution is required to meet the water requirements of other months.

3.1.3 Current Status of Hydrology

3.1.3.1 Surface Water

170. As shown by the Figure 3.3 the area to be benefitted falls in Mi Oya (95), Deduru Oya (99) and Kala Oya (93) basins. Considering the cropping intensities of the irrigation systems, all three river basins are under water-stress. However, parts of Kala Oya basin is benefitted by Mahaweli water diversions. Deduru Oya basin is benefitted by the recently constructed Deduru Oya reservoir. These three rivers record very low flows during June-August.

171. Nalanda reservoir was built across Nalanda Oya in mid 1950s, with the objective of augmenting supply to Kalawewa (currently Mahaweli System H) (Nandalal and Ratnayake, 2001). Nalanda Oya is a tributary of Amban Ganga. At present, the impounded waters are mainly used to augment supply to Dewahuwa and Wemedilla schemes, by diverting water at Ebbawala regulator, to Welamitiya Oya. The spill waters of Nalanda feed Bowatenne reservoir (NWP Water Balance Study). The Nalanda reservoir capacity is not fully utilized due to structural weaknesses of the dam, but it is proposed to be repaired under the ongoing Dam Safety and Water Resource Project (DSWRP) funded by the World Bank. The rehabilitation work is expected to be completed by 2015

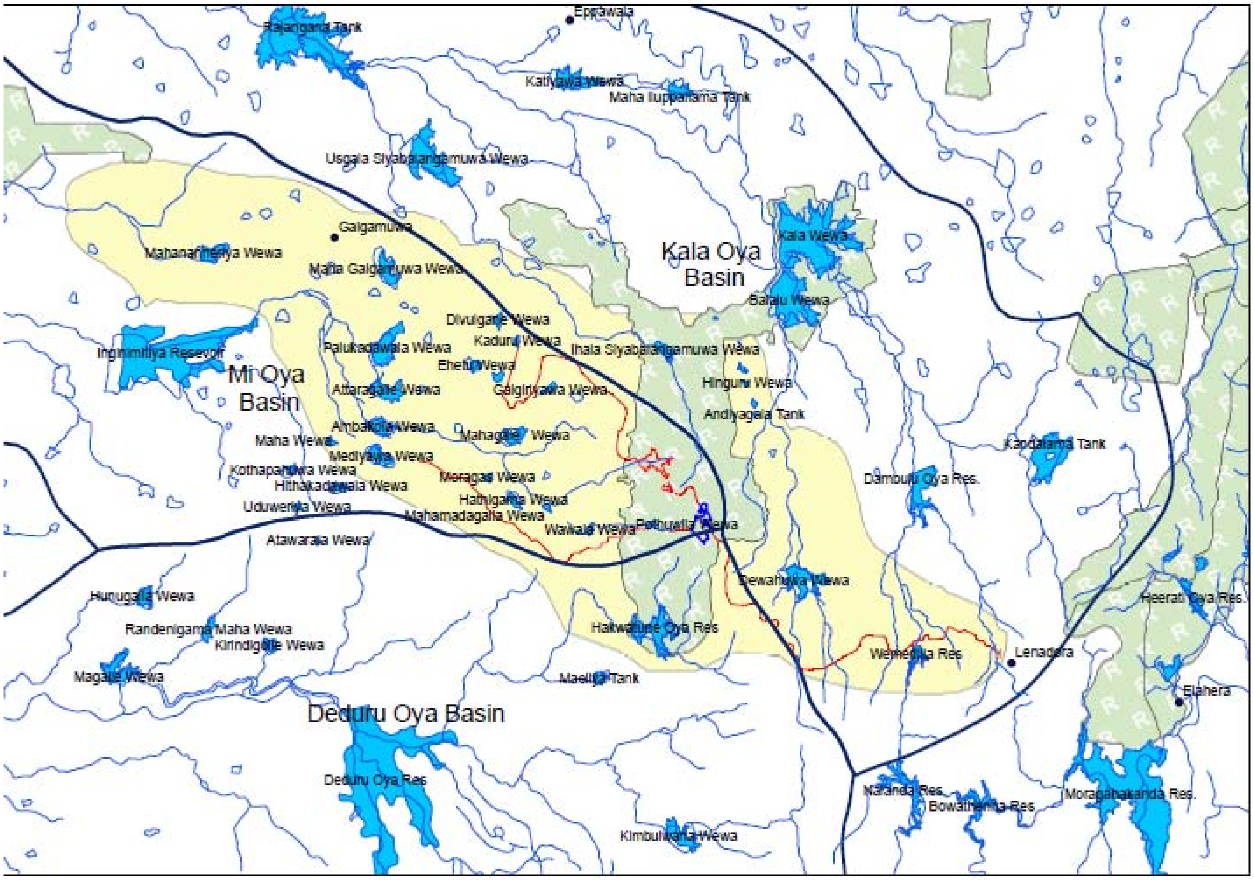


Figure 3-2 Major River Basins in the project area

3.1.4 Groundwater

172. According to the classification of Panabokke[6], the groundwater aquifers in this area can be classified as "regolith aquifer" (Figure 3-3). This aquifer is highly dependent on the small tank cascades and their water levels.

[6]Ground water acquifers in Sri Lanka – Panabokke and Perera 2005

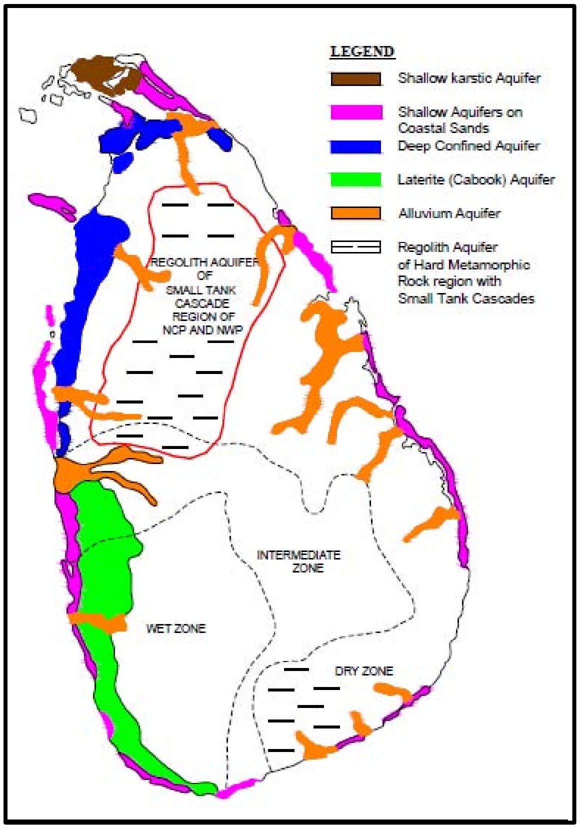


Figure 3-3 Groundwater aquifers in Sri Lanka

3.1.5 Surface Water Quality

173. There have been several studies in the Mahaweli River and associated irrigation systems. Some selected studies are cited below:

a. Quality of irrigation water in Sri Lanka:

This study had been carried out in 20 irrigation reservoirs, eight of them in the Mahaweli basin. Data had been collected from the previous studies and from institutions such as National Water Supply and Drainage Board (NWS&DB) and it is difficult to assign a specific period for the data set. The study has focused on agriculture and used salinity hazard measured by total soluble salt content, sodium hazard measured by relative proportion of sodium ions to other locations, total alkalinity related to calcium and magnesium concentration and toxicity as criteria. It is noted that high alkalinity combined with high Sodium Absorption Ratio (SAR) increases the sodium hazard.

174. The following observations by Silva[7] are highly relevant to the current study:

- The SAR appears to rise when water level is low.

[7] Quality of irrigation water – status and trends, Asian Journal of Water, Environment and Pollutin Volume I No 1 and 2 (2004)

- None of the irrigation reservoirs SAR exceeding the recommended threshold values
- Low salinity and corresponding low SAR in Kalawewa and Kantale tanks can be attributed to dilution resulting from transfer of water via Bowatenne
- EC (a predictor of salinity) of Parakrama Samudra and Minneriya (receiving mainly Ambanganga waters) indicate no significant increase of TDS during the 43 years studied, and well below the threshold value
- In contrast EC has decreased since trans-basin diversion of Mahaweli river to dry zone in mid 1970s
- High evaporation in the downstream reservoirs could prevent dilution of total dissolved solids (TDS)

175. Studies have been carried out at Polgolla pool (Bandara et al (undated), NWS&DB (2012), De Silva/FAO (undated) and the results indicate that water quality has deteriorated there mainly due to the flow of agricultural waste from upstream. However, there is an intake of NWS&DB at Polgolla, and water quality is monitored there. Another point to consider is that water from Polgolla passes through Ukuwela Power House and a tunnel and a natural canal before the proposed diversion to NWP. As such, there could be positive impacts on the water quality due to aeration. However, to assess the magnitude of benefit, a detailed water quality survey including the data from critical locations, NWP area, and the temporal distribution has to be made.

b. Quality of receiving water

176. The main source of water for NWP canal is Bowatenna Reservoir. 100 MCM of water will be extracted from this reservoir to be transferred to NWP. Water quality parameters of Bowatenne reservoir immediately upstream of the diversion point to NWP Canal are given in the table

Table 3-2 Water quality of Bowatenna Reservoir

Parameter		pH	EC µS/cm	Salinity TDS (mg/l)	SAR (high level	SAR (low level)	Chlorides (CL$^-$)mg/l	Sulphates (SO_4^-)mg/l
	Observed value	7.19-8.19	84-90	98	0.199	0.545	6.92-97.90	3.68-97.9
Specified limits	Drinking water with simple treatment	6.0-8.5		-			200 (max)	250 (max)
	Bathing water	6.0-9.0						
	Irrigation	6.0-8.5	700 (max)	500	6-15	6-15	100 (max)	1000 (max)

Source: E I L Silva[8]

[8] Silva, E.I.L, 2004. Quality of irrigation water in Sri Lanka- Status and trends. Asian Journal of Water, Environment and Pollution. Vol1. No.1&2. Pp.5-12

TDS – Total dissolved solids, SAR- Sodium Absorption Ratio, High level –reservoir at high water level, Low level – reservoir at low water level

3.2 Biological Environment

3.2.1 Presence of Protected Areas (PA)

177. The proposed North Western Province canal, 78.6 km in length, passes mainly through man-modified habitats such as home gardens, paddy fields, agricultural lands and a single protected area, Kahalla-Pallekele Sanctuary which includes part of previously declared forest reserves, Kahalla and Pallekele. Table 3.3 shows the extent of forest reserves and the sanctuary in the proposed project area. The Kahalla-Pallekele Sanctuary and Forest reserve complex have been established primarily to protect the catchment of Deduru oya, Mi oya and Kala oya. It is also one of the few protected areas present in the north-western province of Sri Lanka. All the proposed project activities take place in the Kahalla-pallekele Sanctuary. Neither, the Forest Department or Department of Wildlife Conservation has have a management plan for the Forest reserves or the Sanctuary. Therefore the proposed project activities have been discussed in detail with Forest Department and DWC staff to obtain their views of the proposed project activities that will take place within the Sanctuary. Based on these discussions it has been agreed to realign the existing electric fence to the edge of the human settlement to enhance the area available for elephants and carry out enrichment planting in the teak planted area in order to enhance the carrying capacity of the Sanctuary that can compensate for the loss of habitat (approximately 340 ha) arising due to the establishment of the two reservoirs Maha Kithula and maha Kirula.

Table 3-3 Forest Reserves and protected areas located within the project area.

Name	Category	Extent (ha)	District	Date Declaration
Ma Eliya	FR	381.2	Kurunegala	02. 08.1935
Kahalla	PR	34.0	Anuradhapura	
Kahalla	FR	3292.5	Anuradhapura	11.10.1935
Pallekele	FR	12,721.4	Kurunegala	04.02.1896
Kahalla- Pallekele	S[1]	21,690.0	Kurunegala/ Anuradhapura	11.07.1989

FR - Forest e, PR - Proposed Forest Reserve, S - Sanctuary

Part of Kahalla and Pallekele Forest Reserves are found within the Kahalla- Pallekele Sanctuary

Table 3.4 shows the length of canal sections passes through different types of habitats.

Table 3-4 Chainages and the main habitats along the NWP canal sections

Sections	Chainage (km)	Length (km)	Land use	Name of FR
Main Diversion Canal (Dambulu oya to Wemedilla reservoir)	0- 7.820	7.820	Paddy, home gardens, scrublands, Chena, degraded forest	None
Canal from Wemedilla new Sluice	0- 0.560	0.560	Paddy, home gardens, scrublands	None
Existing Devahuwa feeder canal	0- 5.150			None
Canal from Nebadagahawatte to Mahakitula	5.150-23.940	23.940	Paddy, home gardens, scrublands, Chena, degraded forest, coconut, Teak, other plantations	Kahalla Forest Reserve/ Kahalla Pallekele Sanctuary (only 2.8 km within the sanctuary including the tunnel 700 m)
Canal from Mahakitula to Pothuwila tank	0- 1.490	1.490	Forest, home gardens, scrublands, coconut, cashew	Pallekele Forest Reserve/ Kahalla Pallekele Sanctuary
Canal from Mahakitula to Mahakirula tank	0- 3.660	3.660	Forest, scrublands, Teak	Kahalla Forest Reserve/ Kahalla Pallekele Sanctuary
Canal from Mahakirula to Upper Mi oya	0-21.230	21.230	Forest, Scrublands, Paddy, home gardens,	Kahalla Forest Reserve/ Kahalla Pallekele Sanctuary (only 5 km within the sanctuary)
Canal to Mediyawa cascade system	0-19.900	19.900	Paddy, home gardens, scrublands, coconut	None
		78.600		

3.2.2 Ecological Resources – Flora

178. The project area encompasses two floristic regions: 'Northern Intermediate Lowlands' and ‘Dry and Arid Lowlands’. The typical natural vegetation type expected to be found in the northern intermediate lowlands is Tropical Moist Semi-Evergreen Forest (*Filicium-Euphoria- Artocarpus- Myristica* series). Tropical dry-mixed evergreen forests, *Manilkara* community, mixed community (*Chloroxylon-Vitex-Berrya-Schleichera* series), Tropical thorn forests (*Manilkara-Chloroxylon-Salvadora-Randia* series), Damana and Villu grasslands, Flood-plain wetlands, riverine and gallery forests are found in the dry and arid lowlands floristic region. The project area is situated in the intermediate and dry zone of the country and the habitat types such as dry-mixed evergreen forest (undisturbed and degraded), scrublands, degraded Teak plantations established by the Forest Department, rock outcrop vegetation in

the hills (e.g. Galkiriyagama), and riverine forests along the banks of streams are found in the project area. Home gardens, agricultural croplands, paddy fields and seasonal tanks are man modified habitat types in the area.

179. Agro-ecologically this area belongs to the IM3b (intermediate mid country), IL3 (intermediate low country), and DL1 (dry- lowlands) agro ecological zones having undulating terrain with Reddish Brown Earths and Low Humic Gley Soils. The average annual rainfall is 1000 to 2000 mm and the north-east monsoon (October- January) brings more rain to this area. The mean annual temperature is > 27.5 ^{o}C and the altitude of the project area varies from 217 to 103 m above mean sea level.

(a) Methodology

180. Although the research methodologies have been addressed in a separate chapter above, it is noteworthy to mention specific methods adopted for ecological surveys. A reconnaissance survey was carried out to identify the sites selected for the project activities (canal trace, proposed reservoirs Mahakitula and Mahakirula in Kalahalla- Pallekele sanctuary, resettlement areas, and areas to be irrigated under the project) and to determine the major habitats/vegetation types. Information gaps in ecological aspects of the project were identified. Moreover, a sample study was required to ascertain the quality and extent of habitats/ vegetation types and their locations.

181. A detailed field investigation was carried out at the identified project locations to prepare a species inventory of the different habitats/ vegetation types; to identify endemic and endangered fauna and flora and to understand impacts of proposed project activities on the ecology. The line transect survey method (100 x 5m) was used to enumerate the plant diversity in the project area. The coordinates of the line transects were recorded. In addition an opportunistic data collection was done wherever possible outside line transects and sampling plots in order to ensure complete documentation of the fauna and flora in the area. Secondary information on biodiversity and environmental issues were collected through personal communication with villagers and relevant officers. This was also done by reviewing published documents and unpublished data. In addition, photographic records were made of the visual aspects of biodiversity. Lists of plants were prepared with reference to different habitats / vegetation of the study area. The major natural vegetation formations found in these areas are dry-mixed evergreen forest (undisturbed and degraded) and scrublands.

182. Species identification was based on latest literature available for flora {Dassanayake, and Clayton, (1996 - 2000), Dassanayake, and Fosberg, (1980) and (1981 - 1991) Dassanayake, *et al*., (1994 - 1995) and (2006)} of Sri Lanka. The nomenclature of the species present was based on Senaratna, L.K. (2001). The conservation status of the species was determined according to National Red List 2012 of Sri Lanka) and Global (IUCN (2013) IUCN list of threatened fauna and flora.

Habitats of the Project Area

183. The major natural habitats found in the project area are relatively undisturbed dry-mixed evergreen forests, degraded dry-mixed evergreen forest (secondary forest), scrublands, and riverine forests on the banks of streams. In addition, teak and eucalyptus plantations, damaged by elephants, are found within Kahalla- Pallekele Sanctuary.

184. Relatively undisturbed dry-mixed evergreen forest is found in the area around Mahakirula tank (152 ha) and the canal trace within Kahalla- Pallekele Sanctuary. The habitats found in the area of Mahakitula proposed reservoir (172 ha) are degraded dry-mixed evergreen forest, scrublands and elephant damaged teak plantations. The canopy of dry-mixed evergreen forest consists of trees such as– *Manilkarahexandra* (Palu), *Alseodaphne semecarpifolia* (Wewarana), *Vitex altissima* (Milla), *Syzygium cumini* (Madan), *Pleurostylia opposita* (Panakka), *Schleichera oleosa*(Kon), *Dialium ovoideum* (Gal Siyambala), *Chloroxylonswietenia* (Burutha), *Pterospermum suberifolium*(Welan), *Berrya cordifolia* (Halmilla), and *Diospyrosebenum* (Kaluwara). *Drypetes sepiaria* (Wira) forms the sub-canopy of these forests. The understorey vegetation includes medium sized trees such as *Diospyros ovalifolia* (Kunumella)*, D. ferrea, Limonia acidissima, Nothopegiabeddomei*and shrubs such as *Ochna lanceolata* (Kera)*, Tarenna asiatica* (Tharana)*, Memecylon angustifolium, M. capitellatum, M. umbellatum, Mallotus resinosus, Croton laccifer* and *Dimorphocalyx glabellus* (Thenkuttiya).

185. Some forest patches in the project area are degraded forests owing to forest clearance for chena cultivation[9] and removal of canopy and sub canopy trees. After the abandonment, these lands have been colonized by pioneer species such as grasses and scrub vegetation. The degraded areas have not converted back to the closed -canopy forests through natural succession and these could be regarded as scrublands. Species such as *Bauhinia racemosa* (Maila), *Carissa spinarum* (Karamba), *Catunaregam spinosa* (Kukuruman)*, Dichrostachys cinerea, Flueggea leucopyrus* (Katupila), *Gmelina asiatica* (Demata), *Grewia orientalis, Hugonia mystax, Ichnocarpus frutescens, Lantana camara* (Gandapana)*, Memecylon umbellatum, Phyllanthus polyphyllus* (Kuratiya)*, Scutia myrtina, Syzygium cumini* (Damba), *Toddalia asiatica* (Kudumiris)and *Ziziphus oenoplia* were recorded from the scrublands.

186. There are narrow strips of riverine forests found along the banks of streams such as Irudeni oya. *Terminalia arjuna* (Kumbuk) is the most common riverine species. Other species such as *Polyalthia longifolia*, *Madhuca longifolia*, *Diospyros malabaricum* (Timbiri), *Nauclea orientalis* (Bakmi) *Diospyros ferrea, Pongamia pinnata* (Karanda), *Hydnocarpus venenata* (Makulla), and *Vitex leucoxylon* (Nebada), are found in these forests.

187. The rock outcrops and associated vegetation in Galgiriyakanda proposed forest reserve consists of trees such as *Diospyros ebenum* (Kaluwara), *Diospyros nummulariifolia*, *Diospyros ovalifolia* (Kunumella), *Drypetes sepiaria* (wira), *Vitex altissima* (Milla), *Pterospermum suberifolium* (Welan), *Manilkara hexandra* (Palu), *Chloroxylon swietenia* (Burutha), *Wrightia angustifolia, Cassia fistula* (Ehela),

[9] Slash and burn cultivation

Alseodaphne semecarpifolia (Wewarana), *Walsura trifoliolata* (Kirikon), and *Strychnos nux-vomica* (Goda-Kaduru). The understorey of the forest is consist of species such as *Polyalthia korinti* (Ulkenda), *Carissa spinarum* (Heen Karamba), *Carmona retusa* (Heen Thambala), *Glycosmis mauritiana, Croton laccifer* (Keppetiya), *Mallotus rhamnifolius*, *Memecylon umbellatum* (Korakaha), *Catunaregam spinosa*(Kukurumanna), *Ochna lanceolata* (Malkera), *Tarenna asiatica* (Tharana), *Flueggea leucopyrus* (Katupila), and *Ziziphus oenoplia* (Heen Eraminya).

Flora in the project area

188. A total of 133 plant species (77 trees, 17 shrubs, 10 herbs, 28 climbers or creepers and 1 epiphyte) belongs to 112 genera and 47 families were recorded in all habitats in the project area. A detailed list of plant species recorded in the project area during the study is given in Annex VI-V- Tables 1, 2 and 3.

Table 3-5 Summary of Plant Species

No of Species	Endemic Species	Indigenous species	Exotic Species	Nationally Threatened
133	10	120	3	4

Threatened and Endemic Flora

189. Four threatened and 10 endemic plant species found in the dry zone were recorded within the general area of project footprint. Out of 133 recoded species four are Nationally Threatened (Table 3.6). All recorded endemic and threatened flora species are not unique or restricted to the project area.

Table 3-6 Endemic and Threatened plant species recorded

Family	Species	Local Name	HA	TS	CS	GCS
Apocynaceae	*Wrightia angustifolia*		T	E		NE
Asteraceae	*Vernonia zeylanica*	Pupulu	C	E		NE
Ebenaceae	*Diospyros nummulariifolia*		T	E		EN
Ebenaceae	*Diospyros ebenum*	Kaluwara	T	N	EN	DD
Erythroxylaceae	*Erythroxylum zeylanicum*		T	E		NE
Fabaceae	*Derris parviflora*	Sudu Kala Wel	C	E		NE
Flacourtiaceae	*Hydnocarpus venenata*	Makulla	T	E		NE
Melastomataceae	*Memecylon capitellatum*		T	E		NE
Melastomataceae	*Memecylon petiolatum*		T	E	VU	NE
Rubiaceae	*Haldina cordifolia*	Kolon	T	N	VU	NE
Rubiaceae	*Mitragyna parvifolia*	Helamba	T	N	VU	NE
Tiliaceae	*Diplodiscus verrucosus*	Dikwenna	T	E		NE
Verbenaceae	*Premna alstoni*		S	E		NE

(HA – Habit, **T** – Tree, **C** – Climber or Creeper, Ep- Epiphyte, **TS** – Taxonomic Status, **E** – Endemic, **N** – Indigenous, **CS** – Conservation Status Red list 2012 GCS- Global Conservation status, **EN**- Endangered, **VU** – Vulnerable, NE- Not assessed, DD- Data Deficient)

3.2.3 Ecological Resources – Fauna

Study Methods

190. All literature available on the project site has been reviewed and relevant information was collected. A reconnaissance survey was carried out to identify major habitats / vegetation patterns in and around the immediate impact zone of the project. Detailed field investigations were carried out at sites identified along the proposed project area based on the findings of the reconnaissance survey, land use maps and satellite images of the study area. A total of 48 sites were sampled covering the entire span of the identified direct and indirect impact zone of the project.

191. The field investigations were carried out during the period October 2013 to December 2013 which covers both the migratory and rainy season in the project area. Point counts and short transects were carried out in the sites identified along the project area. All the species observed were recorded with respect to its location and the results were pooled according to the habitat. All the sampling points were geo referenced with GPS coordinates so that the data can be linked to a GIS platform if necessary. Further, the same sampling sites can be repeated if post construction monitoring work is to be carried out. The current status of the ecosystem with respect to disturbance by humans and the existing threats were also recorded. Based on this data the faunal inventory of the study area was compiled and the species assemblage present in the different habitats and in the immediate impact zone of the project was determined. Finally, possible ecological impacts and existing environmental problems/ issues within the proposed project area and outside of the project area were documented. In addition, secondary information on biodiversity and environmental issues were collected through personal communication with villagers and relevant officers of the DWC and FD. This was also done by reviewing published documents and unpublished data. In addition, photographic records were made of the visual aspects of biodiversity.

192. Species identification and nomenclature of the species present was based on the latest literature published on the fauna and flora of Sri Lanka. The conservation status of the species was determined according to IUCN list of threatened fauna and flora (see Annex II)

Faunal inventory of the project site

193. Total number of 181 faunal species was recorded in the project area. Among them are butterflies, dragonflies, land snails, inland fishes, amphibians, reptiles, birds and mammals (Table 3.7). Of them, 18 species are endemic to Sri Lanka. The faunal assemblage included seven species listed as Nationally Threatened Species (5 Nationally Endangered species and 2 Nationally Vulnerable species). A further six species listed as Nationally Near Threatened (MOE, 2012) were also observed. The faunal assemblage also included five species listed as Globally Threatened (3 endangered species and 2 vulnerable species)

and 9 species listed as Globally Near Threatened (IUCN, 2013). The faunal assemblage recorded in the project area also included one exotic fish species and nine species of migrant birds that inhabit forest habitats.

Table 3-7 Summary information of fauna

Taxonomic Group	Total	Endemic	Migrant	Exotic	CR	EN	VU	NT
Dragon flies	11	1						
Butterflies	35	1					1	
Land Snails	3	2						
Fish	6	1		1				
Amphibians	4							
Reptiles	19	3						1
Birds	78	7	9					2 (4)
Mammals	25	3				5 (3)	1 (2)	3 (5)
Total	**181**	**18**	**9**	**2**	**0**	**5 (3)**	**2 (2)**	**6 (9)**

Abbreviations: * - Proposed endemic species, CR - Critically Endangered, EN - Endangered, VU - Vulnerable, NT - Near Threatened, Numbers in parenthesis are globally threatened species.

Dragonflies: Total number of 11 species of dragonflies and damselflies were recorded. This included one species that is endemic to Sri Lanka. Most of the dragonflies were recorded in the tank habitats. None of the species observed are listed as threatened species.

Butterflies: Total number of 35 butterfly species was recorded. This included one species that is endemic to Sri Lanka. All the species observed are commonly occurring species in the dry zone and intermediate zone of Sri Lanka. Only a single species of butterfly *Papilio crino* (Banded Peacock) recorded at the project sites is listed as nationally threatened. The species was observed in the area that will be inundated due to both Maha kirula and maha Kithula tanks. This species has a wide distribution in Sri Lanka. However, it is listed as a threatened species due to decline of its habitat. The habitat loss expected in Kahalla-Pallekelle Sanctuary due to the proposed project is less than 1% of the available habitat and therefore will not have a significant impact on this threatened species.

Freshwater Fishes: Total of six species of freshwater fish including one endemic species and one exotic species were recorded from the aquatic habitats present within the direct impact zone of the project. None of the species recorded are listed as threatened species.

Amphibians: Total number of 4 amphibian species was recorded. None of these species are endemic to Sri Lanka or listed as threatened species. All four species are commonly occurring species in human dominated landscapes.

Reptiles: Altogether 19 species of reptiles including 3 endemic species was recorded. All the species recorded are commonly occurring species in the dry zone. None of the reptile species recorded is listed as nationally threatened species.

Birds: A total number of 78 bird species was recorded including seven endemic species. Further, nine migratory species of birds that inhabit mainly forest habitats were also observed, especially in the Kahalla-Pallekele sanctuary and foothills of Galgiriyakanda proposed forest reserve.

Mammals: A total number of 25 mammal species including three endemic species were recorded. Most number of threatened species was observed among the mammals, including five Nationally Endangered and one Nationally Vulnerable species (MOE, 2012). Most of these endangered species were observed within the Kahalla-Pallekele sanctuary. Further, the 25 species of mammals observed included five Globally Threatened species (IUCN, 2013).

Identification of Rare, Threatened, Endemic or Commercially Important Species

194. Most of the species observed in and around the sites identified for the proposed project activities are commonly encountered species in the dry and intermediate zone of Sri Lanka. A total of 18 endemic species of fauna were recorded from the study area (Table 3.8). Many of the endemic species observed in the project area are common species showing an island wide distribution. None of the endemic species observed are restricted to the study area. Observed lack of endemism in the project area is not an unusual phenomenon given the fact that dry and intermediate zone habitats support lesser number of endemics compared to the wet zone off Sri Lanka. None of these endemic species will be significantly affected by the project as only a small proportion of their population occur in the area that will be directly impacted by the proposed project.

Table 3-8 List of endemic fauna observed in the area impacted by the proposed project

Family	Scientific Name	English Name	TS
Protoneuridae	*Prodasineura sita*	Stripe-headed Threadtail	E
Pieridae	*Appias galena*	Lesser albatross	E
Camaenidae	*Beddomea frifasciatus*		E
Cyclophoridae	*Theobaldius Spp.*		E
Cyprinidae	*Puntius singhala*	Filamented Barb	E
Agamidae	*Otocryptis nigristigma*	Black spotted kangaroo lizard	E

Family	Scientific Name	English Name	TS
Trionychidae	*Lissemys ceylonensis*	Flapshell turtle	E
Natricidae	*Xenochrophis cf. piscator*	Checkered Keelback	E
Bucerotidae	*Ocyceros gingalensis*	Sri Lanka Grey Hornbill	E
Campephagidae	*Tephrodornis pondicerianus*	Common Woodshrike	E
Columbidae	*Treron pompadora*	Pompadour Green-pigeon	E
Phasianidae	*Gallus lafayetii*	Sri Lanka Junglefowl	E
Pycnonotidae	*Pycnonotus melanicterus*	Black-crested Bulbul	E
Ramphastidae	*Megalaima rubricapilla*	Crimson-fronted Barbet	E
Timalidae	*Pellorneum fuscocapillum*	Sri Lanka Brown-capped Babbler	E
Cercopithecidae	*Macaca sinica*	Sri Lanka toque monkey	E
Cercopithecidae	*Semnopithecus vetulus*	Purple-faced leaf monkey	E
Tragulidae	*Moschiola meminna*	Sri Lanka mouse-deer	E

Abbreviations: **TS** - Taxonomic Status; **E** - Endemic

195. Seven Nationally Threatened and five Globally Threatened species of fauna were recorded from the study area. In addition, six Nationally near Threatened and 9 Globally near Threatened species were also recorded in the direct impact zone of the project site (Table 3.9). As in the case of endemic species number of threatened species was also found to be low in the immediate impact zone of the project. None of the threatened species are restricted to the project areas as these species demonstrate relatively wide distributions in Sri Lanka albeit being listed as threatened species. None of the faunal species observed are exploited at a commercial scale. Some of the fish and mammal species are consumed by the villagers as a source of food.

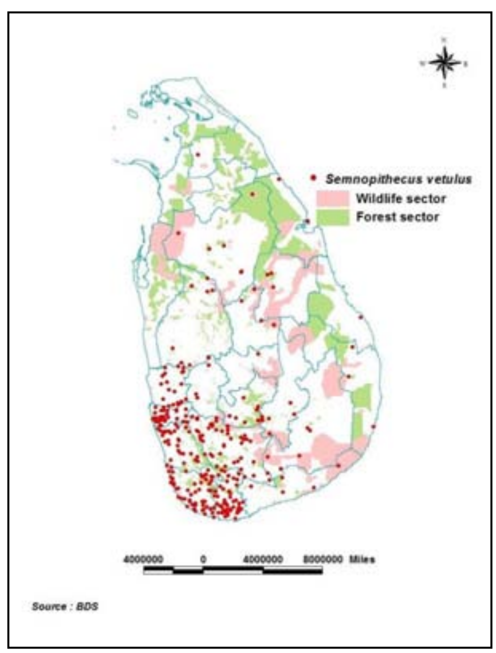
Table 3-9 List of threatened fauna recorded in the area impacted by the proposed project

Family	Scientific Name	English Name	TS	NCS	GCS
Papilionidae	*Papilio crino*	Banded peacock	N	VU	
Testudinidae	*Geochelone elegans*	Indian star tortoise	N	NT	LC
Accipitridae	*Ichthyophaga ichthyaetus*	Grey-headed Fish-eagle	N	NT	NT
Anhingidae	*Anhinga melanogaster*	Oriental Darter	N	LC	NT
Bucerotidae	*Anthracoceros coronatus*	Malabar Pied Hornbill	N	NT	NT

Family	Scientific Name	English Name	TS	NCS	GCS
Threskiornithidae	*Threskiornis melanocephalus*	Black-headed Ibis	N	LC	NT
Manidae	*Manis crassicaudata*	Pangolin	N	NT	NT
Cercopithecidae	*Macaca sinica*	Sri Lanka toque monkey	E	LC	EN
Cercopithecidae	*Semnopithecus priam*	Grey langur	N	LC	NT
Cercopithecidae	*Semnopithecus vetulus*	Purple-faced leaf monkey	E	EN	EN
Lorisidae	*Loris lydekkerianus*	Grey slender loris	N	NT	LC
Felidae	*Prionailurus viverrinus*	Fishing cat	N	EN	EN
Felidae	*Panthera pardus*	Leopard	N	EN	NT
Mustelidae	*Lutra lutra*	Otter	N	VU	NT
Ursidae	*Melursus ursinus*	Sloth bear	N	EN	VU
Elephantidae	*Elephas maximus*	Elephant	N	EN	EN
Cervidae	*Rusa unicolor*	Gona	N	NT	VU
Sciuridae	*Ratufa macroura*	Giant squirrel	N	LC	NT

Abbreviations: **TS** - Taxonomic Status; **GCS** - Global Conservation Status; **NCS** - National Conservation Status; **E** - Endemic, **N** - Native, **EN** - Endangered, **VU** - Vulnerable, **NT** - Near Threatened; **LC** - Least Concern.

Further analysis of the species listed as Nationally or Globally Endangered (EN) observed in the project Impact Zone:



Semnopithecus vetulus (Purple-Faced Leaf Monkey (E), Kalu Wandura (S), **NCS**: EN, **GCS:** EN)

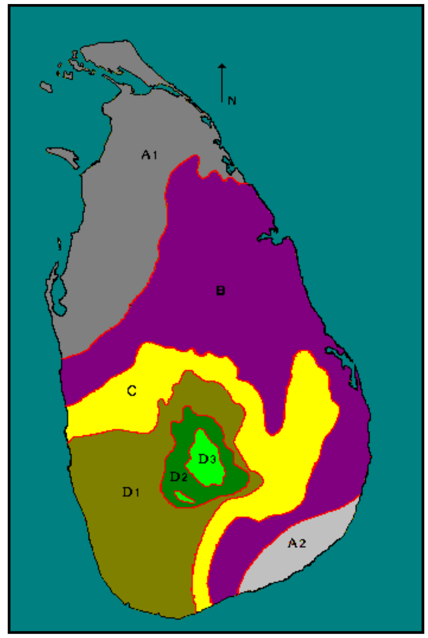
196. *Semnopithecus vetulus* is an endemic primate that is distributed in forest and non forest habitats in the wet zone and riverine forest in the intermediate and dry zones of Sri Lanka. Thus far it has been reported from over 500 locations in Puttalama, Kurunegala, Anuradhapura, Pollonaruwa, Ratnapura, Badulla, Kandy, Matale, Matara, Galle, Hambanthota, Kalutara, Colombo, Gampaha, Kegalle, Nuwara Eliya, Trincomalee, Mannar, Mullaittivu and Vavunia districts. Even though this species shows a wide distribution in Sri Lanka (Extent of Occurance is 54,000 km^2) its habitat is lost at a rapid rate due to urban development

and development activities resulting in a population reduction, especially in the Wet zone where much of the population is present. Therefore, it has been listed as an Endangered (EN) species in 2012 National Redlist as well as the Global List of threatened species (www.redlist.org).

This species was encountered in the Ginihirikanda forest reserve located in the command area of the project. Therefore, the habitat or the population of this species will not be impacted by the proposed project activities.

Macaca sinica (Toque Monkey (E), Rilawa (S), **NCS**: LC, **GCS:** EN)

197. *Macaca sinica* is an endemic primate that is distributed in forest and non forest habitats throughout Sri Lanka. Thus far it has been reported from over 500 locations in Puttalama, Kurunegala, Anuradhapura, Pollonaruwa, Ratnapura, Badulla, Kandy, Matale, Matara, Galle, Hambanthota, Kalutara, Colombo, Gampaha, Kegalle, Nuwara Eliya, Trincomalee, Mannar, Mullaittivu and Vavunia districts. This species shows a wide distribution in Sri Lanka (Extent of Occurance is 54,000 km^2).



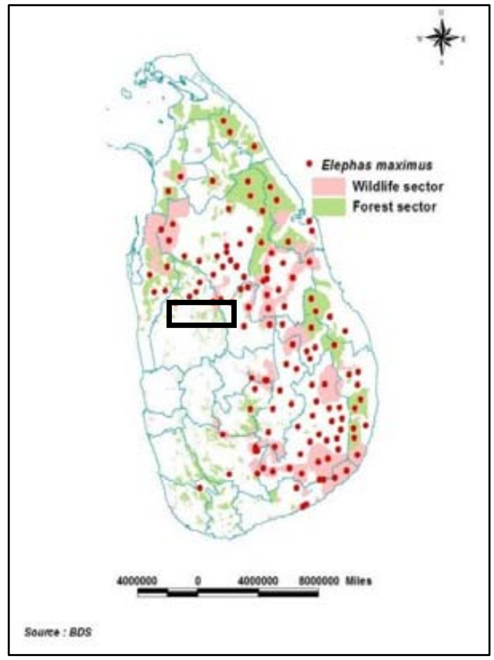
198. Three sub species has been recognized in Sri Lanka, *Macaca sinica sinica* (zones A, B and C in the attached map), *Macaca sinica aurifrons* (zones D1 and D2 of the attached map) and *Macaca sinica opithomelas* (zone D3 of the attached map). According to the IUCN 2012, all three sub species has been listed as endangered species (www.redlist.org). However, according to the National Redlist 2012 (where assessment is only carried out at species level) *Macaca sinica* has been listed as a least concern (LC) species as the species is not in danger of becoming extinct. However, it should be noted that the two sub species *Macaca sinica aurifrons* and *Macaca sinica opithomelas* have smaller populations and are subjected to significantly high levels of habitat loss compared to *Macaca sinica sinica*.

199. *Macaca sinica sinica,* the sub species that was recorded in the project affected area has a large population size. The species was recorded within the Kahalla-Pallekele Sanctuary as well as locations outside the sanctuary along the canal trace as well as the command area of the project. The species occur in a wide variety of habitats such as forest, scrublands, home gardens and agricultural land. The project will not have a significant affect on this species as only less than 1% of its habitat and population occur in the area affected by the project activities.

Elephas maximus (Asian Elephant (E), Aliya (S), **NCS**: EN, **GCS:** EN)

200. *Elephas maximus* is a native megaherbivore that is distributed mainly in forest and non forest habitats in the intermediate and dry zones of Sri Lanka. Few small isolated populations occur in the wet zone. Thus far it has been reported from over 500 locations in Ratnapura, Puttalama, Kurunegala, Anuradhapura, Pollonaruwa, Badulla, Matale, Hambanthota, Moneragala, Trincomalee, Baticaloa,

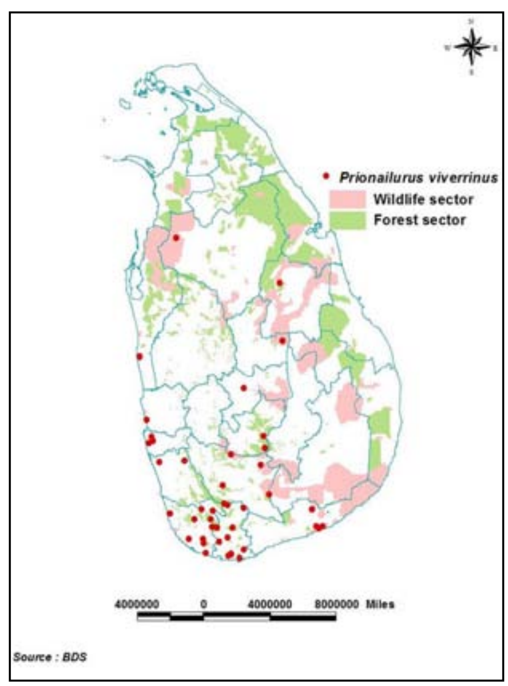
Mannar, Mullaittivu and Vavunia districts. Even though this species shows a wide distribution in Sri Lanka (Extent of Occurance is 37660 km^2) its habitat is lost at a rapid rate due to development activities resulting in a high level of human elephant conflict that is contributing to more than 90% of elephant mortalities in Sri Lanka. Each year more than 200 elephants die due to the human elephant conflict and it has also undergone nearly a 50% reduction in its population over the past 100 years. Further, it has been extirpated from much of its original range. A similar situation is found globally where it has undergone a drastic range reduction and high mortality rates are recorded across all its range states owing to human-elephant conflict. Therefore, it has been listed as an Endangered (EN) species in 2012 National Redlist as well as the Global list of Threatened Species (www.redlist.org).



201. This species has been recorded in the Kahalla-Pallekele Sanctuary as well as the command area of the project. As elephant is an edge species that prefers secondary growth forests where its food is found in abundance the density of the elephants were found to be higher in the periphery of the Sanctuary and in the command area they occupy small disturbed forest patches and plantation forests that are scattered throughout the command area. As they move through these forest patches they tend to come into conflict with humans while the males also engage in crop raiding. The project activities will only impact less than 1% of its habitat or population. However, the command area of the project is inhabited by a much larger population that has lead to a high level of human elephant conflict. Implementation of the project will result in a change in cropping pattern that will result in loss of access to dry season feeding areas which is likely to exacerbate the current level of conflict. Therefore, Ministry of Irrigation and Water Resource Development has commissioned a separate study in collaboration with IUCN Sri Lanka to develop and implement strategic plan to mitigate the human-elephant conflict in the region.

Prionailurus viverrinus (Fishing cat (E), Handun Divia (S), **NCS**: EN, **GCS:** EN)

202. ***Prionailurus viverrinus*** is a native medium sized carnivore that is distributed in forest and non forest habitats in the wet, intermediate and dry zones of Sri Lanka. Thus far it has been reported from over 100 locations in Ratnapura, Puttalama, Kurunegala, Anuradhapura, Pollonaruwa, Badulla, Matale, Galle, Matara, Hambanthota, Moneragala,

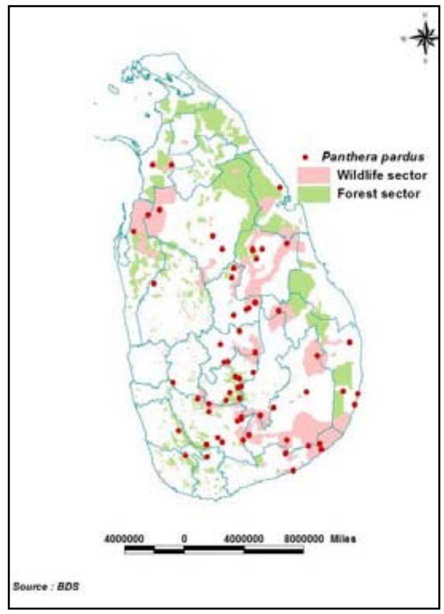


Trincomalee, Colombo, Gampaha, Kalutara, Kegalle, Batticaloa, Mannar, Mullaittivu and Vavunia districts. This species shows a wide distribution in Sri Lanka (Extent of Occurance is 31,350 km^2). Its habitat is lost at a rapid rate resulting in a population reduction. Further, it has been extirpated from much of its original range. Each year many fishing cats are killed due to road accidents and deliberate hunting Therefore, it has been listed as an Endangered (EN) species in 2012 National Redlist and Global list of Threatened Species (www.redlist.org).

203. This species has been recorded during the survey in the riverine forests and tank catchments both within and outside the area affected by the project. However, the impact on its habitat is insignificant as much of its range in Sri Lanka falls outside the project affected area as can be seen in the attached map.

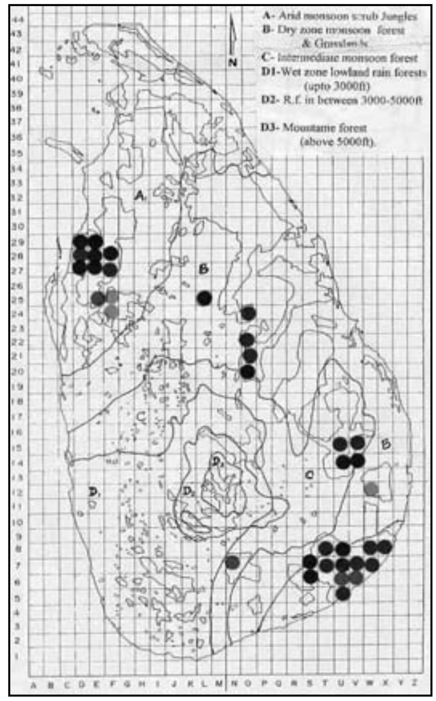
Panthera pardus (Leopard (E), Kotiya (S), **NCS**: EN, **GCS:** NT)

204. *Panthera pardus* is a native large carnivore that is distributed mainly in forest habitats in the intermediate and dry zones of Sri Lanka. Small isolated populations occur in the wet zone. Thus far it has been reported from over 100 locations in Ratnapura, Puttalama, Kurunegala, Anuradhapura, Pollonaruwa, Badulla, Matale, Hambanthota, Moneragala, Trincomalee, Batticaloa, Mannar, Mullaittivu and Vavunia districts. This species shows a wide distribution in Sri Lanka (Extent of Occurance is 45500 km^2).



205. However, its habitat is lost at a rapid rate and much of the population is restricted to protected areas and shows a patchy distribution as can be seen in the distribution map. Further, it has been extirpated from much of its original range. Each year many leopards are killed for their skin and teeth as well as due to conflict with cattle farmers. Therefore, it has been listed as an Endangered (EN) species in 2012 National Redlist. However, this species show a wide global distribution and the global population is listed as Near Threatened in the Global list of Threatened Species (www.redlist.org).

206. This species was encountered in the forest habitats within the Kahalla-Pallekelle Sancturey which supports less than 1% of its population as the sanctuary is much smaller in extent compared to locations such as Ruhuna National Park, Wilpattu National Park, Wasgomuwa National park and Horton Plains National Parl where much larger populations are reported.



Melursus ursinus (Sloth bear (E), Walaha (S), **NCS**: EN, **GCS:** VU)

207. *Melursus ursinus* is a native large omnivoroes that is distributed mainly in forest habitats in the dry and arid zones of Sri Lanka. Thus far it has been reported from over 100 locations in Puttalama, Kurunegala, Anuradhapura, Pollonaruwa, Hambanthota, Moneragala, Trincomalee, Batticaloa, Mannar, Mullaittivu and Vavunia districts. This species shows a wide distribution in Sri Lanka (Extent of Occurance is 32000 km^2). However, its distribution is patchy and restricted mostly to protected areas. Further, it has been extirpated from much of its original range. Therefore, it has been listed as an Endangered (EN) species in 2012 National Redlist. However, this species show a wide global distribution and the global population is listed as Vulnereabe in the Global list of Threatened Species (www.redlist.org).

208. This species was encountered in the forest habitats within the Kahalla-Pallekelle Sancturey which supports less than 1% of its population as the sanctuary is much smaller in extent compared to locations such as Ruhuna National Park, Wilpattu National Park and Wasgomuwa National park where much larger populations are reported.

Recognized animal movement pathways and their significance

209. Based on direct and indirect observations it indicates that the area, which is identified for inundation supports a rich faunal diversity. There was evidence to indicate frequent animal movements within the proposed area that will become the future tank bed of the two proposed reservoirs. However, during the survey period that spanned from October 2013 to December 2013, no specific migratory paths or routes were identified within the project area. The area is also utilized by migratory bird species, especially the forest habitats. However, based on the information available on migratory paths used by the migrant birds, it can be concluded that the proposed development does not function as an important flyway of migratory birds. Therefore, while the proposed project will impair animal movements in the project area, it will not be a significant impact as it does not block any known critical animal migration paths.

Special characteristics of the project and vicinity

210. Some of the project activities, namely construction of two reservoirs and 12.9 km length of link canals will be constructed within the Kahalla-Pallekele Sanctuary, one of the few protected areas present in the north-western region of Sri Lanka. Secondly, the area that will receive water in the Ehetu Wewa DS division falls within the foothills of proposed Galgiriyakanda Forest Reserve. These are the only two areas where the project activities take place within or near natural habitats. All other project activities take place in highly human modified landscapes.

Evaluation of the Habitats present in the Project area in relation to ADB safeguard policy

211. According to the ADB Safeguard policy statement, a critical habitat includes areas with high biodiversity value, including habitat required for the survival of critically endangered or endangered species; areas having special significance for endemic or restricted-range species; sites that are critical for the survival of migratory species; areas supporting globally significant concentrations or numbers of individuals of congregatory species; areas with unique assemblages of species or that are associated with key evolutionary processes or provide key ecosystem services; and areas having biodiversity of significant social, economic, or cultural importance to local communities. Critical habitats include those areas either legally protected or officially proposed for protection, such as areas that meet the criteria of the World Conservation Union classification, the Ramsar List of Wetlands of International Importance, and the United Nations Educational, Scientific, and Cultural Organization's world natural heritage sites. Therefore, it is necessary first to identify whether the project affected area qualifies as a critical habitat. Therefore, it is pertinent that the project site is analyzed against the criteria that are presented in the above paragraph that defines a critical habitat.

An area with high biodiversity value

212. An area with high biodiversity value is defined based on a broad set of attributes such as relative size of the area, condition of the area, whether it is a habitat for threatened, endemic or restricted range species or whether it provides crucial connectivity across the landscape. The project impacted area is approximately 342 ha in extent, which is too small to be considered as an ecologically significant landscape. Further, many of the natural habitats in the project area are highly influenced by human activities at present or in the recent past and therefore are not in a pristine condition. These habitat support a much smaller proportion of threatened and endemic species (refer table 3.7, 3.8 and 3.9) compared to some of the high biodiversity habitats in the wet zone of the country such as Peak Wilderness Nature Reserve or Knuckles Conservation Forest. Further, the site does not function as a critical habitat for any of the threatened or endemic species that inhabits the project affected area. Further, none of the species recorded in the project affected area are restricted to the area nor does it function as a habitat that support restricted range species. Finally, the project affected area does not function as a crucial corridor connecting important habitats or landscapes. **Therefore, even though the project impacted area supports a diverse species assemblage it cannot be considered as an area of high biodiversity value**.

Habitat required for the survival of critically endangered or endangered species

213. The species assemblage recorded in the site selected for the proposed project did not include any critically endangered species. Five Nationally Endangered species and four Globally Endangered species were recorded at the study area. However, none of these species are restricted to the study area and less than 5% of their population will be impacted by the proposed project activities (assessment is based on their current distribution in Sri Lanka as described above). Therefore, the survival of these species is unlikely to be severely compromised by the project. Further, the extent of habitat lost due to the project

is estimated to be around 342 Ha which will not have a significant impact other than on less mobile species.

An area having special significance for endemic or restricted-range species

214. Altogether 28 species of endemic plants and animals were recorded in the project affected area. However, none of these species are listed as restricted range species. Therefore, this condition does not apply for the project affected area.

A site that is critical for the survival of migratory species

215. Altogether nine species of migratory birds were recorded in the project affected area. All these species are commonly found in forest habitats of Sri Lanka. Therefore, the project area does not function as a critical habitat for the survival of migratory species.

An area supporting globally significant concentrations or numbers of individuals of congregatory species

216. The project affected area does not function as a habitat that supports congregatory species. Therefore, this criterion does not apply.

An area with unique assemblages of species or that are associated with key evolutionary processes or provide key ecosystem services

217. The area does not support any unique species assemblages or provide key evolutionary or ecosystem services. Thus this condition does not apply.

An area having biodiversity of significant social, economic, or cultural importance to local communities

218. Even though the local communities depend on the biological resources such as obtaining fuel wood, food, medicine in their day to day life at a subsistence level, the biodiversity in the area does not play a significant social, economic or cultural role.

219. **An area either legally protected or officially proposed for protection, such as areas that meet the criteria of the World Conservation Union classification, the Ramsar List of Wetlands of International Importance, and the United Nations Educational, Scientific, and Cultural Organization's world natural heritage sites**

220. The project area does not contain any Ramsar sites or World Heritage sites. However, approximately 16% (ca. 12.9 km out of the total canal length of 78.6 km) of the proposed canal and the two storage reservoirs, Maha Kithula and Maha Kirula will be located inside the Kahalla-Pallekelle Sanctuary declared under the Fauna and Flora Protection Ordinance and managed by the Department of Wildlife Conservation. Therefore this condition does apply for this project. However, the area impacted

inside the Kahalla-Pallekele is less than 2% of the declared area (21,690 ha) and therefore will not have a significant impact on the ecological processes of the protected area.
221. The area identified for development does not contain any critical habitats or restricted or highly endangered species. Thus the project will not have serious adverse impacts on the environment. However, number of environmental impacts will arise due to the proposed project which will be discussed in detail in the next chapter.

Environmental considerations/ problems/ issues in the area

222. The project sites can be categorized mainly as human-influenced-habitats except for the Kahalla-Pallekele Sanctuary. This is amply reflected by the habitats and species assemblages recorded during the survey. The main environmental problems include overuse of agrochemicals causing loss of habitat quality, especially aquatic habitats, illegal extraction of timber trees and destructive harvesting of non-timber forest products, and hunting. Further, the conflict between human beings and wildlife resulting in damages to property and cultivations of human settlements is also a major environmental consideration in the project area. Implementation of the project will result in decrease of habitat for elephants as well as other fauna (estimated loss is approximately 342 ha). Further changes in cropping patterns due to availability of water in the command area of the NWP project will also result in indirect loss of habitat as some elephants will not have access to some of the areas that are not cultivated during the dry season at present. The direct loss of habitat will not have a significant impact on elephants as they have large home ranges (342 ha is less than 1% of the home range of an elephant). However indirect loss of habitat due to changes in cropping intensity can be significant and can lead to further aggravation of the human-wildlife conflict. Also it was observed during the field study that part of the Kahalla-Pallekele Sanctuary is illegally encroached by the villagers for farming, resulting in a loss of habitat for species that inhabit the area.

223. The area identified for agricultural development does not contain any critical habitats or restricted or highly endangered species. However, the area identified for inundation by the proposed two reservoirs under the project constitutes pristine habitat for many faunal species. Number of environmental impacts will arise due to the proposed project which will be discussed in detail in the next chapter.

3.3 Social and Cultural Environment

224. The objective of this socio-economic study is to identify and evaluate the impacts of the proposed project on social and cultural environment and to suggest mitigation measures to avoid or at least to mitigate any adverse impacts

Methodology of the social study

Secondary Data

225. Obtaining information from the existing sources in the Government institutions in the Project Area (The area inside 15 m distance at both sides of the centerline of the proposed canal and water spread

areas of related tanks, areas where various structures would be constructed, proposed resettlement areas for displacing community and areas directly benefitted by the Project) and close proximity.

Interviews

Collection of information by interviewing relevant Government Officers, Village Organizations, Community Groups and Village Leaders etc.

Field Visits

Field visits were conducted to confirm the validity of information and data obtained through socio economic surveys and field studies and also to obtain further information.

Transect Walk

Collection of relevant information by walking from the commencement of the proposed canal to the end of the canal accompanied by a Facilitator and target community following the available maps and survey plans (from surveys conducted by Mahaweli Consultancy Bureau) showing the lands relevant to the proposed NWP Water diversion Irrigation canal and meeting the target community and Government Officers.

3.3.1 PRESENT SOCIO-ECONOMIC & CULTURAL STATUS OF THE PROJECT AREA

3.3.1.1 Information on Project Area & Settlement Distribution

Project Area

226. For the socio economic analysis purpose, the Project Area is defined as

- The area inside 15 m distance at both sides of the centerline of the proposed canal (30 m wide stretch) and water spread areas of the Irrigation Tanks constructed or rehabilitated under the Project and areas where various structures would be constructed,
- Proposed resettlement areas for displacing community and
- Areas directly benefitted by the Project such as Irrigable areas of major, medium and minor irrigation tanks located in Dambulla, Galewela, Polpithigama, Mahava, Ahatu Weva and Galgamuva DS Divisions falling within Kala Oya basin, Mi Oya basin and Hakwatuna Oya sub-basin in Daduru Oya basin and other areas receiving diverse benefits from the Project.

Above description is further illustrated in the following table.

Table 3-10 Details of Project area and No. of beneficiaries

Serial No.	District	DS Division	No. of GND	No. of Villages	No. of residing Families	Population
1	Matale	Dambulla	59	160	20325	71,371
2		Galewela	59	152	21692	74,786

3	Kurunegala	Polpithigama	82	283	25333	88,404
4		Mahawa	68	220	20443	61,580
5		Ahatuweva	35	152	9584	30,072
6		Ambanpola	28	122	8438	25,760
7		Galgamuva	62	189	18916	63,273
	Total 02	07	393	1278	124,724	415,246

Source –1. Resource profile for Kurunegala District-2011 District Policy Planning Office, Kurunegala
2. Resource profiles for Galewela and Dambulla - 2011

Summary of socio economic impacts

227. There would be positive as well as negative impacts incurred by the Project activities carried out in the above project area on the area itself and the community. Nevertheless, the areas in close proximity to the canal would be positively benefitted due to accessibility to water and to the irrigation tanks and thereby enabling cultivation in both yala & maha seasons uninterrupted by any water shortage. Accordingly the project affects differently to the communities in the project construction area and outside, even though they are in the same administrative division and in close proximity to each other.

228. In resettling the people who will be displaced from the Project Construction Area, the host community may raise objections for settling those who will be affected by the project on the lands that they think would belong to their future generation. This thinking is commonly experienced in almost every resettlement process. A more harmonious environment should be created between two parties making the host community aware of the benefits they would get because of the Project and the sacrifice made by the migrant community towards making the project possible.

229. The project aims to augment eight major, medium and minor tanks located within 3 river basins in 7 DS divisions through construction of the proposed canal by which enabling cultivation in both yala & maha seasons and easy access to domestic water. This would directly and indirectly benefit the people living in and around the area in various ways and the project can be considered a multipurpose development project.

230. The Project Area and the areas in close proximity are of special archaeological importance, being located in areas related with folktales to Anuradhapura, Kurunegala and Yapahuva ancient Kingdoms. Some highly respected and worshipped Buddhist temples and ancient ruins are also situated in close proximity. The ancient concept of Tank, Stupa, village & Temple still remains the major philosophy and is well respected and practiced. The elders in the Project community are considering this heritage with reverence and devotion and also share the view that the protecting and transferring this legacy to the future generation is their responsibility. Details of affected persons and associated compensatory measures are discussed in the resettlement plan prepared under the project.

3.3.1.1. a Information on project construction area and villages

Table 3-11 give the spatial distribution of population by GND and Villages in the DS divisions within the Project Area.

Table 3-111 GN Divisions and villages along the NWP canal

Serial No.	District	DS Division	GND	Village
1	Matale	Galewela	Danduyaya	Danduyaya
2	Matale	Galewela	Pahala Bambava	Pahala Bambva, Bogaswewa
3	Matale	Galavela	Ranvadiyava	Kanadana
4	Matale	Galewela	Kospotha	Kospotha
5	Matale	Galewela	Hombbaava	Katupotha, Andagala valavvela
6	Matale	Galewela	Nilagama	Nilagama
7	Matale	Galewela	Aluthweva	Aluthweva
8	Matale	Galewela	Nabadagahawaththa	Nabadagahawaththa
9	Matale	Galewela	Dambagolla	Dambagolla
10	Matale	Galewela	Pibidunugama	Pibidunugama
Subtotal			**10**	**13**
09	Matale	Dambulla	Valamitiyava	Valamitiyava
10	Matale	Dambulla	Lenadora South	Lenadora South
11	Matale	Dambulla	Athabandi weva	Manikdenagama
12	Matale	Dambulla	Pannampitiya	Jankaminipura
Subtotal			**04**	**04**
13	Matale	Naula	Uswaththava	Wemedilla
Subtotal			**01**	**01**
14	Kurunegala	Polpithigama	Hathigamuva	Hathigamuva, Liyanagama
15	Kurunegala	Polpithigama	Polpithigama	Polpithigama
16	Kurunegala	Polpithigama	Kambuvatavana	Kambuvatavana, Boraweva, Vijayapura
17	Kurunegala	Polpithigama	Bulneva	Kiralabokkagama, Yaya 10
18	Kurunegala	Polpithigama	Pallekale	Ulpatha
19	Kurunegala	Polpithigama	Bogolla	Bogolla, Hiralugama
20	Kurunegala	Polpithigama	Moragollagama	Moragollagama, Mapegamuva
21	Kurunegala	Polpithigama	Pohorawaththa	Gonapalagama
22	Kurunegala	Polpithigama	Kumbukulava	Vavuleva
Subtotal			**09**	**15**
23	Kurunegala	Mahava	Konweva	Konweva, Ihalaneththipalagama
24	Kurunegala	Mahava	Pahalagama	Mudiyansegma
25	Kurunegala	Mahava	Ihalagama	Ihalagama
26	Kurunegala	Mahava	Kattambuvava	Madugasgodalla
27	Kurunegala	Mahava	Yaddigama	Yaddigama
28	Kurunegala	Mahava	Kohombakadavala	Sellaperumagama

29	Krunegala	Mahava	Bamunugama	Bamunugama
Subtotal			**07**	**08**
Total	**02**	**05**	**31**	**41**

Source – Field Study, NWP Canal Project 2013 October

3.3.1.1. b Houses & Buildings in the Project Construction Area

231. It appears that attempts have been made to ensure minimum disturbances to the existing buildings during the planning of the proposed canal trace across villages where there is human settlement. This is evident from the fact that only 70 houses and 2 other buildings (Community hall and a Tobacco factory) are affected through its entire length of 78km.

3.3.1.1. c Details of cultivated lands and other lands within the proposed canal

232. Collection of information on cultivated lands was an onerous task compared to gathering information on households & buildings owing to the problematic conditions such as some of the landowners are residing out of the area and the informants are not aware of the actual boundaries of lands etc. The data gathered based on Grama Niladari Divisions is presented in following table 3.12.

Table 3-12 Cultivated and other lands along the NWP canal

District	D.S. Division	Paddy Lands ha	Home gardens ha	Coconut Lands ha	Chena lands ha
Matale	Dambulla	02	17.2	0	0
Matale	Naula	0	01	0	0
Matale	Galewela	24.8	32.1	7.2	0
Kurunegala	Polpithigama	24.24	30.5	2.96	20.5
Kurunegala	Mahawa	3.7	13.67	0	5.18
Total		**54.74**	**94.47**	**10.16**	**25.68**

Source: - EIA Field Information Survey **,**NWP Water Diversion Project October***2013***

In analyzing the above table 3-12 it can be seen that there are some cultivated land in the Project construction area along the proposed 76.5 km long canal.

3.3.2 Socio-economic Profile of Project-affected Households

233. Comprehensive field information survey (socioeconomic survey) was conducted in 2013 as a part of environmental assessment of the Project to identify the scope and significance of potential project impacts on project-affected households (Paths). As the Project is a linear development project, the survey team interviewed more than 90 percent of identified Project affected households in order to develop a comprehensive socioeconomic profile of Paths. The survey identified 70 households in 26 villages as potential physically displaced households and interviewed 64 households. This section

outlines the key findings of the socioeconomic assessment highlighting the socioeconomic impacts of the proposed Project on human settlements.

234. Infant population constitutes 10 percent of the affected population. 21 percent of the population is at the school going age. Half of the population (48 percent) constitutes the labour force in the Project area. Although the old population is as high as 17 percent, only a small percentage of it is in fact retired, as farmers do not retire till they become disabled. Male-female ratio is 40:60

3.3.2.2. Occupations

235. Agriculture is a source of income and livelihood. Small irrigation tanks and irrigation systems, and monsoons rains are the principal water sources for agriculture. Almost every village in the Project Area has an irrigation tank to collect rainwater, and a canal system to convey water to cultivated lands. The cultivable area in a given season depends on the size and capacity of the irrigation system and rain water availability. Farmers distribute water collectively using well established traditions and rules.

236. Only 25 percent of households are engaged in agriculture as their main source of income in the Project area because of high risks associated with farming. In good rainy seasons, villagers store water in irrigation reservoirs and collectively manage water carefully for irrigation and domestic purposes. If a drought sets in during a cultivation season, they could lose the entire crop. Another risk is wild animals harming the crops. As a result, the majority (75 percent) are engaged in different occupations such as government employment (14 percent), private sector employment (25 percent), self-employment (17 percent), wage labour (14 percent), and agricultural labour (table 3-13). Despite the risks associated with agriculture, uneducated and poor villagers engage in agriculture by finding their own solutions within their limited capacities for the difficulties encountered a season after another.

Table 3-13 Occupations of the people in the Project Area

Sector	No. of people engaged	Percentage
Government	15	14
Private	27	25
Self employed	18	17
Daily wage labour	15	14
Agriculture labour	05	05
Farming	27	25
Total	**107**	**100**

Source - EIA Field Study, NWP Canal Project 2013 October

237. There are 16 households in the Project area identified by the Government as low-income households. Many of them are headed by widows. Each household receives a monthly grant from the Government under the *Samurdhi* Relief Programme (table 3-14). They work as daily wage workers in agriculture and non-agricultural activities to supplement the grant, as it is not sufficient to cover their household expenditure.

Table 3-14 No. of Samurdhi recipients in the NWP canal area.

Serial No.	Monthly Grant in RS	No.of families
1	350 and less	02
2	351 - 700	05
3	701 - 1000	08
4	More than 1001	01
	Total	**16**

Source: - EIA Field Information Survey **,**NWP canal Project October ***2013***

3.3.3 Present water supply and water use

238. The proposed project area is supplied with water from the catchments of tanks both major and minor. Cropping intensities of all tanks have shown a declining trend over the years probably due to climate change. The Table 3-15 shows the details of major/medium tanks in the project area and cropping intensities.

239. Most of the irrigation schemes have been commissioned during 1960s and farmers have been settled in the irrigated settlements as per the government policy. The drinking water supply to these settlers was from the dug wells. Later the government initiated pipe borne water schemes in several villages.

3.3.3.1 Present water supply and water use

240. The proposed project area is supplied with water from the catchments of tanks both major and minor. Cropping intensities of all tanks have shown a declining trend over the years probably due to climate change. The Table 3-15 shows the details of major/medium tanks in the project area and cropping intensities.

241. Most of the irrigation schemes have been commissioned during 1960s and farmers have been settled in the irrigated settlements as per the government policy. The drinking water supply to these settlers was from the dug wells. Later the government initiated pipe borne water schemes in several villages.

Table 3-15 Major and Medium irrigation schemes in the project area

River Basin	Major/medium scheme		
	Name of the scheme	Extent (ha)	Cropping intensity (CI)
Kala Oya	Wemedilla	729	1.8
	Dewahuwa	1215	1.8
Deduru Oya	Hakwatuna Oya	2579	1.53
Mi Oya	Mediyawa	486	1.26
	Ambakola wewa	340	1.33
	Attaragalla	419	1.29
	Palukadawala	648	1.04

Source: Irrigation Department

242. Apart from the major and medium irrigation schemes, the project is designed to enhance the supply of water to a large number of village tanks forming cascades which maximizes the reuse of water. The number of such tanks is 350 irrigating 5983 ha in both Kala Oya and Mi Oya river basins. Almost every village in the Project Area has an Irrigation tank to collect rainwater and a canal system to convey water to the agricultural lands. The cultivable area depends on the size and capacity of the irrigation system and water availability. Farmers are doing the distribution of water collectively.

3.3.4 Existing Infrastructure Facilities in the Project Area

243. The considered area includes urban, semi-urban & rural areas and the intended project benefits would reach all these strata. The existing infrastructure facilities of the area are as follows.

Roads

244. Main towns of the area Galewela, Dambulla, Ambanpola and Galgamuva are directly connected to the major road network of the country. Mahava, Polpithigama and Ahatuweva also can be easily accessed through a secondary network. All the rural areas in the area concerned can be reached through motor able road network although some roads have become rugged due to want of proper maintenance.

Transport Facilities

245. As mentioned above, the road networks connecting town areas have an excellent transport facilities operated by both government & private sectors. Usually when reaching the rural areas the situation is gradually deteriorating but the existing facilities are adequate to fulfil day to day needs of the community. Depending on the financial situation people fulfil their requirements by means of bicycles, Motor Bicycles, Three wheelers etc. Furthermore almost every rural area has a private bus, lorry or any other kind of transport operated under private owners to provide necessary transport for the area.

Health Facilities

246. There are two basic hospitals, three A grade District Hospitals, one B grade District Hospital and one C grade District hospital operated under the Department of Health of Sri Lanka located within the

considered area. In addition, depending on the population every DS division has rural hospitals and central dispensaries to extend the health facilities to the rural community. In addition, there is a community Health service reaching to the remotest areas functioning under a Regional Director of Health Services.

Market Facilities

247. Since the area concerned is a combination of rural, semi urban & urban environment, there is a marketing network connecting all these strata. Although Dambulla commercial Centre is situated close to Galewela town, it is of quite a distance to other towns. However, some people use their private transport facilities to take vegetables, fruit & grains from Mahava, Polpithigama etc. to sell in Dambulla commercial Centre. There is also a market network connected with Galgamuva and Ambanpola this way. Hence, agricultural community is able to buy their agricultural inputs and sell their produce through these networks without much effort although there is the question of quality of service.

Electricity Supply

248. There are no lapses in provision of electricity supply in urban & semi urban areas. It appears that the CEB makes every effort to meet the demand in rural areas too. 82,790 houses in the area have electricity connections whereas 26,442 houses do not.

Education Facilities

249. The community of the area has been bestowed with a fair opportunity in obtaining a formal education. Taking into consideration, the ethnic distribution Tamil medium schools also have been established and the children enjoy the opportunity to learn in Sinhala, Tamil or English depending on their preference. The presence of Central Colleges, Maha Vidyalas, Kanishta Vidyalas and primary schools give the opportunity to the children of the community to obtain education up to university entrance level within the area. The education facilities available in the area are given in the table 3-16.

Table 3-16 Education facilities in the Project area

Serial No	DS Division	Sinhala medium	Tamil medium	Sinhala & English medium	Total
1	Dambulla	33	02	-	35
2	Galewela	35	04	-	39
3	Polpithigama	53	-	-	53
4	Mahava	30	03	04	37
5	Ahatuweva	14	-	01	15
6	Ambanpola	14	01	01	16
7	Galgamuva	33	07	02	42
	Total	212	17	08	237

Source 1. Statistical Handbook 2011, Statistics section, Kurunegala District Office

2. Resource Profiles of Galewela& Dambulla DS Divisional Secretariats 2011

3.3.5 Existing Health and Other Social Issues.

250. Following health and other social problems are observed to be prevailing in the project area according to outcomes of the discussions with government officers, village leaders, community groups and from media reports.

I. Scarcity of clean drinking water (High salt content)
II. Increasing number of patients suffering from chronic kidney disease (CKDu)
III. Human elephant conflicts and crop damages by wild animals.
IV. Problems arising due to migration of mothers for foreign employment
V. Excessive use of agro chemicals and unsafe use of agro chemicals
VI. Respiratory problems associated with dust

251. The project is designed mainly to enhance the supply of irrigation water and drinking water mainly to Hakwatunaoya sub basin and upper Mi Oya basin. Communities are affected by chronic kidney disease (CKDu). The cause for the CKDu is still unknown and, there are different schools of thought for the cause. Polpithigama and Mahawa DS Divisions are the areas in which increased incidence of CKDu is reported. As an example, in Polpithigama Divisional Secretariat area 228 kidney patients have been recorded out of total population of 63,113 in the area.

252. There several NGOs working to help the patients. The government also has set up treatment facilities in the area in Nikawewa in Polpithigama Divisional Secretariat area. Many of the scientists' believe that the cause for the kidney disease is drinking water from dug wells and use of pesticides. If that were the case introducing Mahaweli water to the area would be a beneficial to curb the situation. However, good awareness programmes on use of agro chemicals should be carried out in the project area. Human elephant conflict and water scarcity appear to be a common problem especially in Kurunegala District. Houses established close to elephant crossings are more vulnerable. Drinking water problem is more common in dry zone areas in the project area especially during dry period. Respiratory problems are more often along the main roads.

3.3.6 Socioeconomic Conditions of Physically Displaced Households

253. It was identified that 22 families in 20 houses (2 families are sub-families) will be partially affected. A portion of their land is needed to be acquired and their houses will be partially damaged. However, the reaming land portion is sufficient for their houses to be built. The details of affected persons and associated compensatory measures are discussed in the resettlement plan prepared under the project.

3.3.6.1 Population data in the Project Construction Area

254. Considering about gender structure of the affected families, the study has revealed that all 22 heads of households are male. No disable or vulnerable families were identified.

Table 3-17 Number of households affected

District	GSD	GND	Sex		Effect of Residence		Condition of HH		
			Male	Female	Relocation	Isolate	Good	Disable	Vulnerable
MATALE	DAMBULLA	Lenadora North	2		2		2		
		Ethabendiwewa	4		4		4		
		Welamitiyawa	4		4		4		
	GALEWELA	Danduyaya	1		1		1		
		Ranwediyawa	2		2		2		
		Pahalabambawa	4		4		4		
KURUNEGALA	MAHAWA	Kospota	2		2		2		
		Konwewa	3		3		3		
		TOTAL	22		22		22		

Please note that 02 APS are sub families out of above 22 HHs, therefore only 20 houses will be affected.
Source: Resettlement survey 2014

255. Within the Construction area of the NWP Water Diversion project, there are 66 people (31 male and 35 female) in 22 households in 8 Grama Niladari Divisions (3 DS divisions). The following table shows information regarding the age, sex and marital status of the affected population.

Table 3-18 Population, Sex, Marital Status and Age of affected families

GND	Age group ,Below 18 years				Age group 19 – 59 years						Age group over 60 years					
	Male		Female		Male			Female			Male			Female		
	Married	Unmarried	Married	Unmarried	Married	Unmarried	Widow	Married	Unmarried	Widow	Married	Unmarried	Widow	Married	Unmarried	Widow
Lenadora-North				3	1	1		1								
Ethabendiwewa		1		1	3	3		3	1		1			1		
Welamitiyawa				2	3	1		4			1					
Danduyaya		2			1			1								
Ranwediyawa		1			2			2								
Pahalabambawa				1	2			3	1		2			1		
Kospota		**1**		1	1			2			1					
Konwewa				4	3			3								
Total		**5**		12		16	5	19	2		5			2		

Source: Resettlement survey 2014

Considering about the ethnicity and religion of the population all are Sinhala Buddhists. Details are included into the table below.

Table 3-19 Ethnicity, Religion and gender of families

GND	Sinhalese		Buddhist	
	Male	Female	Male	Female
Lenadora North	2	4	2	4
Ethabendiwewa	8	6	8	6
Welamitiyawa	5	6	5	6
Danduyaya	3	1	3	1
Ranwedayawa	3	2	3	2
Pahalabanmbawa	4	6	4	6
Kospota	3	3	3	3
Konwewa	3	7	3	7
TOTAL	31	35	31	35

Source **-:**Resettlement survey **,**NWP Canal Project ***2014***

3.3.6.2. Houses & Buildings in the Project Construction Area

256. It appears that attempts have been made to ensure that minimum disturbances to the existing buildings during the planning of the proposed canal trace across 41 villages where there is human settlement. This is evident from the fact that only 20 houses are affected through its entire length of 78 km. The detailed information on houses and building in the Project construction area is given in following table .

Table 3-20 Affected Residences and Residential allotments

GND	Effect of Houses			Effect of Residential allotments	
	Fully	Partly	Isolate	Fully	Partly
Lenadora North		02			02
Ethabendiwewa		04			04
Welamitiyawa		04			04
Danduyaya		01			01
Ranwediyawa		02			02
Pahalabambawa		02			02
Kospota		02			02
Konwewa		03			03
TOTAL		**20**			**20**

Source: - Resettlement survey **,**NWPC Project ***2014***

3.3.6.3. The number and types of Households/buildings and home gardens:

257. Among the affected households there are 7 Households in the Galewela DS Division, 10 in Dambulla DS Division and 5 in the Mahava DS Division. Especially, many households in Galewela DS Division are located in small patches of land within town limits. Most of these families are employed in Government and private sector and some are self-employed and have lived in the area for nearly 40 years. There are also some (about 10%) who are engaged in various occupations beyond the town limits.

258. According to the social survey, the total affected residential land area is about 5 acres. This mainly includes highland crops, coconuts, banana and fruits. In addition to this, there are small stretches of paddy lands. Affected paddy land area is limited to 0.5 acres. Although a substantial extent of lands are governments lands given to families for land development under permits, they have lived in these lands for more than 40 years and thereby claim full ownership. In parallel to this EIA a detailed socio-economic survey is being undertaken to finalize the resettlement plan. More accurate information found in the resettlement plan prepared for the project.

Table 3-21 Land ownership – Residence lands of Households (Highland & paddy lands)

GOD	**Outright**			**Swarna boomi**			**Jaya boomi**			**Dambulla temple (Rajakari)**			**Bambawa temple (Lease)**		
	A	R	P	A	R	P	A	R	P	A	R	P	A	R	P
High lands															
Lenedara North		3						3							
Ethabendiwewa				1			1			1	2				
Welamitiyawa										3	2				
Danduyaya		2													
Ranwediyawa	2		20												
Pahalabambawa													1	3	
Kospota	1	2													
Konwewa	3							2							
PADDY															
Ethabendiwewa										2	2				

Source: - Resettlement survey **,**NWPC project ***2014***

Table 3-22 Type of Structures (Residence Houses) and facilities available

GND	Permanent			Semi-permanent			Electricity Availability.		Pipe Bourne water	
	<750	750-1500	>1500	<750	751-1500	>1500	Y es	No	Yes	No
Lenadora North	2							2		2
Ethabendiwewa	4						2	2	2	2
Welamitiyawa	1	2	1				4		1	3
Danduyaya		1					1			1
Ranwediyawa	1	1					2			2
Pahalabambawa	1			1			2		2	
Kospota	1			1			2			2
Konwewa	3						3		1	2
Total	**13**	**4**	**1**	**2**			**16**	**4**	**6**	**14**

Source: - Resettlement survey **,**NWPC Project ***2014***

3.3.6.4. Income and Income Generation activities of the Project Construction area community

259. Agriculture is the main income generating activity of the communities within the Project Construction Area by tradition and heritage. Small irrigation tanks and irrigation systems located in the area are the principal water sources for agriculture. There is also the rain-fed cultivation of paddy and chena crops in practice. But the farmers face uncertainties due to lack of water both in Yala & Maha seasons and also due to damage by wild life. People tend to find other sources income owing to these uncertainties. Considering the income level of the families about 70% receive a monthly income more than 10,000 rupees.

Table 3-23 Annual Income of Households

GND	**Up to 60,000 - Rs**	**Rs.60,000 – 120000**	**Rs.120,000 – 500,000**
Lenadora North		01	01
Ethabendiwewa		02	02
Welamitiyawa		01	03
Danduyaya			01
Ranwediyawa			02
Pahalabambawa		02	02
Kospota	01		01
Konwewa		01	02
Total	**01**	**07**	**14**

3.3.6.5. Occupations of Project Construction Area Community

260. According to the information gathered at the EIA field information survey, among the affected families more than 40% is engaged in agriculture as their major income generating activity. Another 36% earn their major income as Government or private sector employment. Remaining are engaged in business or self employment.

261. The agriculture of the project area is presently based mainly on rainwater. In seasons with good rainfall people store water in irrigation tanks and collectively manage water carefully for irrigation and domestic purposes. If a drought, sets in during a cultivation season not only that they would fail to obtain good harvests but would have to face loss of harvest depending on the severity of drought. Also there is the possibility of wild animals harming the crops. This situation has led to the present trend of seeking employment elsewhere. Still there are some people who would stick to the tradition and engage in agriculture finding their own solutions within their limited capacities for the difficulties encountered and making various sacrifices. The following table gives information on the employment situation of the affected families.

Table 3-24 Employment status of affected households

GND	Farming	Government Sector		Private Sector		Business	Hire labour / Driver	Self-employment
		Permanent	Non-permanent	Permanent	Non-permanent			
Lenadora North	1					1		
Ethabendiwewa	2				1		1	
Welampitiya	3	1						
danduyaya							1	
Ranwediyawa					1			1
Pahalabambawa	1			3				
Kospota	1			1				
Konwewa	1	1						1
TOTAL	**9**	**2**	**0**	**4**	**2**	**1**	**2**	**2**

Source - Field Study, NWP Canal Project 2014

262. There is also the trend of new generation being alienated from agriculture and pursuing jobs in the townships. At the discussions held with such youngsters it was revealed that they have perceived difficulties and uncertainties associated with agriculture and having higher education they are of the opinion that they should earn a permanent income in a safer job.

3.3.6.6 Low income receivers in the Project Construction Area (Samurdhi Recipients)

263. There are 05 families in the directly affected area identified as low-income families by the Government. All of these families are headed by male (widowers). They receive a monthly grant from the Government under Samurdhi Relief Program. As observed during the field surveys these family members are engaged in labour work to supplement the grant, as it is not sufficient to cover the actual expenditure. 4 out of 5 are dissatisfied about the grant.

Table 3-25 No. of Samurdhi recipients directly affected

GND	No. of HH	Monthly Amount & No. of Recipients				Satisfaction	
		600	500	400	240	Yes	No
Ethabendiwewa	1		1				1
Welamitiyawa	2	1			1	1	1
Danduyaya	0						
Ranwediyawa	0						
Pahalabambawa	1			1			1
Kospota	0						
Konwewa	1		1				1
TOTAL	**5**	**1**	**2**	**1**	**1**	**1**	**4**

Source: - Resettlement Survey **,**NWP Canal Project ***2014***

3.3.6.7 Cultural, Historical and Archeological aspects/considerations

264. The areas like Galewela, Dambulla, Polpithigama, Maho, Ehetuwewa, Ambanpola and Galgamuwa which are situated within the NWP Canal Diversion Project area are considered as archeologically, historically and culturally important areas when considering the exiting historical and archaeological factors in the said areas.

265. Specially, Ibbankatuwa area in Dambulla with many archaeological factors has proved that it has a long history expanding up to pre-historic era. It is revealed by the folklore and archaeological factors in the areas within the NWP Project Area that the particular areas were remained during the ancient period as surveillance zones of the state, administrative areas reigned by the Provincial Administrators of the then Kings Devanam Piyatissa, Dutu Gemunu, Walagamba and Dathusena who reigned the Anuradhapura, Polonnaruwa, Yapahuwa, Kurunegala Kingdoms and as manors (Nindagam) gifted for agricultural activities. Also, the monuments depicting the methodology used in the ancient era for the socio-economic and religious development within the concept of "Wewa, Dageba, Gama, Pansala" (Tank, Pagoda, Village, Temple) are still existing in the area.

266. Even today, the areas such as Dambulla, Rangiri Dambulu Temple, Sigiriya, Bambawa Temple, Yapahuwa Temple, Ehetuwewa Reswehera Temple and Galhiriya Kanda (Area famous for Saliya Asokamala Legendary) that have religious and historical values are respected not only by the Buddhists but also by the devotees of the other religions and some historical areas that are admired by every disciples of the every religions become culturally valued areas.

267. The existing major and minor tanks and connected irrigation systems in the project area that prevailed from the ancient era are the important historical factors that disclose the advancement of the agricultural sector in the era of our ancient kings.

3.4 Methodology of the Archaeological study

268. Historical analysis of the Area was carried out by searching literature evidences, studying old records, research in the museums, studying new documents, studying different folk stories and studying maps, plans and photographs.

269. Identification of the archaeological sites in the project area was mainly carried out through non-destructive methods such as study of Arial photographs, field walks, collection of samples, etc. All identified archaeological remains are graphically and photographically recorded and presented by way of location maps with GPS coordinates, plans, sections, elevations, and details drawing where necessary. All artefacts were recorded to identify their location and analysed. The investigation methodology adopted in this survey is to evaluate the site in order to test for the extent and character of strata, assemblage, artefacts and ecology. During this survey investigations were carried out to also identify any physical archaeological remains. The evaluation was carried out by surface field Surveys.

270. The method of systematic field walks were used to explore the entire area systematically. Collection of samples, establishment of marks, taking photographs, preparation of plans was carried out at the site during the survey. According to studies carried out within the project area 39 archeologically important sites have been identified (Table 3-26). Please see the Figure 3.5 for location map of archaeological sites.

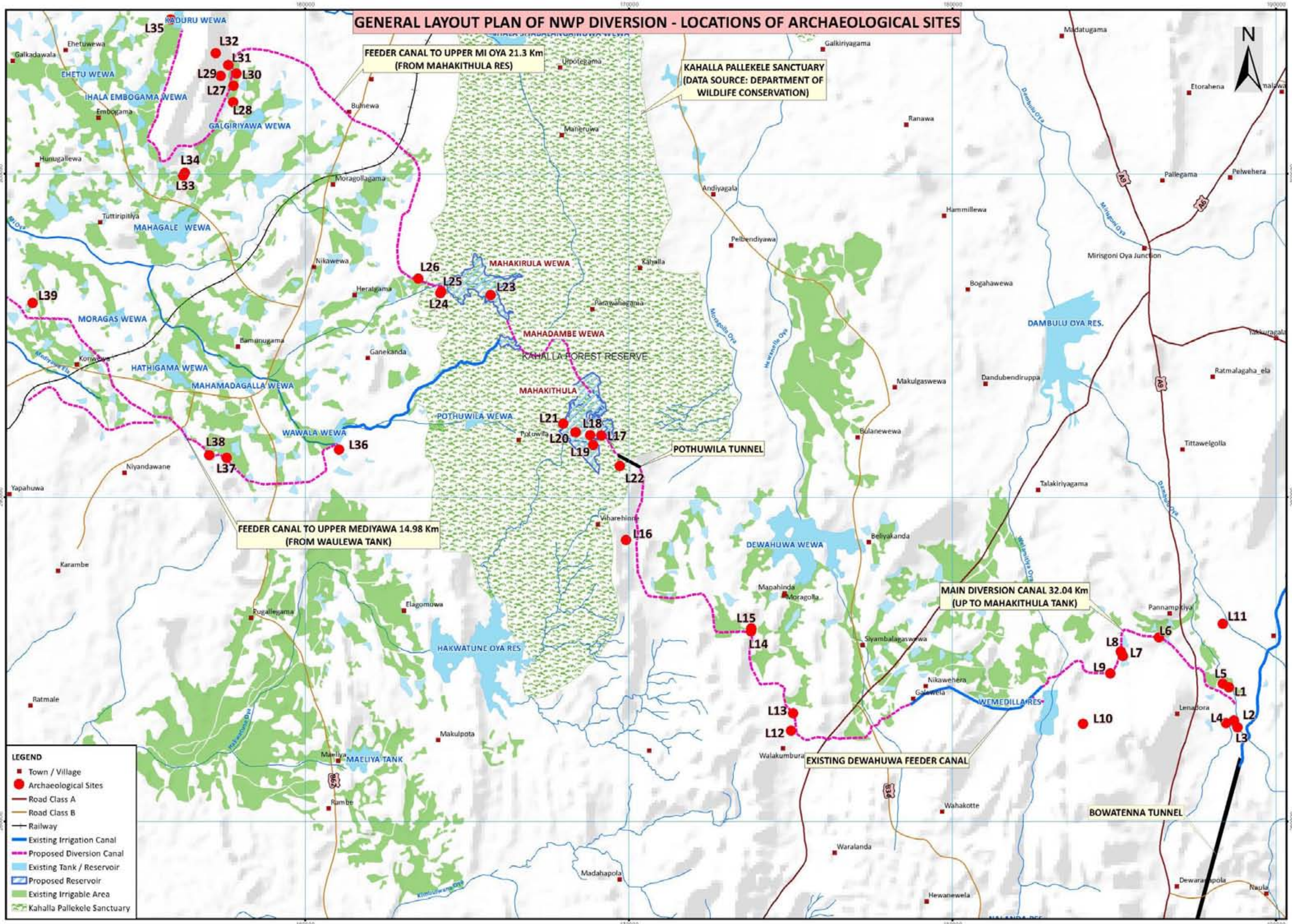


Figure 3-5 Locations of archaeological sites

3.4.1 Important Archaeological Sites

271. Following is a summary of findings of Archaeological Impact Assessment, and the full report is given in the annexure VI – IV of this report.

Table 3-26 Names of archaeological site, description and the location.

Site	Brief Description	Location
Ancient Iron Slag Deposit Map Reference (L1)	Approximately 50 x 50 meters in a cultivated area within a distance of about 268 meters from the right side of the Canal was identified as a natural mound.	Dambualla D S Division, Lenadora South GS Division.
Ancient Quarry Map Ref (L2)	Crystalline lime stone and Dolomite within a distance of about 600 meters from the left side of the Canal from the Bowatenna Tunnel was identified as a natural mound.	Dambualla Divisional Secretariat Division, Lenadora South GS Division
Mound Belongs Ancient Settlers Map Ref (L3)	Red Ware belongs to the early historical period. The deposit could be identified in an area of 75 x 50m with lime stone and Dolomite deposits within a distance of about 480 meters from the left side of the Canal	Dambualla Divisional Secretariat Division, Lenadora South GS Division
Ruined Area Map Reference (L4)	Ruined structure with uncarved stone pillars, a part of a statue, bricks and tiles were identified in an area within a distance of about 665 meters from the left side of the Canal	Dambualla Divisional Secretariat Division, Lenadora South GS Division
Mound Belongs Ancient Settlers near the Ambagahadalupotha Tank. Map Reference (L5)	Red ware and plain red ware together with Iron Slag in an area approximately 75 x 75 m within a distance of about 253 meters from the right side of the Canal.	Dambualla Divisional Secretariat Division, Lenadora South GS Division
Ancient Settlement near the Gallenawatta Tank Map Reference (L6)	Potsherd and Iron Slag in a land within a distance of about 12 meters from the right side of the Canal.	Dambualla D S Division, Ethabendiwewa GS Division
Manikdena Ancient Tank Map Reference (L7)	Manikdena Ancient Tank will be fed by the proposed canal.	Dambualla D S Division, Ethabendiwewa GS Division
Ancient Settlement near the Manikdena Ancient Tank Map Reference (L8)	Ancient Settlement near the embankment of the Manikdena Ancient Tank was identified which has potsherd and Iron Slag in an area of about 2 acres in a land	Dambualla Divisional Secretariat Division, Ethabendiwewa GS Division
Ancient Settlement near the Udamehela Tank Map Reference (L9)	Ancient Settlement at the end of the embankment of the Udamehela Tank was identified which has potsherd within a distance of about 39 meters from the left side of the Canal.	Dambualla Divisional Secretariat Division, Ethabendiwewa GS Division
Ancient Settlement No. 1 near the Kongolla Tank Map Reference (L10)	Ancient Mound near the Kongolla Tank was identified which has potsherd and iron Slag in an area of about 150 x 150 m within a distance of about 18 meters from the right side of the Canal.	Dambualla Divisional Secretariat Division, Ethabendiwewa GS Division
Ancient Settlement No. 2 near the Kongolla Tank Map Reference (L11)	Ancient Mound near the Kongolla Tank was identified which has potsherd, iron Slag, Chinese and British ceramic ware in an area of about 75 x 75 m belongs to the land of officer in charge of fields within a distance of about 40 meters from the right side of the Canal.	Dambualla Divisional Secretariat Division, Ethabendiwewa GS Division
Ancient Potsherd Deposit	Ancient Potsherd Deposit was identified within	Dambualla Divisional

Map Reference (L12)	a distance of 106 meters from the left side of the Canal.	Secretariat Division, Kospotha GS Division
Ancient Settlement at the Kalgasyaya Village Map Reference (L13)	Ancient Mound for a size of about 100 x 80 meters with Red Ware potsherd and Iron Slag was identified within a distance of about 05 meters from the left side of the Canal.	Dambulla Divisional Secretariat Division, Kospotha GS Division
Neelagama Ancient Temple Map Reference (L14)	Rock cut caves on the early ancient period is situated in a Rock Hillock within a distance of about 123 meters from the left side of the Canal.	Dambulla Divisional Secretariat Division, Matale District, Neelagama GS Division
Ancient Caves Near Neelagama Ancient Temple Map Reference (L15)	Rock cut caves on the early ancient period is situated in a Rock Hillock within a distance of about 03 meters from the left side of the Canal	Dambulla D S Division, Neelagama GS Division
Ruined Area at Korakahagolla Map Reference (L16)	Ruined Area with bases of stone pillars with a spared of potsherd is situated in a land which also includes a mound may be a stupa was identified within a distance of about 35 meters from the left side of the Canal.	Dambulla Divisional Secretariat Division, Pibiduna Gama GS Division
Ruined Tank Map Reference (L17)	Ruined Tank with a 75 m embankment was identified within a distance of about 40 meters from the right side of the Canal.	Kurunegala District, Polpithigama Divisional Secretariat Division,
Cairn Burial Site of Gorakapelessa Map Reference (L18)	Cairn Burial Site in an area of 100 x 100 m was identified within a distance of 100 meters from the left side of the Canal inside Pahalla Pllekele Forest Reserve.	Kurunegala District, Polpithigama Divisional Secretariat Division.
Ancient Iron Slag Deposit Map Reference (L19)	An ancient Iron Slag Deposit of approximately 75 x 75 meters in the teak planted area with red ware potsherd within a distance of about 100 meters from the left side of the Canal was identified as a natural mound.	Kurunegala District, Polpithigama Divisional Secretariat Division
Ruined Mahakitula Tank Map Reference (L20)	Mahakithula Tank has been completely ruined and in which the ancient sluice could be identified. There are several stone slabs in the area where the sluice was.	Polpithigama Divisional Secretariat Division, Kalugala GS Division
Ancient Settlement near the Mahakitula Tank Map Reference (L21)	A deposit of about 50 x 50 m with Black and Red ware towards the South East of the Mahakithula Tank was identified within a distance of about 90 meters from the left side of the Canal.	Polpithigama Divisional Secretariat Division, Kalugala GS Division
Mahadambe Tank Map Reference (L22)	Mahadambe Tank which has already been repaired is to be expanded under the project.	Polpithigama D S Division, Dambe GS Division
Ancient Settlement Map Reference (L23)	A deposit of about 100 x 80 m with Red ware potsherd and Iron Slags near the Mahadambe Tank was identified.	Polpithigama Divisional Secretariat Division, Dambe GS Division
Mahakirula Tank Map Reference (L24)	Mahakirula Tank is to be expanded under the project.	Polpithigama D S Division, Herath Gama GS Division
Ancient Settlement near the Mahakirula Tank Map Reference (L25)	A deposit of about 40 x 50 m with pot shreds towards the left of the Mahakirula Tank was identified within a distance of about 268 meters from the left side of the Canal.	Polpithigama Divisional Secretariat Division, Herath Gama GS Division
Ancient Pot Shred Deposit Map Reference (L26)	An ancient Pot Shred Deposit with Red Ware of approximately 35 x 35 meters near the left bank of the Kirala canal within a distance of about 33 meters from the right side of the Canal.	Polpithigama Divisional Secretariat Division, Herath Gama GS Division

Jayalthgamawewa Ancient Tank Map Reference (L27)	Jayalathgamawewa Ancient Tank with a ruined approximately 150 m embankment.	Polpithigama D S Division, Tambuwatawana GS Division
Nelumwewa Ancient Tank Map Reference (L28)	Ancient Tank with a ruined approximately 75 m embankment	Polpithigama D S Division, Tambuwatawana GS Division
Gorakagahawewa Ancient Tank Map Reference (L29)	Ancient Tank with a ruined approximately 75 m embankment	Polpithigama D S Division, Tambuwatawana GS Division
Polgahawewa Ancient Tank Map Reference (L30)	Ancient Tank with a ruined approximately 80 m embankment.	Polpithigama D S Division, Tambuwatawana GS Division
Ancient Settlement near the Polgahawewa Ancient Tank Map Reference (L31)	A settlement which has been vacated by the settler about 5 years ago was identified within a distance of about 114 meters from the right side of the Canal.	Polpithigama Divisional Secretariat Division, Kduruwewa GS Division
Karagaswewa Ancient Rock Temple Map Reference (L32)	Karagaswewa Ancient Rock Temple with caves used for an image house may be belongs to the early historical period with a shatters pot shreds was identified within a distance of about 97 meters from the right side of the Canal.	Polpithigama Divisional Secretariat Division, Karagaswewa GS Division
Metigannawewa Ancient Tank Map Reference (L33)	Metigannawewa Ancient Tank which is completely ruined was identified within a distance of about 558 meters from the left side of the Canal.	Polpithigama Divisional Secretariat Division, Watuwattegama GS Division
A caved stone with a Cobra Figure Map Reference (L34)	A carved stone with a cobra figure was identified in an area ruined by treasure hunters near the Metigannawewa Ancient Tank which was identified within a distance of about 635 meters from the left side of the Canal.	Polpithigama Divisional Secretariat Division, Watuwattegama GS Division
Kaduruwewa Ancient Tank Map Reference (L35)	Kaduruwewa Ancient Tank which is the end of the NWP Canal	Polpithigama D S Division, Kaduruwewa GS Division
Ruined Area near Wawulewa Ancient Tank Map Reference (L36)	A ruined area with roughly carved stone pillers ransacked by treasure hunters were identified near the Wawulewa Ancient Tank within a distance of about 209 meters from the left side of the starting point of the Canal leading to Ambakolawewa.	Polpithigama Divisional Secretariat Division, Kumbukulawa GS Division
Rock Monastery of Liyanagama Map Reference (L37)	A carved cave in which a monk is inhabited was identified near the Ihalawatte Tank.	Polpithigama D S Division, Hathigamuwa GS Division
Area with Artifacts near Rock Monastery of Liyanagama Map Reference (L38)	Land belongs to between Ihalawattewewa and Liyanagama Rock monastery was identified with an area of about 100 x 75 m full of Red Ware and Red Painted ware shreds.	Polpithigama Divisional Secretariat Division, Hathigamuwa GS Division
Rock Monastery of Kowilkanda Map Reference (L39)	An area with carved cave and ancient stone pillars were identified with in the area of rock monastery of Kowilkanda	Mahawa D S Division, Moragaswewa GS Division

CHAPTER 4

4. ANTICIPATED ENVIRONMENTAL IMPACTS OF PROPOSED PROJECT

4.1 Hydrological Changes in Amban Ganga

Operation Phase

272. Impact on current water users: Nalanda reservoir is mainly a storage reservoir upstream of Wemedilla reservoir. Spill waters of Nalanda feed Bowatenne reservoir. However, when the original purpose of constructing Nalanda reservoir is considered, Mahaweli System H does not require waters from Nalanda reservoir at present. Moragahakanda and Kaluganga projects, which are ongoing, are expected to be completed by the time stage 1 of NWP diversions start. In addition, repairs/modifications to Nalanda reservoir would add to its flexibility to divert water to NWP and to supplement water to NWP. Currently, the annual spillage at Nalanda reservoir is estimated as 20.9 m million m^3 occurring during October to April, during the rainy periods for the dry zone. When the structural repairs are completed the reservoir will be filled to design FSL and spillage will be reduced.

273. About 90 ha is being cultivated downstream of Nalanda dam. Water is released to the downstream lands through the bottom outlet, which will cater for environmental flows as well. Nalanda reservoir also issues water to Wemedilla and Devahuwa Reservoirs (Please refer Figure 2-4). As the diversion to Wemedilla is to be taken place at a higher elevation, it will not affect either environmental flows or water for downstream users.

Environmental Flows: Diversion of water from Nalanda reservoir will reduce the spills from the reservoir to Amban Ganga upstream of Bowatenne. The river reach from Nalanda to Bowatenne is about 3 km, and water is supplied to about 93 ha from this river reach with irrigation releases from Nalanda dam. The monthly averaged distribution of spills of Nalanda reservoir and irrigation releases (in million m3) are as follows:

Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Spills	0.22	3.86	7.98	2.67	1.21	2.63	2.39	0.00	0.00	0.00	0.00	0.00
Irrigation release	0.08	0.23	0.16	0.24	0.24	0.08	0.10	0.37	0.39	0.36	0.11	0.08

Source of data: Acres Model Simulation Results, Run Time A10A, by WMS (MASL)/MCB.

It can be seen that the spills from Nalanda reservoir is negligible during May to September. During this dry period, there will be the irrigation releases to the command area of the Nalanda reservoir

274. The environmental flow requirement during the zero-irrigation demand periods is recommended to be released from the bottom outlet. It is understood that currently accepted practice is to issue 5 ft^3/s (about 0.14 m^3/s) to the downstream from the bottom outlet during zero-irrigation demand periods, and this practice is recommended to be continued, with necessary adjustments according to changes in environmental or domestic demands. During irrigation issues a separate environmental flow is not needed as the return flow is sufficient to cater the environment needs.

4.2 Hydrological Changes in Mi Oya and Hakwatuna Oya Basins

Operation Phase

275. A water balance study has been undertaken during pre feasibility stage and later to study the whole basin considering existing and proposed developments. It is proposed to divert water to Mi Oya and Hakwatuna Oya basins in two stages.

Stage 1: Divert about 30 MCM from Nalanda reservoir water to Hakwatuna Oya basin via Wemedilla-Devahuwa-Mahakithula-Hakwatuna Oya route in addition to the current diversion of about 30 million m3 to Wemedilla and Devahuwa schemes.

276. Impacts on current status of hydrology:

Deduru Oya basin: The diversions will have a positive impact on Deduru Oya basin through water transfer to Hakwatuna Oya reservoir. Refer Fig 3.2.
Kala Oya Basin: The diversions will have a positive impact on Kala Oya basin through water transfer to Wemedilla and Devahuwa reservoirs.
Mi Oya Basin: The diversions will have a positive impact on Mi Oya basin through water transfer to Mahakithula and Mahakirula reservoirs and about 500 ha in the minor tank cascade systems
Maintenance of the minimum storage of 1/3 capacity in the tanks (even during the dry seasons) will have an environmental benefit to the wild animals. It will enable the maintenance of a comparatively high groundwater level during dry periods, which helps improving the groundwater quality and minimize the drought effects on forests.

Stage 2 -Diversion of Mahaweli water to Mi Oya Basin from a point downstream of existing Bowatenna Irrigation Tunnel

277. The Stage 2 developments include:

New diversion weir across Dambulu Oya and a lined canal of length 8.0 km (capacity 10 cumec) from downstream of Bowatenna tunnel diversion at Dambulu Oya near Lenadora to divert 100 MCM annually to connect to existing Devahuwa Feeder Canal (Wemedilla Left Bank Main Canal).

278. New diversion canals within the NWP benefitted area

<u>Impacts:</u> Stage 2 comprises of diversion of another 100 MCM annually from downstream of Bowatenna irrigation tunnel to Upper Mi Oya irrigation systems once the Moragahakanda-Kaluganga project and Upper Elahera Canal have been completed.

279. It is earmarked to feed about 9,000 ha Under Stage 2 involving minor tanks en-route from Bowatenna to Maha Kithula wewa, Mediyawa cascade, and balance minor tank cascade in upper Mi Oya basin, Abakola wewa, and Attaragalla and Palukadawala reservoirs. There are several water users downstream of Bowatenna and upstream of Huruluwewa. These users will not be affected by the proposed transfer as 85 MCM is issued to these users annually, according to water balance study.

Impact of newly built reservoirs and Anicuts on environmental flows:

280. The consultants have used rainfall/runoff relationships and monthly-averaged rainfall to derive the monthly local inflow series at main storage/diversion nodes. In this study the regression coefficients derived for the Mi Oya and Yan Oya basins were used. The following structures can have an effect on the environmental flows downstream of them:

Restoration of Mahakithula reservoir on Hakwatuna Oya and diversion of a part of water to Mi Oya

281. After restoring the Mahakithula reservoir, a bifurcation structure downstream of Mahakithula will apportion water to Hakwatuna Oya reservoir and Mi Oya basin via Mahakirula reservoir. Current local inflows to Hakwatuna Oya reservoir and Mahakirula are as follows:

Month	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
Hakwatuna	1.64	3.09	1.71	0.77	0.41	0.55	1.64	0.63	0.06	0.07	0.06	0.18
Mahakirula	017	0.32	0.18	0.08	0.04	0.06	0.17	0.06	0.01	0.01	0.01	0.02

282. The total annual local inflows to Hakwatuna and Mahakirula are 10.81 and 1.13 million m^3 respectively. In the stage 1 of development, the diversions to Hakwatuna Oya will be 10 million m^3 in addition to inflows, and the inflows remain the same. As such, there will be no negative impact on the environmental flows.

Mahakirula Tank

Maha Kirula Reservoir: Modifications to the Headwork which impacts the current spilling pattern.

When the water balance studies are perused, it can be seen that there will be a considerable increase to the inflow to Maha Kirula Reservoir. The outflow from the Mahakirula sluice is 12.4 MCM while the spillage is 12 MCM annually.

Anicut for diversion to Mediyawa cascade

283. The feasibility study states that there will be continuous release of water downstream for irrigation purposes from the newly built reservoirs like Mahakithula and Mahakirula during irrigation issues. During off-seasons at least local inflow which is estimated to be 0.2 m^3/sec to the reservoir shall be released downstream to meet domestic and environmental requirements. The diversion anicut which is downstream of the reservoir that diverts water to the Mediyawa system, shall be fully opened to maintain the Mi Oya natural flow conditions during off seasons.

4.2.1 Flooding

Construction and operation phases

284. Mahakithula and Mahakirula reservoirs are located across main tributaries of Deduru Oya and Mi Oya. Both rivers are prone to floods as both have steep gradients in catchments. Therefore, floods are expected especially in wet periods in the worksites. The proposed reservoirs will have a mitigation effect on floods. But more streams confluence Mi Oya and Deduru Oya at downstream locations of reservoirs. Hence, the flood waters arising from the catchments of those streams will

not be mitigated by the proposed reservoirs. Therefore, flooding may be a problem during operation phase also, but not as a result of the project, and should be less. Floods may have devastating effects depending on the magnitude of flood. Mi Oya Basin and Hakwatuna Oya (sub basin of Deduru oya basin) receive large amounts of water during North East monsoon. Flooding is a common phenomenon during the rainy seasons. Beneficiary areas close to the streams usually affected by flooding. This is a usual situation in the area. But, floods are not created as a result of the proposed diversion. The proposed reservoirs will mitigate floods to a certain degree.

4.3 Impacts on ecology due to hydrological changes

4.3.1 Ecological Impacts

Operation Phase

Habitats and Flora

285. A major part of the proposed canal (about 65 km out of 76 km) traverses (through human modified habitats such as home gardens, paddy fields, agricultural and abandoned lands. The species assemblage observed in these habitats was dominated by common species which are generally found in such manmade habitats. These species show a high degree of adaptability to changes and therefore will not be affected a great deal by the proposed project.

286. In addition to these highly human modified habitats the two reservoirs, Mahakitula and Mahakirula, will result in the inundation of several natural habitats such as scrub, dry-mixed evergreen forests, degraded dry-mixed **evergreen** forest, degraded teak plantation, and riverine forests. The total inundation extent of these two reservoirs is about 342 ha. New Access roads will not be created and the existing e jeep and cart tracts available in the sanctuary wil be used to access the sites. These tracts are used even now. Each of these habitat supports rich floral assemblages that are different to what was encountered in the manmade habitats. The species richness in these habitats is comparatively high and the species composition also different from the manmade habitats.

287. The main impact anticipated in these natural habitats includes the habitat degradation, fragmentation and loss of habitat. There will not be a total loss of habitat for any animal or plant species in the project area. After, the construction the volume of water retained by the reservoirs will be increased and the availability of water for animals during the dry season would be a beneficial impact In addition, the water in the canal that traverses through the sanctuary would be available for animals. Also water table would be increased and water recharging of the nearby area of reservoirs would be a beneficial factor for plant growth. Majority of habitats and species that are affected by the proposed project are found in surrounding areas and therefore the overall impact is not significant considering the extent and magnitude of the impact.

288. Only a few endemic and threatened species were identified in the study area during the survey. This includes 10 endemic and one endangered plant species (*Diospyros ebenum*- Kaluwara). This is the normal pattern observed in dry zone habitats which are rich in terms of diversity but poor in terms of endemic or threatened species compared to wet zone forests. Forests that are present in

the direct impact zone were declared as forest reserves (Kahalla FR (1935), Pallekele FR (1896)). Recently declared (1989) Kahalla- Pallekele sanctuary encompass major parts of these two forest reserves. Other than these there are no declared Nature Reserves, National Parks, Elephant Corridors or Protected Wetlands in the direct impact zone or close proximity to the direct impact zone of the project.

Impacts on Fauna

289. The proposed NWP canal traverses mainly through human modified habitats such as paddy fields, cultivated lands, home gardens and abandoned lands except for 1.4 km long link canal that will be constructed within the Kahalla-Pallekele sanctuary the two proposed tanks, *Maha Kithula* and *Maha Kirula* will inundate forest, scrub forest and teak planted areas within the Kahalla-Pallekele sanctuary. Each of these habitats supports faunal and floral assemblage that is different to what was encountered in the manmade habitats within which the NWP canal will be established. The species richness within the Kahalla-Pallekele sanctuary was comparatively high and further the species composition also differed from the manmade habitats. Thus the environmental impact due to the two tanks will be much greater. The main negative impacts that will arise includes loss of habitat as well as blockage of movement paths for animals, especially large charismatic species such as Asian Elephant, Sloth bear, threatened and endemic reptiles, birds and butterflies.

290. Most of these impacts can be mitigated with proper design and following environmental best practices (see next chapter). Therefore measures described in the environmental management plan should be implemented to minimize negative impacts of the project. The contract documents shall contain requirements of environmental mitigation measures identified in the EMP. Based on the field investigations carried out to date the major environmental impacts identified are as follows:

Impact on terrestrial fauna and flora due to loss, fragmentation and change of habitats:

Operation Phase

291. The project will result in habitat fragmentation in the Kahalla-Pallekele sanctuary due to the construction of the link canal between Mahakithula and Maha Kirula reservoirs. However, the link canal that will be constructed within the Kahalla-Pallekele sanctuary will be an earthen canal and designed as a natural stream without lining the canal with concrete. Further, this canal will be subjected to seasonal drying. Water will be issued through this canal only when there is a deficit in Mahakirula Reservoir. Therefore, the fragmentation effect will only be applicable to times when there is flow of water in the link canal. Thus the proposed project will not have a significant fragmentation effect on natural habitats. The link canal between Mahakithula and Mahakirula reservoirs is a trapezoidal earthen canal. Around 50% of the length is cut and cover section and animal movement is not affects in these sections. Further another 7.5% of the length is a natural canal. The balance 42.5% is open earthen section and animal crossings are provided at appropriate locations to facilitate animal movement. (Annexure VI-I infrastructure) Therefore the only significant impact that will arise due to the project will be loss of habitat (approximately 342 ha) due to the establishment of the two tanks. These forest habitats are important biodiversity repositories as was evident by the species that were recorded in these habitats.

292. This impact will be irreversible in effect as this will result in permanent conversion of these habitats into a reservoir. The terrestrial species that were utilizing this area will lose their habitat.as the terrestrial species assemblage in the inundation area will be replaced by an aquatic species assemblage. Further, during the construction stage removal of vegetation cover and existing buildings may result in loss of habitats (feeding, roosting and breeding sites) of animals. Thus it can be concluded that terrestrial species occupying both natural and manmade habitats in the proposed reservoir area will be adversely affected by the project due to habitat loss. However, the area impacted is less than 2% of the available habitat and therefore the habitat loss resulting due to the project will not be significant. As the project envisages construction of a long canal, another negative impact that will arise will be fragmentation of habitats, especially of those animals that have low mobility. Further, in the sections where the canal is lined with concrete, animals can fall into the canal that will result in either death or injury to these animals.

Impact on Forest Reserves:

293. The area that will be inundated due to the two proposed tanks falls within the Kahalla-Pallekele sanctuary. The sanctuary comprises a total area of 21690 ha. Therefore, this activity will result in loss of some forest, scrub and teak planted area. Further the later part of the NWP canal will be traversing around the foothills of Galgiriyakanda proposed forest reserve and therefore will not have a significant impact on this forest reserve.

4.3.2 Fauna

Impact on nearby wildlife reserves and wildlife migration:

Construction Phase

294. The only wildlife reserve that is present in the project direct impact zone is the Kahalla-Pallekele sanctuary. Other than this there are no Nature Reserves, National Parks, Elephant Corridors, Forest Reserves or Protected Wetlands in the direct impact zone of the project. Therefore the project will have a moderate impact on the Kahalla-Pallekele sanctuary.

295. Further, animal movement in the area is likely to be blocked due to the establishment of the two tanks and the canals, which can be identified as a negative impact of the project. No specific animal corridors were observed during the survey. Further, the proposed development will result in loss of habitat of the species occupying the area that will be inundated. However, the loss of habitat due to the project is less than 2% of the available habitat in the sanctuary and therefore will not be significant. The proposed development will also not function as a permanent barrier to animal movement as the reservoir will be maintained at full supply level for only a short period and thereafter the tank bed will become progressively exposed as the water level recedes which will facilitate movement through the tank bed. The area that will be inundated is also utilized by nine species of forest dwelling migratory birds, especially the riverine forests and other forest habitats. Therefore, the project will result in loss of habitat for these migrant birds as well. None of the migrant birds observed in the project area are restricted to this area. Further, all the migrant species observed show a wide distribution in Sri Lanka. As such the loss of habitat for these species will not be a significant impact.

Impact on wetlands due to changes in the water balance:

Operation Phase

296. The proposed project will not have a significant negative impact on wetlands. In fact the project will result in the creation of water bodies/wetlands, the two tanks, *Maha Kithula* and *Maha Kirula* as well as the canals. Therefore aquatic species as well as aquatic associates will benefit from the establishment of the project. Further, number of seasonal and perennial tanks will be augmented by the water brought in from the project which is also going to be a beneficial for the aquatic species and aquatic associates that inhabit the project area.

Introduction of invasive species due to the project:

Construction Phase

297. At present only a few invasive alien species occur in the project area. However, during the construction stage earth moving machinery as well as construction material such as soil and gravel that are brought into the site can introduce weeds of invasive alien species into the area. Further, the areas cleared of vegetation to extract borrow material as well as construction material storage areas are also potential sites for establishment of alien invasive species. Therefore, during the construction stage there is a strong possibility of introduction and establishment of invasive plant species into the project area which can subsequently spread into surrounding areas.

298. Also many of the wetland areas in the project site already contain several invasive alien plant species of which the main one is *Eichornia crassipes* (Water hyacinth). The increased availability of water will increase the potential for these aquatic alien species to further spread in the area. Such introduced invasive alien species can have a significant impact as they can cause blockage of water ways as well as make the land unsuitable for farming as well as spread into natural areas and pose a threat to native fauna and flora.

Impact on rare and endemic species:

299. A few endemic and threatened species were identified in the study area during the survey. This includes eighteen species of endemic animals and eight species of globally or nationally threatened animals. This is the normal pattern observed in dry zone habitats which are rich in terms of diversity but poor in terms of endemic or threatened species compared to wet zone forests.

Other impacts that will arise due to the proposed project include:

Construction Phase

300. Recruitment of labourers for project construction will generate sewage, waste water and solid waste at camp sites. Such workers might harm natural habitats by hunting and felling trees illegally. The camp sites are located along Ibbagamuwa Polpithigama road close to Polpithigama town and near Wemedilla Reservoir. Both of these sites are outside of the sanctuary. Contractors' equipment yards will be located near two reservoirs. Noise and vibrations that will arise due to activities such as excavation, cutting, filling and compaction work, as well as operation of construction related vehicles

during the construction phase will cause disturbance especially to the fauna that inhabits the project area.

301. Clearance of plant cover during the construction phase could cause soil erosion, which in turn will result in increased sedimentation of natural waterways. Further, land preparation for the project could result in blockage or alteration of natural flow paths causing changes in the drainage patterns in the area. Occupational safety of labour recruited and safety of community living close to construction area need to be given attention.

4.4 Impacts on Agriculture

Operation Phase

302. Under the proposed project, there is no development of new lands. Instead, CI under major, medium and village reservoirs will be increased. The CI for village tank cascades will be increased from 0.9 to 1.4 while the average CI of major and medium reservoirs will be increased up to 1.8. With the implementation of the project positive impacts are expected in the agriculture sector in the project area.

303. The major and medium schemes and, majority of village reservoirs and land mass which will receive diverted Mahaweli water under the proposed canal project are located in Low Country Dry Zone(DL1) and Low Country Intermediate (semi- dry) zone(IL3)regions. Galewela DS area falls under Mid Country Intermediate Zone (IM3b). The Table 4.1 provides the characteristics such as annual rainfall, terrain and typical land use within the proposed NWP canal project area.

Table 4-1 Characteristics of Agro-Ecological zones in the project area

Agro-Ecological Zone	Climatic Zone	Annual Rainfall (mm)*	Terrain & Land Use
DL1B	Dry Zone Low Country	> 900	Undulating Terrain Rain fed upland crops, Paddy, Scrub, mixed home gardens, Forest plantations
IL3	Intermediate Zone Low Country	> 1,100	Undulating Terrain Coconut, Paddy, Mixed home gardens
IM3B	Intermediate Zone Mid Country	> 1,200	Rolling and Undulating Terrain Mixed home gardens, Export agriculture crops, Vegetable, Paddy

* 75% Expectancy Value of Annual Rainfall

Source: Environmental Atlas of Sri Lanka, Central Environmental Authority, 2005

304. Normally, in the dry and intermediate zones, irrigation tanks are dried up towards the end of yala season. Farmers start maha season cultivation only when the water in the tank comes up to a level, which can support a crop. The paddy extent cultivated in maha season, under medium and small irrigation tanks depends on the water level in the tank which in turn depends on the rainfall.

Filling of these tanks with Mahaweli water to nearly 30% of the tank capacity before the onset of maha rains will help to encourage and persuade farmers for timely cultivation.

305. If the farmers can start cultivation on the correct time, they can use traditional methods of land preparation, weeds and pest management etc.; thus minimizing the use of herbicides and other pesticides. (When the cultivation is delayed farmers use herbicides extensively to prepare the land within a short period of time; and as most of the time critical growth period of the crop coincides with pest resurgences, use pesticides more frequently). However, with two cultivation seasons instead of hitherto practiced one cultivation may increase use of agrochemicals.

306. Timely cultivation, will help the farmers to use maha rains effectively and efficiently to cultivate the total asweedumized paddy extent under the tank which will result in increase of cropping intensity. Assured irrigation water supply will help the agriculture extension officials to promote timely cultivation, use of improved agricultural practices, high yielding crop varieties, and timely use of inputs such as fertilizers etc. which will lead to increase in average yields and reduce cost of production.

Mitigation of impact of drought Exposure

307. As shown in the document “Water, Climate Change Vulnerability in Sri Lanka” (Supplementary document to The National Climate Change Adaptation Strategy for Sri Lanka 2011-2016) both irrigation sector and drinking water sector vulnerability with respect to drought widespread in the island. However, more concentrated in the Dry and Intermediate Zones specially the three river basins in North Western Province (NWP) including the upper catchment. Thus, the proposed project diverts Mahaweli water to NWP play a very important role in mitigating the impacts of drought on agricultural production and drinking water.

Highland (Chena) Cultivation

308. During the dry (yala) season, farmers cultivate root-crops such as beet, radish, leafy vegetables, maize and chili using micro irrigation systems such as drip irrigation and sprinklers on highlands. As the dry season progresses the water level in the shallow dug wells drops and the streams dry out, farmers face difficulties in irrigating crops. This often results in reducing crop yield and yield quality. Storage of water in reservoirs would facilitate the cultivation of yala crops with irrigation water security. Such storage water may lead to improve the ground water table in the surrounding areas.

309. Seepage water will help to maintain the ground water table at a reasonable depth close to the ground surface even in the dry season which is a positive impact. Thus, the farmers will be able to use ground water to cultivate crops more effectively and efficiently and hence improve yield, cropping intensity etc. By using water from shallow dug wells and close by streams, and use of advanced irrigation methods such as drip and sprinkler irrigation, it is possible to cultivate 3-4 crops of high income generating short term (40- 60 days) crops such as beet-root, radish, and green chili etc.

Homestead Development

310. As in other areas of the dry zone, people in the project area have neglected their homesteads mainly due to difficulty in maintaining in the dry period. Traditionally, homesteads in the dry and intermediate zones are located closer to the village tanks so that people have easy access to tank water for their day-to-day activities. Homesteads are mostly covered with perennials such as Coconut, Mango, Cashew, Tamarind jack, Kohomba (Margosa) which provide shade to the homestead and semi-perennials such as banana, orange and lime. Growth and the yield of these trees get affected during yala season due to scarcity of water.

311. A reasonably high ground water table which could be expected to prevail throughout the year due to storage of water in the tanks in both maha and yala seasons, would help to grow perennial fruit trees in the homesteads and high yields. The effect of diverted water on ground water table is limited to areas around canals and paddy fields. The extent of influence depends on many variables such as elevation and soil characteristics. Homesteads also could be undertaken for intensive cultivation of high value crops using shallow dug wells and micro irrigation systems such as drip and sprinklers.

Employment opportunities

312. The social benefits that will accrue as a result of diversion of Mahaweli water to medium and small village tanks in NWP where acute problem of water scarcity prevails will be quite significant. The project is basically geared towards increase in the cropping intensity and agricultural production under irrigation tanks by providing diverted water to cultivate the total asweddumized extent in yala season. This will generate more employment opportunities to the agricultural labourers and thereby increase their income and the living standards. With the diversion of Mahaweli water, the water availability in medium and small village tanks will become more stable for the production of fresh water fish. This will lead to increase in fish harvest, provide protein for the community at a lower cost and enhanced employment opportunities.

4.5 Impacts of Relocation and Resettlement

4.5.1 Information on the affecting Human habitats and displacing community

A resettlement plan detailing compensation for affected persons has been prepared for this project.

313. Twenty (20) houses out of Twenty Two (22) families are directly affected but only one have to be relocated. The families most directly affected refuse to resettle in an area a long distance away from their current residences. The community that would be affected by the proposed project has lived in the area for nearly 40 years and sacrificed in various ways to achieve their present status of socio economic stability. The alienation of people from their native lands will result in the loss of many formerly enjoyed social and economic advantages. In most cases, only part of lands will be taken for the project and the affected person might be able to rebuild a new home in the remaining part of their lands.

4.5.2 Impacts on the land use pattern of the area

314. Although the proposed canal trace falls through 41 villages of 31 GNDs of 5 DS divisions it claims only a 30 m wide stretch (15 m at both sides of the center line) along the canal. Except 5 acres of highlands and 0.5 acres of paddy lands all of other lands are conserved forest. Therefore no significant impacts to the land use pattern with the construction of the proposed canal. Only the 30 m wide land belt will be acquired and the owners will be free to make use of the balance part of their plots as required. Since the proposed canal would supply water to the small tanks in the Project Area the farmers cultivating their lands under the small tanks would have the benefit of irrigation water during both Yala & Maha seasons. Cropping intensity of village tanks will be improved from present level of 0.9 to 1.4. Although these can be pointed out as the positive impacts of the proposed Project owners of small plots may face several other negative impacts such as displacement, land being occupied by the new settlers etc.

4.5.2.1 Impact on Land value in the Area

315. Although there will be a possibility that land value of the agricultural & residential plots of land within the Project Construction area (30 m land belt along the proposed canal) to reduce since the proposed 78 km long canal commencing from Nalanda reservoir runs through remote areas and feeds a number of small tanks on its way, the value of the lands in the close proximity will rise considerably. Furthermore, the canal will refresh the existing connections between relevant 41 villages and 31 GNDs and will lead to fresh connections through marketing etc. and hence the land value of this area will keep on rising.

4.5.3 The Impact on Education

316. The children of the affecting area are presently being educated in various schools and pre-schools located around but no impacts because of living in the same area without relocating. They can enjoy with the same existing facilities. The proposed conveyance canal runs at the edge of the playground of the school for Muslim children located in Kappetiyava village of Ranvadiyava GND. This part of the canal is designed as a conduit to avoid danger. Except for this playground there are no any schools located within the Project Area.

4.5.4 The impact on health services of displacing community

317. Since there are no any health care centers located in the project construction area the impact will be minimum. However, the displacing community should be able to continue to receive healthcare they are receiving at the present location without interruption. The Project Management should take action to provide temporary facilities till they become adapted to the new environment

4.5.5 Impacts on standard of life of the community to be resettled

318. The people in the Project Construction area live in urban, semi-urban & rural environments along the proposed canal way. Their livelihood and lifestyle is inbuilt with the environment they are living. When considered as a whole, resettlement affects individuals in different ways depending on their circumstances. People would not have to completely move out of their places but settle in a place outside the proposed canal boundaries in the same plot. This can be considered as a positive impact as they will be able to reap the advantage of the water and other benefits that would come

with the canal. Most people in Mahava, Polpithigama, Galewela and Dambulla areas fall into the second category and will benefit from the Project.

4.5.6 Impact on Religion & Culture in the Project Construction Area and on the Displacing Community

319. Having located in close proximity to places of special archeological importance such as ancient Kingdoms, the Project area has a historically established Buddhist cultural environment and the economy and society in the area are closely woven together with such environment. The ancient concept of "Tank, Stupa, village & Temple" is still a well- respected and practiced philosophy. 62 families of 25 such villages would be affected by the proposed Project along with 2 families of other faiths.

320. Although not a single place of worship (Temples, churches, and mosques) would be affected by the proposed Project, the displacing community would be deprived of their consolation in performing religious activities conventional to the particular area. Adaptation to a new location would be difficult and stressful in this case and it takes time to build up such environment in an entirely strange place under unfamiliar circumstances.

4.5.7 Socio-Economic & Cultural impacts in the Project Area outside the Project Construction Area

321. The project targeted area is influenced by dry zone weather in which heavy rains are received in Maha season and low or no rains to receive during yala season. Communities have accustomed to store rain water as much as possible in various irrigation tanks in the area and plan their cultivation carefully by managing available water. In maha season when fair amount of rain is expected the practice is to cultivate vegetables and other subsidiary crops in uplands and paddy in lowland areas. In yala season they opt for subsidiary crops with low water requirement and use exceptionally marshy lands for paddy. Sometimes when severe drought conditions prevail they tend to go for shared cultivation where they share lands close to irrigation tanks for cultivation or cultivate a part of their land to save water.

322. Due to changes in global weather patterns, in last few years expected amounts of rainfall had not occurred in those dry areas. This has led to people seeking additional income from other livelihood sources and tending to temporarily give away their land on lease and stay away from agriculture. The NWP Water Diversion canal is proposed to augment major, medium and minor irrigation tanks in the area so that the farmer community of the area would be able to cultivate their lands without facing water shortages. Table 4-2 presents the irrigation tanks that would be augmented under the proposed Project.

Table 4-2 Major Reservoirs augmented by the project

Serial No	River Basin	Name of tank	Irrigable Area	DS Division
1	Kala Oya	Wamadilla	729	Dambulla
		Devahuva	1,215	Galewela
2	Deduru Oya	Hakvatuna Oya	2,579	Polpithigama
3	Mi Oya	Madiyava	486	Ambanpola
		Ambankola Weva	340	Ambanpola, Ahatuweva
		Atharagalla weva	419	Ahatuweva
		Palu kadawala weva	648	Ahatuweva, Galgamuva
Total	**03**	**07**	**6,416**	

Source - : Range Offices ,Department of Irrigation–Kandy and Kurunegala

Impact on land use pattern, income level of the community and health and safety in the Area

323. When irrigation facilities of the area are improved with additional water to 7 major tanks and 350 minor tanks in the area for both Yala & maha seasons, there would be an improvement in Ground water elevation in the area. This may lead to development of natural vegetation in the area in the form of small bush forests. Also people in the area would have good harvests from their perennial crops such as coconut, Jack fruit, Mango etc. Ultimately, there would be many more positive impacts in the agriculture field in the area due to the Project and changes in land use patterns also could be anticipated. Some of the benefits from improved land use as follows:

- With the augmentation through the proposed NWP Water Diversion Canal it would be possible to cultivate agricultural lands in both Yala & Maha seasons and raise Cropping Intensity and thereby earn a fair income .
- Rise in Production of rice & other subsidiary crops.
- Upgrading of income of the farmers and thereby uplifting of socio-economic standards.
- Rise in initiation of various commercial activities related to agriculture would increase employment opportunities in the area.
- The possibility of development of fresh water fish farming in irrigation tanks improvement of nutritional status of the community.

324. It would be certainly possible to witness above transformations in agriculture sector in the area and similar positive impacts could be anticipated other related fields too.

- There would be fair coordination between people in the project area due to the proposed road along the proposed conveyance canal. Development of connecting roads could be anticipated which would lead to development of a new road network. There would be positive and negative impacts associated with this development.
- With the connecting network associated with the proposed canal the remoteness of these rural areas would tend to diminish and they would be open to the wide world.
- Due to the development associated with the Project the land value and values of other assets of the area would tend to increase.

- The problem of poor access to safe drinking water which has presently become a threat to health &sanitation of the project area community would be solved.
- As a result of enhances water availability the Cropping Intensity will be increased. Along with higher CI use of agrochemicals will also be increased. This effect need to be mitigated.

325. When looking at the project area as a whole, these areas are of importance with respect to historical, religious, cultural and environmental aspects. Yet, they stayed undiscovered due to remoteness and difficulty in access to the area. With the development of new roads and connections there will be sight seers who prefer new adventures visiting the area hence the value of the area would raise. This would be a strong positive impact of the proposed project.

4.6 Stability of slopes and tunneling site

Construction Phase

Slope Failure and Landslide Potential of the Project Area and its surroundings.

326. It is necessary to consider landslide potential and slope failures with respect to three reservoir sites and Tunnel Site. Mahakirula proposed dam axis runs across existing Mahakirula wewa. As revealed from the preliminary investigations the banks and periphery of the reservoir mainly consists of high resistive quartzite material and overburden is also not thick. Therefore possibility of land slide is a less concern in this site. However precautions must be taken to remove detached unstable rock fragments, if any.

327. The Pothuwila tunnel about 700 m long runs across a ridge with maximum elevation of 20-22 m at the central part which is composed of quartzite. At the inlet & outlet portals no fracture free bedrock encountered. Since the overburden is thick showing gradual weathering profile during the construction of tunnel necessary precautions shall be taken to avoid any slide /slope failures. Before opening up for construction of portals strengthening measures will have to be taken.

328. Also denudation of the forest cover shall be kept to minimum in this area. Surface drainage should also be improved to minimize the percolation. Moreover it is recommended to do detailed Geological investigation (Drilling) at the tunnel trace in order to do proper design of the tunnel giving due consideration to weak areas, recommend grouting & shotcreting at the inlet &outlet portal areas concrete lining & anchor bolting where ever necessary in the intermediate area. Once the above measures are adopted adverse effects on the environment will be minimal while arresting any possible leakage into the tunnel or from the tunnel, any slippage of fractured rock. Open channel condition may be adopted at the inlet & outlet areas if the rooks are of highly weathered nature. This would be economical too.

4.7 Human Elephant Conflict

Operation Phase

329. Human-elephant conflicts are reported from the surrounding areas of the Kahalla-Pallekele Sanctuary through which the canal traverses and the two reservoirs will be constructed. In these areas, lands are not cultivated during the Yala season because of scarcity of irrigation water. As a result, elephants use such lands as their feeding grounds. When the project augments irrigation

water supply to these areas, cultivators will cultivate their land in the Yala season too depriving elephants of their feeding grounds. This may lead to confrontation between such farmers and elephants as elephants can encroach into crops and property of the villages. Thus the escalation of human-elephant conflicts has been identified as a significant impact of this project and several mitigating measures are proposed (see next chapter). However, it should be noted that the establishment of the two reservoirs will increase the availability of food during the dry season as the draw down area of the reservoir will support grasses and herbaceous species that can function as source of food for elephants and other grazers inhabiting the Sanctuary. Further, approximately 300 ha will be annexed to the park due to realignment of the existing electric fence to the ecological boundary between the Sanctuary and the surrounding human use area. This area should be managed as an elephant habitat by preventing forest regrowth either through controlled burning or periodic clearing.

4.8 Pollution Aspects

Construction Phase

4.8.1 Air Pollution

330. Localized Air pollution can occur due to exhaust dust and fumes generated due to construction activities. Large number of machinery and heavy equipment will be deployed during the construction phase of the project. In addition, there will be considerable vehicle movement in and around the project sites. Diesel and petrol will be used as fuel in these machinery and vehicles. As a result of fuel combustion CO, SO_2 and Oxides of Nitrogen (NO_x) will be discharged to atmosphere. Gasses like NO_x, CO mainly emitted to atmosphere during rock blasting. Permissible ambient air quality limits are given in Table 4-3.

Table 4-3 Permissible ambient air quality

Parameter	Permissible level (mg/m^3)
SPM (Small Particulate Matter)	0.50
SO_2 (Sulphur Dioxide)	0.20
NO_2 (Nitric Oxide)	0.25
CO (Carbon Monoxide)	30.0
O_3 (Ozone)	0.20

Source: CEA (Gazette Extra Ordinary no 850/4, December 20, 1994)

331. There will be impacts to environment due to clearing of lands for construction of reservoirs, roads, canals and ancillary structures. Fumes containing these gasses and particulate matter will be emitted if solid waste is burnt. Smoke generated thus may be a nuisance to public and workers employed by the project. The two main reservoirs in the project are located in the Kahalla Pallekele sanctuary. Hence the construction activities in these reservoirs will not affect the people. The tunnel

site is also located inside the sanctuary and hence disturbance to human life is minimal except for construction labour.

Dust from construction

332. Earth work, blasting operations, material transportation, storage yards, quarry activities and borrow pit activities of the project during construction will generate dust. As the main construction work is located in the sanctuary area, impacts on air quality where there are settlements is minimal. However, construction of canals may cause pollution in nearby communities.

4.8.2 Noise and Vibration Impacts

Construction Phase

333. The impacts of noise and vibrations are expected to be high during the construction period. Construction noise and vibration varies greatly depending on the construction process, type and condition of equipment used, layout of construction site. Many of these factors are traditionally left to contractors which make it difficult to accurately estimate levels of construction noise.

334. Overall construction noise levels are governed primarily by the noisiest pieces of equipment. For most construction equipment, the engine which is usually diesel driven, is the dominant noise source. Table 4-4 illustrates the noise levels from 15 m and 30 m of the noise generating construction equipment used during various stages of construction. Although the noise levels in the table represent typical values there can be wide fluctuations of operating conditions of the equipment and the technique used by the equipment operator. Noise and vibration impacts will be primarily due to quarry operations and blasting operations. Noise and resultant vibration will travel through air, along the surface of the ground and through the ground. According to the proposed noise standards of CEA the boundary of construction area shall not produce more noise than 75 dB during day time (6 am to 9 pm) and 50 dB during night time (9 pm to 6 am). Therefore boundaries of worksites where blasting operations are carried out should be kept a minimum 100 m away from residences. No work should be carried out during night time (after 9 pm).

Table 4-4 Noise levels of construction equipment

Equipment	Maximum noise level at 15 m from source – dB(A)	Leq Exposure at 15 m from source – dB (A)	Leq Exposure at 30 m from source – dB (A)
Auger/ Drill Rigs	85	82	76
Telescoping boom bucket trucks	81	71	65
Front End Loader	80	75	69
Dump Truck	71	63	57
Concrete Truck	82	79	73
Vibratory hammer	85	82	76

Generator	82	70	64
Pneumatic drill	85	80	74
Utility truck with crane	81	76	70
Flatbed truck	78	68	62
Compactor	81	75	69
Dozer	85	82	77
Hammer to drive rods	86	80	74
Backhoe	80	75	69
Wood saw to construct forms	88	82	76
Forklift	80	74	69

335. During the construction period, heavy vehicle movements and other construction activities will cause noise. The undulating terrain of the area will help to dissipate this noise and the vegetation could absorb part of it. Therefore, overall impact to the people of the surrounding would not be very significant. However, noise may affect the wildlife of the surrounding area. The construction noise may be generated over a significant period (the proposed construction periods for stage 1 are from 2015 to 2017 and stage two 2017 to 2023) due to noise generated by construction activities. The expected noise levels due to construction activities within the site area will increase up to about 80 to 95 dB (A) depending on the activities. This could cause workers at the site exposed to high noise levels (about 80 dB (A)) and may lead to health problems depending on the exposure time.

4.8.2.1 Rock Blasting

336. Rock blasting is expected in the construction of reservoirs and canals. Explosives will be used according to government regulations and supervision of Police. Explosives will be stored in the blasting material magazine in the Police station. Explosives will be transported to blasting sites under Police escort. Rock blasting and quarry operations are considered as noise and air pollutant source. Rock blasting is mainly involved in the construction of the tunnel. Also some quantities involved in the canal construction. The Pothuwila tunnel is located in the forest reserve and it is far from human habitats. However proper method of blasting should be adopted with regards to explosive type and weight delay - timing variations size and number of holes and rows, method and direction of Blast initiation to avoid undue ground vibrations. The canal in its initial reaches traverses through or near human habitats. After detailed geological investigations, controlled rock blasting will be carried out to avoid any undue ground vibration and air pollution. Ground vibration induced by rock blasting is directly related to the instantaneous change weight and the distance from the blast source.

- Distance from blast to point of concern.
- Orientation of the free face.
- Presence or absence of temperature inversions.
- Burden distance.

- Stemming height and/or material used.
- Weight of explosive detonated per delay period.

4.8.3 Surface Runoff and Erosion during construction

Construction Phase

337. Surface runoff from rainfall is the main parameter that contributes to soil erosion. Soil erosion also depends on several other parameters such as type of soil, slope, vegetation and the nature of topography. Soil erosion is expected to be high during the construction of Mahakithula dam and Mahakirula dam. It also will be high in resettlement areas and canal construction sites.

Soil productivity could decline due to erosion unless steps are taken to control it. There is a high risk of soil erosion from cleared lands and collapse of canal banks. Please refer chapter 5 for mitigatory measures.

4.8.4 Water pollution due to construction machinery

338. Different types of machinery and equipment will be used during construction stage and different types of fuels and lubricants will be used to operate them. Leakages of fuel and lubricants from such machinery could happen at work yards. Discarded lubricants from machinery if disposed of carelessly may pollute water in streams. In this regard, water pollution preventive and corrective maintenance is necessary.

4.9 Impacts on Archaeological sites

Construction Phase

339. The Department of Archaeology conducted an Archaeological Impact Assessment (AIA) in the project area. The report was submitted to MI&WRM in February 2013. This report provided the base for archeological study for the consultant in EIA team. All archaeological artefacts within the project area were plotted on maps to determine whether they fall within the identified areas of proposed activities of the project. Out of 39 identified archaeological sites following sites may have impacts due to the project.

340. According to the archaeological study carried out by the EIA ream member and the AIA report submitted by the Department of Archaeology following three sites are directly to be effected due to the project activities.

1. Cairn Burial Site of Gorakapelessa
2. Ancient Iron Slag Deposit near Cairn Burial Site of Gorakapelessa
3. Stone slabs which may be the remains of the ancient sluice of the Ruined Mahakitula Tank

341. All these sites are located within the Kahalla Pallekele Sanctuary and no social interest is identified in these sites. Over and above the Cairn Burial Site of Gorakapelessa and the Ancient Iron Slag Deposit is located in an area which is already disturbed due to the teak plantation. The Director General of Archaeology in his letter No. H/EXP/EIA/NWP/2013 dated 1st August 2013 has provided

approval for the project hence submerging the two sites due to the construction of the Mahakitula Tank has been allowed. (Annexure VI-IV).

342. Stone slabs which may be the remains of the ancient sluice of the Ruined Mahakitula Tank has to be removed during the restoration of the tank bund on the instructions of the Department of Archaeology and placed in the new tank bund in an exhibition area for which the cost would be borne by the project.

L14.Neelagama Ancient Temple

343. Neelagama Ancient Temple with rock cut caves on the early ancient period is situated in a Rock Hillock within a distance of about 123 meters from the left side of the Canal. GPS Points of the site is 07^0N 46.677 and 80^0E 32.158. Although **no direct impact** will cause due to the construction of the canal, indirect **impact may be caused** when using heavy machinery and rock blasting. However, rock blasting will be determined after auguring the site. The machinery that will be used in the construction will be excavators. If rock blasting is required chemical blasting is recommended to avoid damages to artifacts.

L18. Cairn Burial Site of Gorakapelessa

344. Cairn Burial Site in an area of 100 x 100 m was identified within a distance of 100 meters from the left side of the Canal inside Kahalla Pallekele Forest Reserve. The area consists of two ancient tanks, a settlement and area consisting Iron Slugs. GPS Points of the site is 07^0N 49.841 and 80^0E 29.447. Since the site is due to be submerged with the construction of the Mahakithula Tank **direct impact** of the site could be identified due to project. This has been allowed in the impact assessment conducted by the Department of Archaeology.

L19. Ancient Iron Slag Deposit

345. An ancient Iron Slag Deposit of approximately 75 x 75 meters in the teak planted area with red ware potsherd within a distance of about 100 meters from the left side of the Canal was identified as a natural mound. GPS Points of the site is 07^0N 49.841 and 80^0E 29.447. Since the area is due to be submerged **direct impact** of the site could be identified due to project.

L20. Ruined Mahakitula Tank

346. Mahakithula Tank has been completely ruined and in which the ancient sluice could be identified. There are several stone slabs in the area where the sluice was. GPS Points of the site is 07^0N 49.908 and 80^0E 29.239. Since the tank is expected to be rebuild the stone slabs belongs to the sluice may be disturbed. As such there is a **direct impact** on the site.

L36. Ruined Area near Wawulewa Ancient Tank

347. A ruined area with roughly carved stone pillars ransacked by treasure hunters were identified near the Wawulewa Ancient Tank within a distance of about 209 meters from the left side of the starting point of the Canal leading to Ambakolawewa. GPS Points of the site is 07^0N 49.674 and 80^0E 25.230.

4.10 Impacts on Mineral Resources

348. The only valuable mineral resources found in the project area are Quartz and Kaolin. The Mahakitula and Mahakirula Reservoirs are bordering Kaolin rich areas. The canal from the Mahakitula Reservoir to the Mahakirula Reservoir will also be constructed in this mineral rich area. Excavation will be limited to quantities required for construction purposes only, no further exploitation will be permitted.

4.11 Impacts on water usage/Extraction/Irrigation schemes

4.11.1 Irrigation Schemes

Operation Phase

349. The Project benefits several major irrigation schemes and a large number of minor reservoirs in three river basins, namely, the Kala Oya, Deduru Oya, and the Mi Oya Basins. The NWP Canal commences from Dambulu Oya and flows across the Kala Oya basin close to the ridge of Kala Oya and Deduru Oya basins. This initial reach of NWP Canal joins the existing left bank canal of Wemedilla Major Irrigation Scheme and flows up to Nebadagahawatta tank which will function as a level crossing for the canal. The small reservoir cascades in the upper reaches of the Kala Oya basin will receive water from the NWP canal to cultivate land in both Maha and Yala seasons.

350. The Dewahuwa Major Irrigation Scheme in the Kala Oya basin will be augmented under the project with an additional release from NWP canal. Water will be released from NWP canal to a natural stream in the catchment of Dewahuwa tank. The existing left bank canal of Wemedilla irrigation scheme will be widened to accommodate the addition water coming from Nalanda Oya reservoir and diversions from Dambulu Oya.

351. From Nebadagahawatta level crossing the NWP canal flows up to Mahakithula reservoir, a new reservoir proposed under the project at a location in the upper most reach of Deduru Oya river basin and between Kala Oya and Mi Oya basin boundaries. The Hakwatuna Oya irrigation scheme in the Deduru Oya river basin will receive water from Mahakithula reservoir through Iruwadeniyawa natural stream which directly flows to Hakwatuna Oya reservoir. As the new reservoir is located very close to the Mi Oya and Deduru Oya basin boundaries there is a possibility to release water from Maha Kithula reservoir to Mi Oya basin without filling Maha Kirula reservoir in any water short situations.

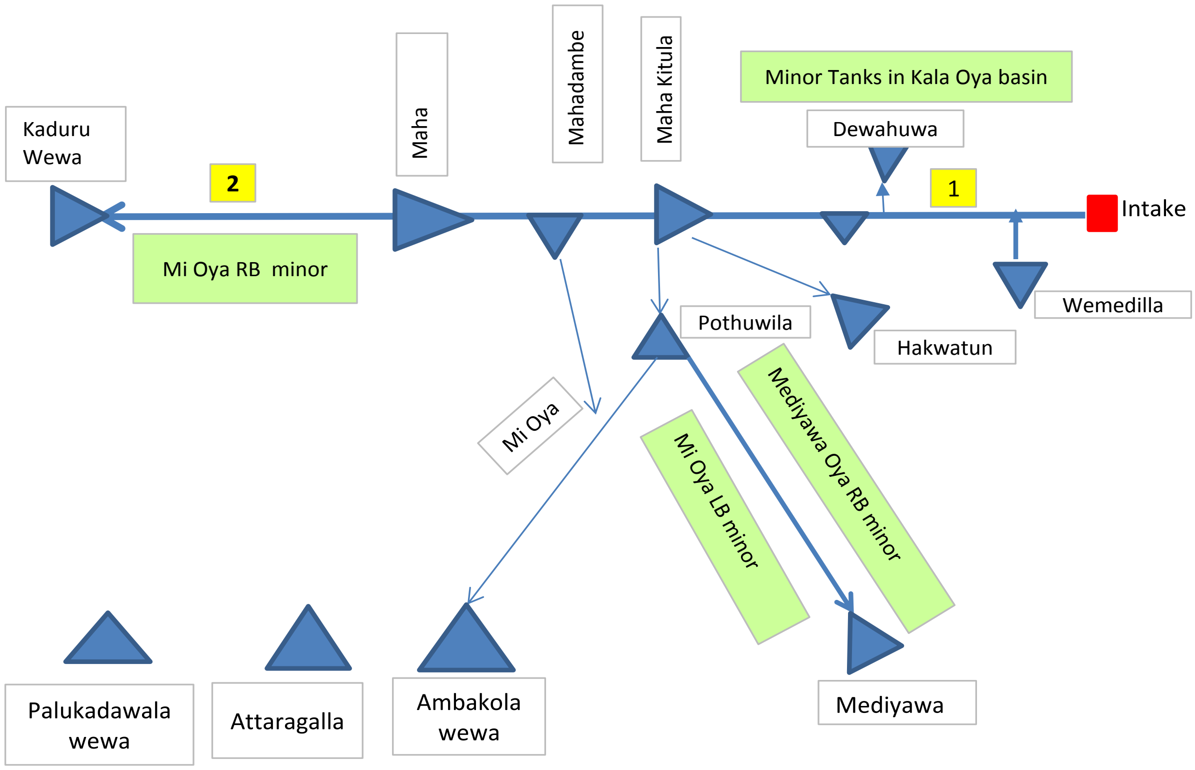
352. Water from Maha Kitula reservoir will be taken through a 3.6 km long canal to Maha Kirula reservoir, another reservoir to be rehabilitated. The canal joining the Mahakithula and Maha Kirula flows via existing Mahadambe tank which function as a level crossing. Both Maha Kirula and Mahadambe reservoirs are in uppermost reach in Mi Oya basin.

353. The second reach of the NWP canal commences from the Maha Kirula reservoir and flows a 21.3 km long distance along the ridge of the Mi Oya basin and Kala Oya basin while feeding minor tank cascades In the right bank side of Upper Mi Oya sub water shed. This canal ends up at Kaduru wewa in Ehatuwewa DS Division.

354. Small tank cascades in the left bank side of Mi Oya will be fed through another canal commencing from Pothuwila tank which is located in upper part of the Mi Oya basin. The Pothuwila tank will be augmented under the project with an additional flow from the Maha Kithula Reservoir. The canal commencing from the Pothuwila reservoir initially flows along the ridge of Mi Oya basin and Deduru Oya basin and changes its direction and flows across Mi Oya basin and joins the Mediyawa Oya augmenting Mediyawa Major Irrigation Scheme.

355. All benefitted small reservoir cascades in the Mi Oya Basin drains out to major irrigation schemes in the middle reach of the basin. The three tanks in the middle reach namely the Ambakola wewa, Attaragalla Wewa and Palukadawala Wewa will benefit from the flows through Mi Oya and the drainage flows coming from the benefitted cascades of reservoirs

The NWP canal layout is shown in the map (Figure 2-3) and the following figure shows NWP canal



network.

Figure 4-1 Canal network in the project area

Major Irrigation Schemes

The following table shows the major irrigation schemes benefitted from NWP Canal Project.

Table 4-5 Major irrigation schemes in the project area

River Basin	Sub Basin	Major / Medium Tank			
		Name	Extent – ha	Current Cropping Intensity	C I with project
Kala Oya	Dambulu Oya	Wemedilla	729	1.8	2.0
	Hewan Ella	Dewahuwa tank	1215	1.8	2.0
Deduru Oya	Hakwatuna Oya	Hakwatuna Oya tank	2579	1.53	1.8
Mi Oya		Mediyawa tank	486	1.26	1.8
		Ambakola wela	340	1.33	1.8
		Attaragalla	419	1.29	1.8
		Palukadawala	648	1.04	1.8
TOTAL			**6416**		

Minor Tanks

356. In the three river basins, water will be issued to cascades from the NWP canal to tanks in the upper reach of the cascade so that other tanks in the cascade will receive water from the tank in the upstream of the cascade. The Table 4-6 gives the small tank cascades that will benefit from NWP Canal Project

Under the project large number of minor reservoirs in cascades will receive water for both seasons

Table 4-6 Small tank cascades in the project area

Scheme	Irrigable area (Ha)	River Basin	CI without project	CI with project
Dambulu oya minor schemes	184	Kala oya	1	1.5
Minor schemes up to Mahakithula	722	Kala oya	1	1.5
Minor schemes in Yapahuwa canal	1,000	Mi Oya	1	1.5
Mi Oya (RB1) minor schemes	1,929	Mi Oya	1	1.5
Mi Oya (RB2) minor schemes	1,001	Mi Oya	1	1.5
Mi Oya (LB) minor schemes	916	Mi Oya	1	1.5
Minor schemes in Mediyawa cascade	231	Mi Oya	1	1.5
Total	5,983			

4.11.2 Extractions

357. The major diversion points are:

- Diversion to Dewahuwa tank
- Diversion to Hakwatuna Oya tank from Mahakitula
- Diversion to Mediyawa and Mi Oya minor tank cascade system from Pothuwila tank
- Diversions to major tanks in lower Mi Oya basin (Ambakola wewa, Attaragalla and Palukadawala from Pothuwila tank
- Diversions to minor tanks in Galgamuwa area from Mahakirula reservoir

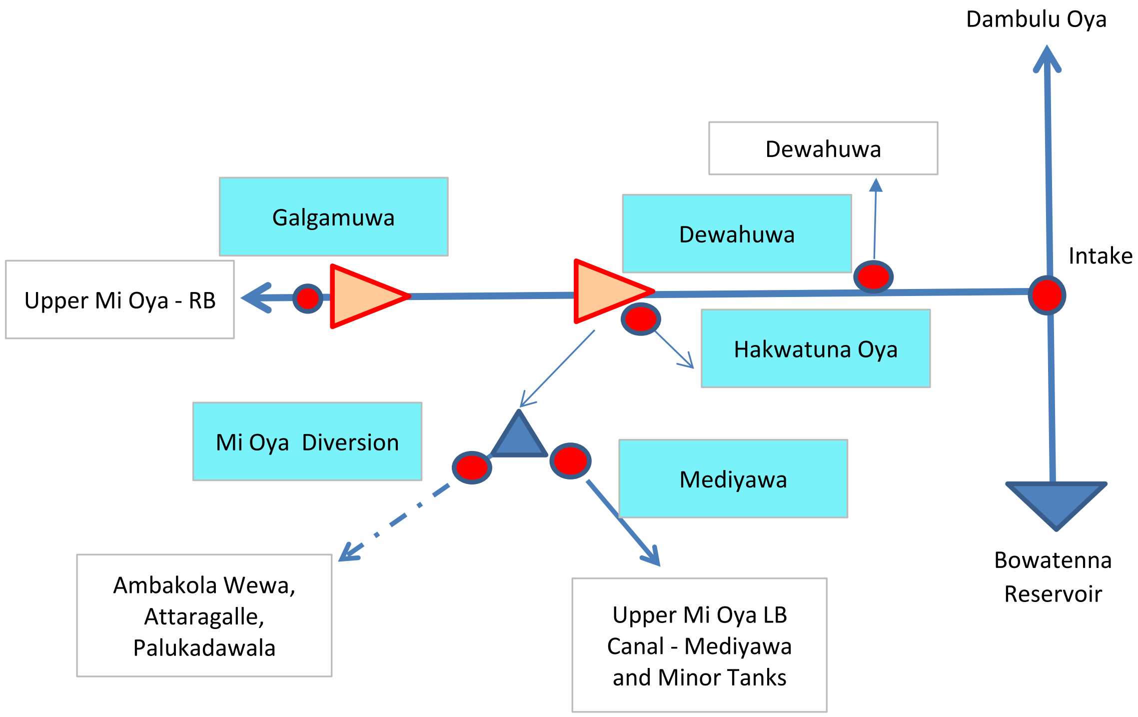


Figure 4-2 Main diversion points in NWP canal project

4.11.3 Impact of water usage

358. The diversion of water under NWP Canal Project would definitely create a positive impact on all three river basins, Kala Oya, Deduru Oya and Mi Oya.

359. The Hakwatuna Oya in Deduru Oya basin faces severe water shortage problems as the catchment inflows have been reduced considerably during the recent past due to the vast cultivation of other field crops in the upper catchment. With the project, the Hakwatuna Oya irrigation scheme will receive water through Iruwadeniya stream to cultivate both seasons. The total diverted quantity will be 28 MCM annually after the full implementation of the project.

360. Currently the major irrigation schemes in Mi Oya basin face water shortages especially during Yala Season as they lie in the dry zone of the country. The cropping intensities of these schemes vary around 1.0 -1.2 and this will increase up to 1.8 with the project.

361. In general the cropping intensities of minor irrigation tanks in Kurunegala district varies around 1.0-1.2 whereas the cropping intensities of minor tanks in Anuradhapura district varies in the range of 0.8-1.0. One of the reasons for higher cropping intensities in Kurunegala District is that major part of the district lie in the intermediate zone. Even though the Upper Mi Oya watershed area lies in the Kurunegala District, majority of the benefit area falls in to the dry zone. Therefore, the current cropping intensity of minor schemes in the project benefit area could be considered to be between 0.8-1.0.

362. With the project the cropping intensity of minor tanks will increase up to 1.8 with 100% cultivation in Maha season and 80% cultivation in Yala season.

363. In addition, the present environment will be enhanced with the project, due to increase in ground water table of the area. With having water throughout the year and cultivation in both seasons under large number of minor tanks in the upper catchment of Mi Oya and Kala Oya basins the present dry environment will decrease.

364. The ground water levels will be changed during the construction and operation of reservoirs and canals. During construction of a dam, ground water level along the dam axis may change due to pumping of ground water in core trench excavation etc. This impact will be temporary.

365. As the proposed NWP Canal will enhance the water availability of the small tanks, a beneficial impact by the proposed project on groundwater can be expected. However, if a detailed water quality study is envisaged, it is recommended that it be combined with groundwater level and quality observations for a substantial period. This will ensure detection of any possibility of water logging and also would provide a baseline for assessing the project impacts.

366. The conveyance canal from Dambulu oya to Mahakithula crosses Kahalla Pallekele sanctuary through a tunnel. The central part of this tunnel runs through a quartzite rock with a maximum thickness of 15 m. In the inlet and outlet portal areas bed rock is found but with fractures. With the construction and operation of the tunnel it is possible to lower the ground water level through fractures in the rock. It is recommended to do detailed investigations of the tunnel and depending on the outcome, it is recommended to strengthen weak areas by grouting, shotcreting, anchor bolting and lining etc.

367. Effect of ground water table along the canals will also be mostly favourable. The water level in the village drinking water wells may increase due to water in the canals. This is a favourable situation. This positive phenomenon will be visible in the irrigable area. Shifting of utilities such as telephone, electricity lines, water pipes will not be required along the trace of the canal..

4.11.4 Associated Facilities

<u>**Upper Elahera Canal (UEC)**</u>

368. For NWP canal to function the UEC should be completed and be functional. UEC is considered and a sub project of the ADB loan. A separate EIA is being done for UEC and all environmental issues have been considered in the UEC EIA report.

Nalanda Reservoir

369. Nalanda reservoir was originally constructed to divert water to Kala Oya basin to augment Kala Wewa. It is a 35 m high concrete gravity dam. The dam was commissioned in 1957. The capacity at FSL is 15.3 MCM. In view of problems facing the dam, in particular doubts about its structural stability, extensive cracking of the dam and the inadequate spillway capacity, the reservoir storage level was reduced by about 3 m below the designed FSL of 367.28 masl, as a precaution. Remedial action is now being implemented under Dam Safety and Water Resources Planning Project (DSWRPP) under MMDE. This project is funded by the World Bank and a separate EIA has been done prior to commencement of the sub project. The repairs are scheduled to be completed in 2014.

4.11.5 Borrow sites, Disposal sites and Quarries.

370. Figure 4.3 shows the selected borrow sites and quarry sites. Borrow area are located in the proposed tank beds. These area will be inundated when reservoirs are commissioned.

371. Quarry sites are located out of the boundaries of wildlife and forest reserves. Some of the rock quarries are now in operation.

372. Excavated rock from the tunnel will be used as construction material for the reservoirs. Excess tunnel muck will be transported out of the sanctuary and deposited in baron lands. Excess canal excavations will be used to fill roads and playground nearby the residents.

4.11.6 Access roads

373. The sites selected for reservoirs are accessible at the moment by 4 wheel drive vehicles and tractors. There are roads used by people living in the villages in close vicinity. These roads will be widened to allow for movement of construction vehicles. No trees will be cut down as the sides of these roads are now cleared of trees.

374. A road is planned along the canal and this road will serve the purpose of access road during construction. The designed canal cross section includes this road and it traverses along the banks of the canal. Hence additional land for this road does not arise.

4.11.7 Occupational health and safety- hazards to workmen, accidents-worker camps etc,

375. Occupational safety is important for all parties engaged in construction. Apart from ensuring the safety of workers, for the client it will be important as more accidents lead to considerable down time and achieving the goals may in jeopardy. For the contractor it will be additional expenditure and because of one accident sometimes one work site may idle for a long hours means loss of productive time. In addition, it may lead to insurance claims and sometimes may end up in legal procedures.

376. Contractors will employ local persons for construction work as temporary construction workers. They may not be familiar working with earth moving machinery and they may be given proper attention by the employers. Fly rocks (rock pieces projecting out of blasting sites) will pose a danger to workers and population living in the vicinity. Dust in heavy earth moving sites may be a health hazards to workers. Inadequate ventilation in the tunnel is a safety risk to workers in the tunnel.

4.11.8 Climate Change

377. While there are a number of climate change parameters, the principal ones directly relevant to the project for the assessment of risk and adaptation measures are changes in temperature and rainfall.

Climate Change Trends

378. The analysis of temperature records over a 100-year period showed an increase in air temperature in all meteorological stations from 1961 to 1990 (Fernando and Chandrapala, 1992). The rate of increase over this period was of the order 0.016^{0}C per annum or the equivalent of 1.6^{0}C per 100 years.

379. Rainfall in Sri Lanka is characterized by high annual variability with alternate dry and wet periods observed from 1880 until about 1970 and a significant reduction thereafter (MIWRM, 2010[10]). Over the period 1931 to 1990 average annual rainfall is reported to have decreased from 2,005 mm to 1,861 mm, a decline of 7% (Jayatilake et al, 2005).[11] The decrease differed between seasons, with the highest decline in the March to April inter-monsoonal period. Also it was noted that the intensities and return period of extreme events appear to have become shorter.

Climate Predictions

380. The current trends and model predictions for temperature indicate that it is most likely to increase over the project lifetime, to 2050 and beyond. The best estimate is an increase of up to 2^{0}C by 2100. As discussed below the project implications are likely to be an increase in irrigation water demand and potential adverse impact on crop productivity.

381. The situation regarding precipitation patterns is somewhat contradictory, with current trends indicating a general decline in rainfall over the past 60 or more years, and climate change models giving mixed predictions of both higher and lower future rainfall. Though there appears to be consistency that in terms of seasonal change, with SWM precipitation increasing and a decline NWM precipitation. Changes in precipitation would have a number of impacts on the project, lower rainfall would reduce water availability, both at field level(reduce effective rainfall) and basin level i.e. transfer from the Mahaweli, and higher rainfall would increase water availability and reduce irrigation demand, and therefore could be an opportunity for increased productivity (increase irrigated areas and higher cropping intensity). Changes in rainfall intensity may also have implications for system design, and duties of canals, cross drainage structures and reservoirs capacities.

Vulnerability Assessment

382. The goal of a vulnerability assessment is to identify current and future vulnerabilities and understand the key determinants of this assessed vulnerability. 'Vulnerability refers to the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change.'

[10] Sri Lanka Water Development Report 2010
[11]Jayatillake, H.M., Chandrapala, L, Basnayake, B.R.S.B, Dharmaratne, G.H.P, (2005). Water Resources and Climate Change. Proceedings of the Workshop on Sri Lanka National Water Development Report, World Water Assessment Programme, Paris.

383. The scheme design and operation include water allocations for irrigation based on three progressive levels of service reliability, these are:

Type of failure	Condition	Upper limit of failure
Irrigation failure	Supply deficit exceeds 5%	20%
Significant failure	Supply deficit exceeds 10%	10%
Total failure	Supply deficit exceeds 20%	5%

Cumulative impacts

384. This section assesses the cumulative impacts in two areas. First the cumulative impacts of NWP and other developments in the project area. Secondly a strategic level assessment of impacts of the entire Mahaweli Water Security Investment Program (MWSIP) which looks at cumulative impacts of the UEC project, North Western Province Canal Project and Raising of Minipe Anicut and rehabilitation of Minipe Left Bank Canal and its associated facilities.

Cumulative Impacts with other developments in the project area

There are no major projects planned in the beneficiary area of NWP canal project in the North Western Province. However, there are several existing projects which will receive multiple benefits due to the implementation of the proposed project.

Deduru Oya Reservoir (75 MCM) was commissioned in 2014. It is a large earthen dam which impound water in Deduru Oya. Hakwatuna Oya is a major tributary of Deduru Oya which has its confluence upstream of Deduru Oya Reservoir. (Fig 2-3) Water from NWP canal is released from Mahakithula Reservoir and released to Hakwatuna Oya tank which will increase the cropping intensity (CI). Drainage water from the irrigable area of Hakwatuna Oya will be collected in Hakwatuna Oya and the river discharge will be increased and it will increase the inflow to Deduru Oya reservoir. This increased inflow will have positive impacts on the irrigation releases from Deduru Oya sluice.

Similarly, existing Inginimitiya Reservoir (73 MCM) situated in the middle reach of Mi Oya will be benefitted from the increased drainage flow from upper Mi Oya irrigation system which will receive increased inflow from the proposed NWP canal.

Cumulative impacts of the Mahaweli Water Security Investment Program

385. Based on the findings of a Strategic Environment Assessment[12] undertaken by the government for the Mahaweli development program, the cumulative impacts of two key areas: biodiversity and hydrology were assessed for the investment program's projects and the under-construction Kaluganga and Moragahakanda Reservoirs, which are associated facilities. Mahaweli systems directly

[12] Ministry of Agriculture Development and Agrarian Services, *Dam Safety and Water Resources Planning Project: Strategic Environmental Assessment - Mahaweli Systems*, December 2012

impacted by MWSIP include system E (Minipe), System IH (Nachchaduwa), system MH (Huruluwewa) System I (Mahakanadarawa).. The project will involve three sub projects

1. **Upper-Elahera Canal Project**

386. This includes, Kaluganga-Moragahakanda link canal and Upper-Elahera canal. Kaluganga and Morgahakanda reservoirs currently under construction are considered as associated facilities to the UEC project.

2. **North-western Canal Project**

387. This includes a canal from Lenadora to Kaduruwewa and establishment of two storage tanks, Maha Kithula and Maha Kirula

3. Raising the Minipe Anicut and rehabilitation of the Minipe LB canal

388. Each of the three sub projects of the proposed MWSIP will have an impact on one or more protected areas that have been established under the Fauna and flora Protection Ordinance or Forest Ordinance managed by the Department of Wildlife Conservation (DWC) or Forest Department (FD) as shown in Table 4-7.

Table 4-7 The protected areas that will be impacted by the MWSIP

Name of the Protected Area	Category	Extent (ha)		Year of Declaration
		Total	Affected	
North Western Canal Project				
Kahalla- Pallekele	S	21,690	342 (1.6%)	1989
Upper Elahera Canal Project				
Elahera-Giritale	S	14,035	190 (1.4%)	2000
Minneriya- Giritale	NR block III	4,745	0	1995
Minneriya	NP	8,889	15 (0.2)	1997
Hurulu	FR	25,000	0	1942
Minipe Anicut and rehabilitation of Minipe LB canal				
Victoria-Randenigala-Rantambe	S	42,089	25 (0.1%)	1987

S- sanctuary, NR- nature reserve, NP – national park, FR- forest reserve **Note**: The proposed project activities of Kalu Ganga, Moragaha Kanda and Kaluganga-Morgahakanda Tunnel will not take place inside any declared protected areas.

Data Sources: MIWRM, 2014a; MIWRM, 2014b; MIWRM, 2014c; NRM, 2008; TEAMS, 1998

Description of protected areas according to the IUCN categorization (Dudley, 2008)

1. **National Park (NP)**: A Category II protected area managed by DWC.

2. **Nature Reserves (NR):** A Category IV protected area managed by DWC.

3. **Sanctuaries (S)**: A Category VI protected area managed by DWC.

4. **Forest Reserve (FR):** A Category IV protected area managed by FD.

389. The environment assessment reports of each of these sub projects have presented an analysis of the impact of the sub project on biodiversity and protected areas. The direct impact area of the MWSIP includes several protected areas. Further, Mahaweli river basin is the largest river basin in Sri Lanka with unique biogeographical attributes (there are several threatened endemic species that are restricted to Mahaweli River Basin). Therefore, the cumulative impact of the three proposed subprojects and their associated facilities on protected areas and critical species in the project affected areas was assessed. This section presents the findings of the cumulative impacts of the proposed MWSIP on the biodiversity in project impact area.

Habitat Diversity

390. Several natural habitat types were recorded in the project affected areas of MWSIP. These include tropical moist semi-evergreen forests, dry mixed evergreen forests, riverine forests and scrublands. A brief description of these habitat types are given below. Extents of these habitats that will be affected by each sub project is given in Table 4-8.

Tropical Moist semi-Evergreen Forest

391. These are closed canopy forest that generally consists of three layers, the canopy (20-25 m), sub canopy (5-10 m) and ground vegetation. The dominant plant species present in these forests include *Berrya cordifolia* (Hal Milla), *Pterospermum suberifolium* (Welan), *Vitex altissima* (Milla), *Lepisanthes tetraphylla* (Dambu), *Stereospermum colais* (Dunu madala), *Haldina cordifolia* (Kolon), *Mitragyna parvifolia* (Helamba), *Ventilago madraspatana* (Yakada Wel), *Holoptelea integrifolia* (Goda Kirilla), *Cipadessa baccifera* (Hal Bebiya), *Trema orientalis* (Gadumba), *Schleichera oleosa* (Koon), *Morinda coreia* (Ahu), *Azadirachta indica* (Kohomba), *Ficus* sp. (Nuga), *Ficus microcarpa*, *Ficus hispida* (Kota Dimbula), *Hibiscus vitifolius* (Maha Epala), *Careya arborea* (Kahata), *Peltophorum pterocarpum*, *Bauhinia racemosa* (Maila), *Flueggea leucopyrus* (Heen Katu Pila), *Croton aromaticus* (Wel Keppetiya), *Bridelia retusa* (Ketakala), *Merremia umbellata* (Kiri Madu) and *Alstonia scholaris* (Ruk Attana)

Dry-mixed Evergreen Forest

392. These are typical dry zone climax forest formations where the canopy reaches between 20-30 m. beneath the canopy layer, the sub canopy (15 m), a shrub layer (5 m) and a herbaceous plant layer (1 m) can be seen. The canopy consists of tree species such as *Manilkara* (Palu), *Drypetes* (Wira), *Chloroxylon* (Burutha), *Alseodaphne* (Wewarana), *Berrya* (Halmilla), *Diospyros* (Kaluwara),

Schleichera oleosa (Kon), *Pterospermum canescens* (Welan), and *Vitex altissima* (Milla). The sub canopy of the forest is dominated by *Drypetes* (Wira) and other medium sized trees such as *Diospyros ovalifolia, D. ferrea, Feronia acidissima, Xylopia nigricans, Nothopegia beddomei, Pleiospermium alatum, Cassia fistula*, *Bauhinia racemosa* can also be seen in this layer. The shrub lyer comprises of species such as *Ochna lanceolata, Tarenna asiatica, Memecylon angustifolium, M. capitellatum, M. umbellatum, Mallotus resinosus, Croton laccifer,* and *Dimorphocalyx glabellus.*

Riverine Forest

393. These are narrow strips of tall forests found along the banks of streams and rivers. This habitat is dominated by water loving trees such as *Terminalia arjuna* (Kumbuk), *Madhuca longifolia* (Mi), *Pongamia pinnata* (Magul Karanda), *Ficus racemosa* (Attikka), and *Nauclea orientalis* (Bakmi). Other species such as *Polyalthia longifolia* (Owila)*, Diospyros malabaricum* (Timbiri)*, Mangifera zeylanica* (Etamba)*, Nothopegia beddome* (Bala)*, Garcinia spicata* (Ela gokatu)*, Diospyros ferrea, Diospyros montana, Diospyros ovalifolia* (Kunumella)*, Homonoia riparia, Cynometra zeylanica, Hydnocarpus venenata* (Makulu)*, Barringtonia acutangula,* and *Vitex leucoxylon,* are found in these forests. *Dimorphocalyx glabellus* (Weliwenna) is the common understorey species found in the riverine forests.

Scrublands

394. Scrub vegetation forms in places where chena (shifting cultivation) have been abandoned. Soon after a chena plot is left to fallow, various herbaceous pioneer species begin to appear followed by woody species in a series of succession leading to the appearance of a secondary forest. It is found in areas where the climax forest is degraded. The degraded areas take a long time to be converted back to closed-canopy forests through natural succession. The early stages of this natural succession are regarded as scrublands. These scrublands comprise of a mixture of tree, herbaceous and shrub species such as *Azadirachta indica, Bauhinia racemosa, Carissa spinarum, Catunaregam spinosa, Dichrostachys cinerea, Flueggea leucopyrus, Gmelina asiatica, Grewia orientalis, Hugonia mystax, Ichnocarpus frutescens, Lantana camara, Limonia acidissima, Memecylon umbellatum, Phyllanthus polyphyllus, Scutia myrtina, Syzygium cumini, Toddalia asiatica and Ziziphus oenoplia*.

Table 4-8 The main natural habitats that will be affected by the MWSIP I

Type of Ecosystem	Extent (ha)		Name of the Sub Project
	Total	Affected	
Moist semi-evergreen forests	24,191,640	3,540 518	Moragahakanda* Kalu Ganga*
Dry mixed evergreen forests	108,108,440	149 300 1,804 4,990	UE Canal NWP canal Moragahakanda* Kaluganga*
Riverine forests	2,229,040	25	Minipe Raising

		5	Kaluganga Link tunnel
		61	Kaluganga*
Scrublands	45,957,560	56	UE Canal
		50	NWP canal
		108	Moragahakanda*

Abbreviations Used: **UE** - Upper Elahera, **NWP** - North-western Province *- Moragahakanda and Kaluganga reservoirs are currently under construction and will not be funded by the MWSIP. However, these two reservoirs are considered as associated facilities for the UEC.
Data Sources: MIWRM, 2014a; MIWRM, 2014b; MIWRM, 2014c; NRM, 2008; TEAMS, 1998

395. Total amount of natural habitats that will be affected by the MWSIP and associated facilities is approximately 11,606 ha. Out of the total extent of natural habitat lost, the projects under MWSIP will only contribute to about 5% (585 ha) while the remaining 95% of the habitat loss will result due to Moragahakanda and Kaluganga projects that include two large reservoirs and large scale resettlement and are currently under construction and considered as associated facilities to the ADB funded project. Compared to the total extent of the available habitat in Sri Lanka, the area affected by MWSIP and associated facilities is estimated to be approximately 0.006%.

Species Diversity

396. The species diversity was found to be highest in the Moragahakanda and Kaluganga projects compared to other sub projects. This could be attributed to the fact that the area impacted by these two projects is much greater than the other sub projects. A summary of the fauna and flora recorded in the project impacted area of each sub project is given in table 4-9.

Table 4-9 A summary of the fauna and flora recorded in each the project affected areas of each sub project of NCP canal stage I and associated facilities.

Project Name	Total	Endemic	Exotic	Migrant	CR	EN	VU	NT
KGP - Flora	401	29	43	0	0 (1)	7 (0)	16 (6)	14 (0)
KGP - Fauna	327	51	1	16	5 (0)	5 (11)	17 (1)	19 (3)
MKP - Flora	456	29	71	0	0 (0)	7 (2)	13 (7)	11 (0)
MKP - Fauna	272	45	2	12	6 (1)	6 (11)	10 (1)	22 (8)
KMT - Flora	130	13	10	0	0 (0)	3 (0)	7 (4)	10 (0)
KMT - Fauna	136	9	0	7	0 (0)	1 (1)	2 (0)	2 (1)
UEC - Flora	174	10	10	0	0 (0)	2 (0)	2 (1)	1 (0)
UEC - Fauna	240	17	1	16	0 (0)	3 (4)	3 (4)	7 (4)
NWP - Flora	133	9	3	0	0 (0)	0 (1)	0 (0)	0 (0)
NWP - Fauna	181	15	1	9	0 (0)	5 (4)	2 (2)	6 (8)
MAR - Flora	240	17	62	0	0 (1)	3 (0)	14 (5)	16 (0)
MAR - Fauna	147	14	1	1	0 (0)	1 (4)	6 (0)	7 (5)

Abbreviations used: KGP – Kalu Ganga Project, **MKP** – Moragaha Kanda Project, **KMT** –Kaluganga-Moragahakanda Tunnel, **UEC** – Upper Elahera Canal, **NWP** –North-western Province Canal, **MAR** –

Minipe Anicut Raising, **CR** – Critically Endangered, **EN** - Endangered, **VU** - Vulnerable, **NT** - Near Threatened.

Data Sources: EML, 2011; IUCN, 2007; MIWRM, 2014a; MIWRM, 2014b; MIWRM, 2014c; NRM, 2008; TEAMS, 1998

Threatened and Endemic Species

397. Altogether 46 endemic plants species were recorded in the project impact areas of all the sub projects. These included 10 species listed as Endangered, 22 species listed as Vulnerable, 22 species listed as Near Threatened and 26 species listed as Least Concern in the National List of Threatened Species (MOE, 2012). Further, out of the 46 endemic species is listed 1 species is listed as Critically Endangered, 3 species as Endangered, 7 species as Vulnerable in the Global List of Threatened Species (IUCN, 2014). It should also be noted that all but 1 species has been evaluated using an old version of the Global Criteria (version 2.3 in 1996) and the status given in the global list is outdated for Sri Lankan flora. Further 35 out of the 46 endemic species have not been evaluated in the Global list. Therefore, the listing provided in the national list is a more reliable depiction of the present conservation status of Sri Lankan flora. In addition to these threatened endemic fauna 17 species of native plants (5 - Endangered and 12 - Vulnerable) listed as Nationally threatened and 17 species as Nationally Near Threatened has been recorded from the project affected areas MWSIP. Likewise 2 native species of plants listed as Globally Vulnerable has also been recorded from project affected areas of MWSIP.

398. Among the fauna recorded in the project impacted areas of each of the sub projects of MWSIP, 66 are endemic to Sri Lanka. These 66 endemic species included 7 species listed as Critically Endangered, 9 species listed as Endangered, 26 species listed as Vulnerable, 32 species listed as Near Threatened and 32 species listed as Least Concern in the National List of Threatened Species (MOE, 2012). Further, out of the 66 endemic species 1 species is listed as Critically Endangered, 12 species as Endangered, 11 species as Vulnerable, 4 species as Near Threatened and 38 species as Least Concern in the Global List of Threatened Species (IUCN, 2014). As in the case of flora, the status indicated in the Global List are outdated for Sri Lankan fauna, especially for the endemic species where the listing provided in the national list is a more reliable depiction of their present conservation status. Further 39 out of the 66 endemic species have not been evaluated in the Global list. In addition to these threatened endemic fauna 12 species of native plants (4 - Endangered and 8 - Vulnerable) listed as Nationally threatened and 23 species as Nationally Near Threatened has been recorded from the project affected areas of MWSIP. Likewise 6 native species of plants listed as Globally threatened (3 - Endangered and 3 - Vulnerable) and 9 species as Globally Near Threatened has also been recorded from project affected areas of MWSIP (please refer to Annex VI-V).

Restricted Range Species

399. Mahaweli River, the largest river basin in Sri Lanka with a watershed area of 10,448 km^2 represents ca. 16% of the land area of the Island. The upper catchment of the Mahaweli river supports one of the most high biodiverse areas in Sri Lanka, the Knuckles Conservation Forest Further, Mahaweli River and some of the sub catchments (Raththota oya, Kalu ganga, Theligamu oya and Kambarawa oya) of the Amban ganga, one of the main tributaries of Mahaweli river, is inhabited by number of fish that are endemic to Sri Lanka and restricted to these sub catchments. Altogether

11 endemic species are restricted to the Mahaweli river basin. All of these species are listed as Critically Endangered or Endangered, except for the recently described species *Calotes pethiyagodai* whose conservation status has not been determined (however, based on currently available data it too will be listed as Critically Endangered). In addition to these restricted species, recent studies indicate that there may be number of yet undescribed species of fish inhabiting Mahaweli river. A list of species that are restricted to Mahaweli river are shown in table 4-10 along with comments on the impact of the proposed MWSIP on these species.

Table 4-10 List of species that are restricted to the Mahaweli river basin

Family	Scientific Name	Common Name	TS	NCS	GCS	Remarks
Cyprinidae	*Devario aequipinnatus*	Knuckles Danio	E	CR	LC	KG and MK
Cyprinidae	*Labeo fisheri*	Common Labeo	E	CR	EN	MK
Cyprinidae	*Laubuca insularis*	Knuckles labuca	E	CR	NE	KG and MK
Cyprinidae	*Systomus martenstyni*	Martenstyni's barb	E	CR	EN	KG and MK
Cyprinidae	*Dawkinsia srilankensis*	Blotched filamented barb	E	CR	CR	KG and MK
Dicroglossidae	*Nannophrys marmorata*	Sri Lankan rock frog	E	EN	VU	Not affected
Agamidae	*Ceratophora tennentii*	Leaf-nose lizard	E	CR	EN	Not affected
Agamidae	*Cophotis dumbara*	Knuckles pygmy lizard	E	CR	CR	Not affected
Agamidae	*Calotes pethiyagodai*	Pethiyagoda’s crestless lizard	E	NE	NE	Not affected
Scincidae	*Chalcidoseps thwaitesii*	Four-toe snake-skink	E	CR	NE	Not affected
Gekkonidae	*Cyrtodactylus soba*	Knuckles forest gecko	E	CR	NE	Not affected

Abbreviations used: TS - Taxonomic Status, **E** - Endemic, **NCS** - National Conservation Status, **GCS** - Global Conservation Status, **CR** - Critically Endangered, **EN** - Endangered, **VU** - Vulnerable, **NE** - Not Evaluated, KG – Kaluganga reservoir (associated facility to MWSIP), MK-Moragahakanda reservoir (associated facility to MWSIP)

Data Sources: Amarasinghe *et al*., 2014; ARROS, 2005; IUCN, 2014; MOE, 2012; Pethiyagoda, 1991; Pethiyagoda *et al*., 2008; Samarawickrama *et al*., 2006.

400. Out of the 11 restricted range species that occur in the Mahaweli river basin five species of freshwater fish has been recorded in the areas to be inundated under the Moragahakanda and Kaluganga reservoirs. None of these species have been recorded in the project impacted area of the three subprojects coming under the MWSIP. The Mahaweli Authority of Sri Lanka with the assistance of IUCN Sri Lanka has already completed a translocation programme where the fish species identified to be impacted by the proposed Moragahakanda and Kalu Ganga development projects have been relocated to suitable locations in the upper catchment of the Mahaweli River.

401. **Mitigation Measures:** Mitigation measures for the ongoing constructions of Kaluganga and Moragahakanda reservoir are currently being implemented (includes reforestation in degraded

areas, introduction of community forestry programs in buffer zones and canal reservations, forestry programs in upper watershed areas, control of invasive species in existing protected areas, habitat enrichment in the protected area network in the immediate vicinity, and declaration of two new protected areas and establishment of elephant corridors to ensure free movement of wildlife and translocation of critical species from project affected areas into safe and suitable sites). The following discusses the overall measures in place to address the key issues for the for the three sub projects that comes under the proposed MWSIP. These include loss of habitat, disruption of movement patterns and death or injury to animals from falling into the canal (applies only to NWP and UEC sub projects), escalation of human-elephant conflict and reduction of downstream flow (applies only to Minipe raising project).

402. **Loss of Habitat**: A habitat enrichment programme will be undertaken with the aim of reforesting/ enriching approximately 1000 ha under the three sub projects (500 ha under Upper Elahara Canal, 350 ha under North-western Province Canal and 145 ha under the Minipe LB canal rehabilitation project) to achieve an overall biodiversity offset ratio of 2. The main aim will be to restore degraded areas or undertake reforestation of plantation forests within protected areas (250 ha in Minneriya-Giritale and 350 ha in Kahalla-Pallekelle Sanctuary). This will lead to increased habitat complexity and thereby enhance the carrying capacity of these protected areas which will compensate for the habitat loss. In addition to these efforts restoration of tank catchments will be undertaken with the aim of reducing the sedimentation of tanks as well as enhance their carrying capacity. Third aim of the reforestation programme is to link existing protected areas to prevent fragmentation of habitats. Such an opportunity is only presented in the Minipe LB canal where it has been proposed to undertake reforestation of the canal reservation to create a riverine forest that can link three important protected areas, namely Victoria-Randenigala-Rantembe Sanctuary, Knuckles Conservation forest and Wasgomuwa National Park.

403. **Disruption of movement patterns and death or injury due to animals from falling into the canal:** Since the upper Elahera canal and north–western province canal project involves establishment of long stretches of open lined canals it will result in disruption of movements of animals, especially less mobile species. Further, animals falling into the canal resulting in death or injury have been identified as a one of the main impacts of some of the long lined canals that are already being operated by the MIWRM. Therefore, the canal design has incorporated structures in the open sections of the canal at 500 m intervals to ensure safe passage of animals across the canal as well as to facilitate those animals that fall into the canal to exit the canal safely.

404. **Escalation of Human-Elephant conflict**: Under each of the three sub projects of MWSIP money is set aside to provide short term solutions for human-elephant conflict that will arise due to the project. However, it should be noted that human-elephant conflict is wide spread socio-political problem that requires a long term solution. Therefore, MIWRM has already commissioned a study through IUCN Sri Lanka to develop and institute a long term human-elephant conflict management strategy within the entire area that will undergo a change in the cropping pattern under the proposed MWSIP to ensure that human-elephant conflict will not prevent accruing the overall benefits envisaged through the proposed water resource development under the MWSIP.

405. **Reduction in downstream flow:** This impact will take place only in one of the three sub projects of MWSIP (the Minipe raising) as the proposed project will result in diversion of more water in to Minipe LB and RB canals. As a result a stretch of about 6.5 km between the Minipe anicut and the confluence between Mahaweli river and Badulu oya will be subjected to low flows. Further, this will result in the reduction of the wetted perimeter of the river. These two impacts will result in a reduction of population densities of aquatic fauna and flora inhabiting this stretch of the river. Therefore an e-flow shall be released to meet the ecological demands of the river. According to the water balance study, taking into account the water flow in this affected section of the river for the past 50 years, the e-flow along with spillages from Minipe anicut will ensure that at least 28% of the Mean Annual Flow of the river will be released into the river. Further, a short (0.5 m) weir will be constructed across the Mahaweli river downstream of the Minipe Anicut so that the e-flow released will be dispersed across the river bed to ensure that the wetted perimeter of the river shall not decrease drastically from its present day level. This will ensure that the aquatic species present in the river will not decline in their distribution and deep pools within the river that can support large fish species such as the Marsheer, are continuously refreshed and therefore the quantity and quality of water in such pools will not decline even with the increase in the diversion of water from the main river after completion of the Minipe raising.

Conclusions

406. The proposed sub projects of the MWSIP will not have any impacts on the endemic and Critically Endangered or Endangered faunal species that are restricted to the Mahaweli River Basin. *Semnopithecus vetulus* (Purple-faced leaf monkey) is the only endemic Endangered species that was recorded in the project impacted area of MWSIP projects. This species was recorded in the command area of the North-western Province Canal sub project and the proposed development activities will not have an impact on this species as it will not result in any habitat loss of the species. In addition to this four non endemic Endangered species, *Elephas maximus* (Asian Elephant), *Prionailurus viverrinus* (Fishing cat), *Panthera pardus* (Leopard) and *Melursus ursinus* (Sloth bear). Other than the Asian Elephants rest of the endangered species occur primarily in protected areas and the proposed development activities will not result in a significant habitat reduction of any of these species.

Hydrology

407. The proposed Project (Mahaweli Water Security Investment Programme-MWSIP) covers three major conveyances namely, Kaluganga-Moragahakanda Transfer Canal (KMTC) of capacity 35 cumec from Kalu Ganga reservoir to Moragahakanda reservoir, and Upper Elehera Canal (UEC) of capacity 40 cumec from Moragahakanda to NCP canal downstream of Huruluwewa supply point and North Western Province Canal (NWPC). These diversions are made possible by other proposed diversions beyond the project scope, such as Randenigala-Kalu Ganga transfer of water, and diversions at Kalinga Nuwara (considered under phase 2 of the program).

408. At Randenigala reservoir, the first diversion point, 180 MCM of Uma Oya water will be diverted to Randenigala, and 555 MCM from Randenigala will be diverted to the proposed Randenigala-Kaluganga Transfer Canal (RKTC), which is only 24% of total flow available at diversion point. RKTC will be augmented from the power flows of the proposed Hasalaka and Heen Ganga reservoirs, to increase the total diversion to Kalu Ganga to 660 MCM annually. The proposed Pumping Station will

abstract 10% of the flow at Kalinga Nuwara (located downstream of Minipe on Mahaweli river). It, while, supplementing from excess flow at Angamedilla will transfer 245 MCM to Elehera-Minneriya Yoda Ela.

409. It has been observed that more than 900 MCM (2005-2010) of water spills over at Minipe anicut annually. The long-term average spillage is estimated to be more than 1,000 MCM per annum (1970-2010). Due to diversions at Randenigala, and raising of Minipe Anicut, annual spills over the Minipe Anicut will be reduced to 278 MC after the Project. Reference to the recommendations of the IEE report, a minimum of 8 cumecs will be released from the silt ejectors incorporated to the anicut, as well.

410. Kalu Ganga reservoir will be operated such that there would be sufficient releases from the reservoir to Parakrama Samudra Scheme (PSS) to maintain its water level above 50% storage level and to maintain its CI at 200% level.

411. The NWP Canal will divert about 130 MCM of water from Dambulu Oya at downstream of Bowatenna tunnel and from Nalanda Reservoir. This water is stored in two reservoirs in Kahalla Pallekele sanctuary and released to Hakwatuna oya and upper Mi Oya to augment the water supply of medium and small tanks to increase the cropping intensity.

412. The proposed Pumping Station at Kalinga Nuwara will abstract 10% of the Mahaweli flow at that location (located downstream of Minipe). This amount of water will be extracted out of the excess flow at Angamedilla, which spills during the rainy season each year. River maintenance flow allowed in the designs at Kalinga Nuwara is a minimum of 4.25 cumecs (MCB, 2012c). Angamedilla flows will be reduced from 398 MCM to 306 MCM/annum, due to these diversions (MCB, 2012b).

413. Diversions from UEC would benefit Mahaweli systems IH and MH as well and enable augmenting agricultural and drinking water requirements of the NWP consisting of water scarce upper reach of Mi Oya basin and Hakwatuna Oya reservoir scheme of the Deduru Oya basin. Additional water retained in small tanks will enhance groundwater resources, as well.

414. Diversions at proposed diversion points allow for river maintenance flow which would include downstream consumptive use with provisions for the future demands and the environmental needs. The proposed diversion routes link Victoria, Randenigala, Kalu Ganga and Moragahakanda reservoirs having more than 2000 MCM storage for regulation and storage. The introduction of more than one diversion routes (alternative routes) for all major irrigation systems, crop diversification during yala season , and promoting effective water management programs will enhance the adaptation capacity of the system against climate change. Provisions are made to extend pumping at Kalinga Nuwara to the Maha season under drought situation to maintain safe water levels in main storage reservoirs.

415. In the NWP Canal Project designs, the concept of environmental flow has been incorporated as “river maintenance flow”, defined as “the minimum discharge required to maintain sufficient depth of water, flow velocity, water quality, aquatic ecosystem and scenery, requirements of all the livestock in and around the river, sea water extrusion, prevention of estuary clogging, ground water table and riparian rights of people, etc.” Considering the uncertainties and inadequacy of data, the adopted process of calculation takes the minimum monthly flows into consideration, which is described in the annexed report on Cumulative Impacts.

416. Both the NCP Canal and NWP Canal will augment the water supply to small tank cascade systems located in the NCP and the NWP. From the ancient times, these tanks have utilized the return flows from upstream tanks to store and supply to the crops in the command area.The NCP and NWP canals will directly augment a set of small tank irrigation systems in the MalwathuOya,

ParankiAru, Pali Aru, KanakarayanAru, Ma Oya and Yan Oya (UEC and NCP Canals) and MiOya, HakwatunaOya/DeduruOya (NWP Canal). The water availability in these river basins will be enhanced due to direct diversions as well as return flow resulting after crop water use in the directly benefited schemes. However, it is unlikely that there will be any excessive return flow during yala season because the water balance studies carried out by the MCB shows that water supply by the NCPC and NWPC will be sufficient only for 80% of the command area in that season.

417. The regolith aquifer in these parts of the country is heavily dependent on surface water and additional water retained in small tanks and the return flows will enhance groundwater resources as well, especially in the dry season. In the Maha season when there is a lot of rain, groundwater is recharged by both rainfall and surface water in the tanks. As such, groundwater levels are generally high during Maha season, and NCP/NWP Canal diversions are unlikely to make a significant change during the rainy period. However, NCP/NWP canal diversions can increase the groundwater levels in the Yala season, benefitting tail-end farmers who suffer from water shortages who could tap this water source. In addition, groundwater is used for domestic purposes.

418. Studies carried out in similar diversion projects have shown that groundwater levels are enhanced after diversions, but they fall down in the command areas after irrigationsand small tank cascades benefitted by NCP and NWP canals can be expected to perform in the same manner. Tank water levels are also likely to fall during the end of yala season. Therefore, high groundwater levels cannot be expected throughout the year. Problems such as water-logging and salinisation have not been reported from similar diversion and small tank augmentation projects such as WeliOya and Mau Ara. However, it is recommended that the quality of return flow is periodically monitored, considering the increased cropping intensity and promotion of crop diversification, after the project implementation.

4.12 IMPACT ANALYSIS

419. An assessment of the impacts of the NWP canal project on the surrounding environment was based on existing information and specialist studies. Table 4.11 illustrates a simple Impact Matrix (modified Leopold Matrix) to analyze impacts based on the expert evaluation of effect of different project activities on environment. This matrix would help to find out which components of the environmental and social impacts are more severe and also to find out whether such impacts are positive or negative and its level of significance.

420. The horizontal columns of the Matrix indicate various project activities during planning, construction & post construction phases and vertical rows indicate different environmental and social dimensions considered in the EIA assessment namely Ecology, Hydrology, soil, chemical and socio economic elements in terms of how their impacts would be as against the activities proposed. The severity of impacts is indicated numerically as follows:

0-No impact, 1- Low positive impact, 2- Medium positive impact, 3-High positive impact, -1-Low negative impact, -2-Medium negative impact, -3- High Negative Impact

These numbers are assigned in the matrix based on the identified impacts during the analysis and as discussed in chapter 4.

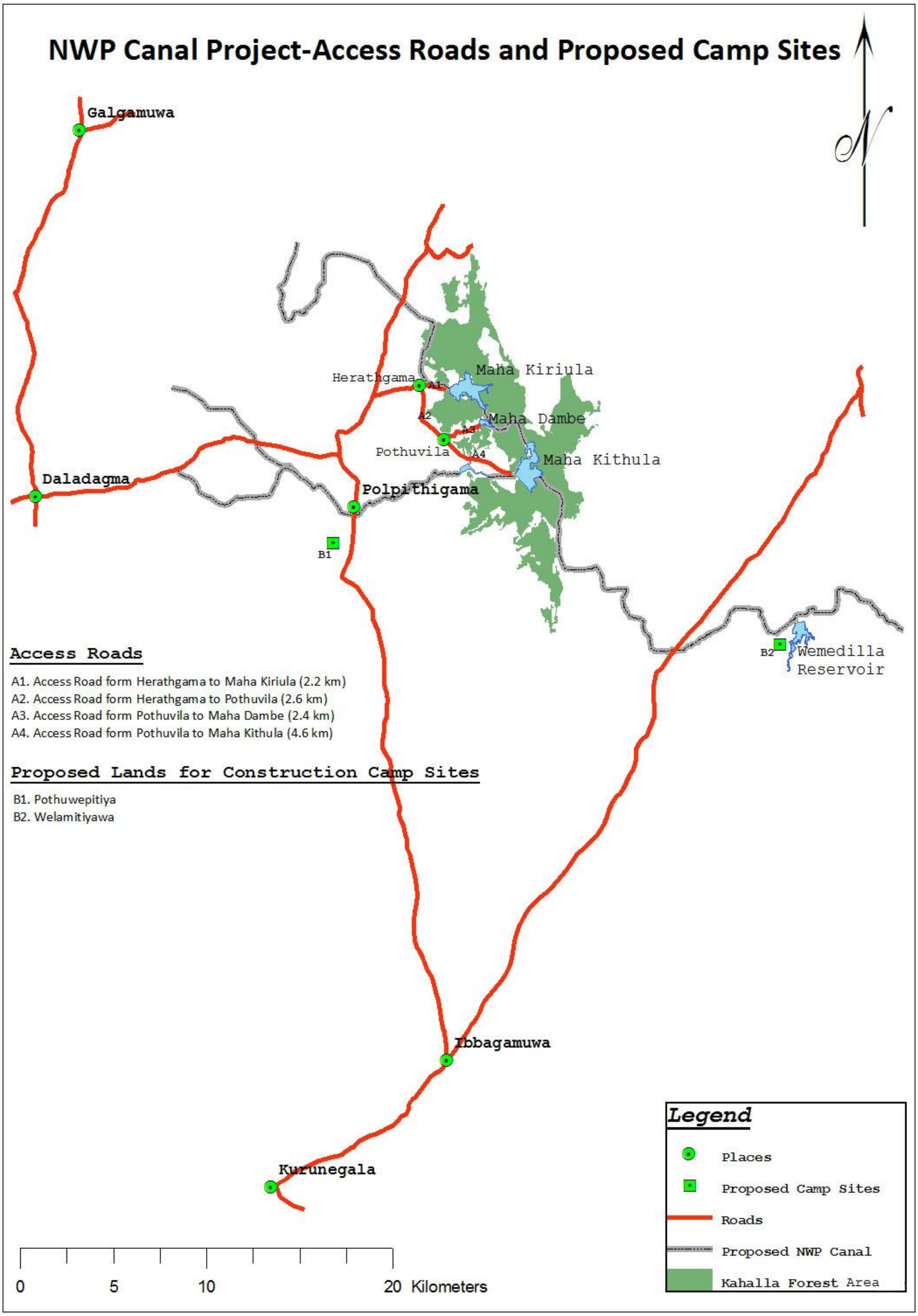


Figure 4-3 Borrow areas and quarries

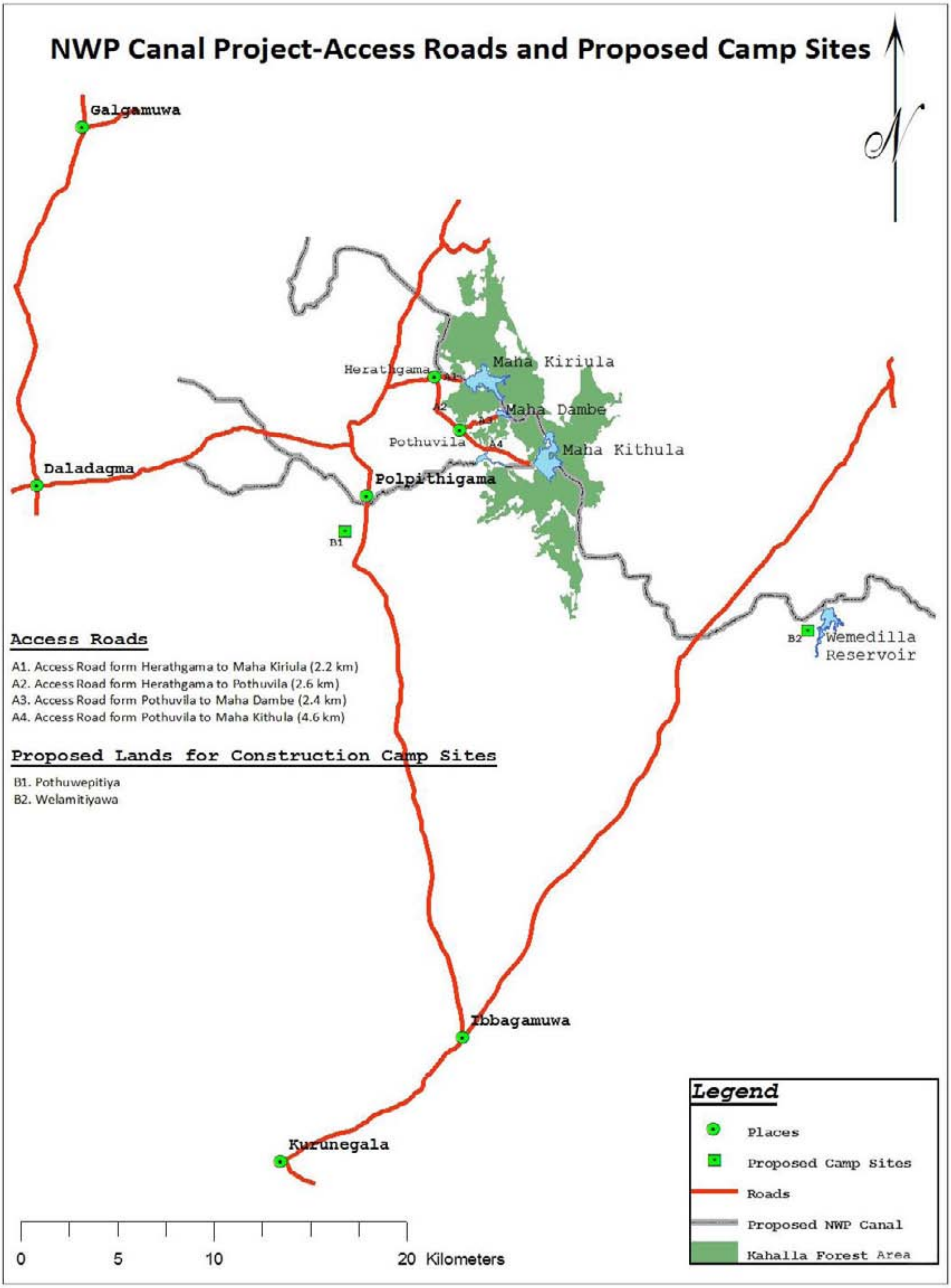


Figure 4-4 Camp sites and Access Roads

Table 4-11 Impact Matrix

Scoping Matrix for the NWP Canal Project EIA

Impact	Planning Phase				Construction Phase															Post Construction Phase					
Activities -> / Parameters	Land acquisition	Resettlement	Soil Investigations	Testing of construction materia	Migration of workers	Securing Access	Worker Camps	Land Clearing, Disposal of biodegradable Materials	Excavation	Compaction	Blasting & Drilling	Transport of construction	Barriers - Fencing	Culvert, bridges and Channel Associated Structures	Tunneling	Embankments & retaining wall	Construction Waste	Solid Waste	Landscaping, Rehabilitation, Restoration	Provision of Irrigation Water	Provision of Drinking Water	Reservoirs	Spills	Secondary developments	Changes in accessibility
Water																									
Turbidity	0	-1	0	0	0	0	0	-2	-3	0	-1	0	0	-1	-1	-1	-2	0	2	0	0	0	-1	0	-1
Ground water quality	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	2	0	0	0
Air																									
Particulate matter and dust	0	0	0	0	0	0	0	-2	-2	-1	-3	-1	0	0	0	0	-1	0	1	0	0	0	0	0	-1
Noise and vibrations	0	0	0	0	0	0	0	0	-3	-2	-3	-2	0	-1	-2	0	0	0	0	0	0	0	0	0	0
Hydrology																									
Flooding	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	-1	0	0
Ground water levels	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	2	0	0	0
Stream flow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Drainage patterns	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Earth																									
Soil erosion	0	-1	0	0	0	0	0	-2	-2	1	0	0	0	-1	0	-1	0	0	1	0	0	0	0	0	0
Stability	0	0	0	0	0	0	0	-1	-1	1	0	0	0	0	-1	1	0	0	1	0	0	0	0	0	0
Fauna- Terrestrial																									
Species diversity	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Rare & endangered species	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Habitats	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	1	0	0	-2	0	0	0
Migration patterns	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Human Elephant Conflict	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-2	0	0	0	0	0
Fauna - Aquatic																									
Rare & Endangered Species	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diversity	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0
Disease- insect vectors	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	-1	0	0	0
Flora- Terrestrial																									
Species diversity	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Habitats	0	-1	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	1	0	0	-1	0	0	0
Flora - Aquatic																									
Species Diversity	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0
Rare & Endangered Species	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Habitats	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0
Land Use																									
Residential	-1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
Agricultural	-1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	1	0	0	0
Wetlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0

Impact	Planning Phase				Construction Phase															Post Construction Phase					
Activities -> Parameters	Land acquisition	Resettlement	Soil Investigations	Testing of construction material	Migration of workers	Securing Access	Worker Camps	Land Clearing, Disposal of biodegradable Materials	Excavation	Compaction	Blasting & Drilling	Transport of construction material	Barriers - Fencing	Culvert, bridges and Channel Associatc Structures	Tunneling	Embankments & retaining walls	Construction Waste	Solid Waste	Landscaping, Rehabilitation, Restoratio	Provision of Irrigation Water	Provision of Drinking Water	Reservoirs	Spills	Secondary developments	Changes in accessibility
Aesthetics																									
Scenic views & sites	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	2	1	0	0
Topographic character	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0
Human Interest																									
Housing	-2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Health and safety	-1	1	0	0	-1	0	0	0	-1	-1	-1	-1	0	0	-1	-1	0	0	0	0	2	0	0	0	0
Water uses	-1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0
Historical/ religious/ archeological sites	-1	1	0	0	0	0	0	0	-1	0	-1	0	0	0	0	0	0	0	0	0	0	-2	0	0	0
Education	-1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transportation																									
Existing transportation systems	0	0	0	0	0	0	0	0	0	0	0	-2	0	-2	0	0	0	0	0	0	0	0	0	1	0
Economic																									
Land values	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	1	1
Employment opportunities	0	0	0	0	1	1	1	1	0	0	0	1	0	1	0	1	0	0	1	1	0	0	0	1	1
Livelihood	-1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	2	0	1	1
Tourism	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	1
Local economic conditions	-1	1	0	0	1	0	1	0	0	0	0	1	0	1	0	0	0	0	0	3	1	1	0	1	1
Regional economic conditions	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	1	1
National economic conditions	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0

CHAPTER 5

5. PROPOSED MITIGATORY MEASURES

421. During the EIA it was observed that certain mitigatory measures were already implemented to minimize environmental and social impacts. These are:

- Shifting of canal center line to avoid houses on the canal trace to minimize number of people be affected. This has now being achieved by the resettlement team.
- Canal center line was shifted to minimize the effect on archaeological sites. The canal center line was shifted to minimize the impact to Neelagama Ancient Temple.
- Several reaches of the canal was decided to change from open canal to closed conduit in order to minimize disturbance to people on the canal bank.

5.1 Mitigatory measures – Hydrology and water quality

Mitigation of Hydrological Changes in Ambanganga

422. A detailed water balance study has been carried out during planning stage. The proposed water distribution diagram is shown in Figure 2-4 of this report. The storage of Nalanda is being increased restored to its original capacity of 15.3 MCM, with the rehabilitation of the dam. This will enable enhanced diversion during the dry periods.

423. It is noted that the diversions to Systems H, MH, and IH will be increased after the completion of Moragahakanda and Kaluganga reservoirs via UEC. As incorporated in the design, diversions to NWP from Nalanda will be commenced only after the UEC has been constructed.

Mitigation of Hydrological Changes in Mi Oya and Hakwatuna Oya

424. As mentioned in the above section developments are designed to augment current water supplies, any reduction in environmental flows is not expected. Water balance studies had shown that diversion is needed and also possible only during a few months of the year. Hence, diversion proposals of this nature and magnitude will be effective only if diverted water is stored and well regulated. Nalanda, Wemedilla, Maha Kithula and Maha Kirula reservoirs located at higher elevations will serve this purpose.

5.1.1 Measures to ensure riparian rights in the area

425. The environmental flow requirement during the zero-irrigation demand periods is recommended to be released from the bottom outlet. It is understood that currently accepted practice is to issue 5 ft^3/s (about 0.14 m^3/s) to the downstream from the bottom outlet during zero-irrigation demand periods, and this practice is recommended to be continued, with necessary adjustments according to changes in environmental or domestic demands.

5.1.2 Sedimentation control during construction

426. Following mitigatory measures are proposed to control sedimentation during construction.

- Earthwork should be mainly carried out during the dry season.

- Existing drainage paths in the working area should not be disturbed. Temporary drainage paths should be created to avoid drainage congestion.
- Loose earth should not be left unattended and soils should be compacted to specified standards degree of compaction.
- Coffer dams at appropriate locations, sand bag barriers, temporary soil mounds, silt traps etc. should be constructed to avoid sediment inflow to streams.
- If loose soil dumps need to be kept for a long time it should be properly covered.

5.1.3 Flooding

427. Flooding should be expected during the construction phase of the project. Following measures are suggested to mitigate impacts caused by the flooding.

- Identify possible flood plains on either side of streams.
- Levels of previous critical floods should be marked.
- Cofferdams should be designed to a suitable return period and floods above that will overflow coffer dams during north east monsoon (November/December). Constructions should be strategically adjusted during flood vulnerable months.
- Workers should be made aware of possible flood hazards.
- A close coordination with District Disaster Management Centre is required.

428. Proposed two reservoirs which are situated in the upper catchment. These reservoirs will buffer floods but, confluences of several more streams are in the downstream of the reservoirs. Floods occurring in these streams will affect downstream in extreme events. ID shall prepare a set of standing orders as in the case of other major schemes. This document should be available in all irrigation engineers' offices to follow in the case of flood emergency. It should include instructions to officers handling various structures on operating sequences of spill gates, warnings that should be given proper to opening of gates etc.

5.1.4 Measures to contain water pollution due to construction machinery

429. It is recommended to construct workshops of adequate size in each machinery site with necessary maintenance equipment. Bio degradable detergents should be used in cleaning machinery and waste water should be treated before disposal. Waste water must be treated in sediment tanks exposed to sunlight. The waste lubricants and fuels should be collected and not discharged to the environment

430. Many workers are involved in project activities and will reside at camp sites. These camp site are proposed outside of the sanctuary. See fig 4-4 for locations of campsites. Liquid and solid wastes generated in these sites can affect surface and ground water at shallow depths. This effect can be mitigated by treating wastewater from kitchens, washing and bathing areas shall be treated in soakage tanks/pits before discharging into streams. Sanitary sewerage should be treated in septic/soakage tanks.

5.1.5 Measures for changes of in groundwater and surface water

431. It is recommended to undertake a good monitoring system to monitor hydraulic, physical and chemical properties of the ground water and surface water. Heavy metals, Pesticides, Electrical conductivity, pH, BOD etc will be monitored under the monitoring programme. It is suggested to

make observations in 6 locations during and after the construction phase. Suggested locations are 2 location in Hakwatuna Oya, 2 locations in Mi Oya and two selected locations in minor tanks.

5.1.5.1 Surface water quality

432. It is important to monitor surface water quality also especially during operation period. Same locations are suggested to make observations. However, the locations should be finalized after consultations of water quality experts. Heavy metals, Pesticides, Electrical conductivity, pH, BOD etc will be monitored under the monitoring programme. It is suggested to make observations in 6 locations during and after the construction phase. The measurement programme should commence 3 months prior to construction to serve as base line data.

5.2 Mitigatory measures – socio-cultural

5.2.1 Resettlement of displaced community

5.2.1.1 Development of ways & Means and Principles for Land acquisition, and Resettlement using a community participation

433. Based on NIRP which spells measures to avoid or minimize adverse impacts of resettlement by facilitating to self-support and revive their productivity, a resettlement action plan will be implemented based on the conditions stipulated in the policy along with a methodology of community participation. The preparation of a detailed Resettlement Action Plan (RAPs) by a qualified and experienced Resettlement Consultant is currently under preparation.

434. A closer investigation of the field undertaken for the purposes of this resettlement plan revealed that only 22 families were affected, and the impact was partial. It is concluded that for all these families but one, they could relocate in the unaffected portions of their lands. The remaining family has voluntarily acquiesced to move to an adjacent plot of land which will be provided by the project.

5.2.2 Mitigatry measures on improving livelihoods of the relocated persons

435. The project will affect livelihoods, sources of incomes and social networks of the people who will be impacted by the project. Appropriate level of compensation as reflected in the resettlement plan, for such losses and alternative sources of income are to be provided to such affected persons. (Please see the resettlement plan for details)

5.2.3 Mitigatory measures for resolving conflicts between the residents of the area and the migrants

436. At resettlement sites, the project will provide basic facilities such as road facilities, transport facilities, health and sanitary facilities, communication facilities, educational facilities, recreation facilities, and trade facilities which could be used by both resettles and their host community. Key arrangements to build good relationship on socio-economic and cultural aspects between host community and the relocates and follow up for a considerable period of time.

437. The host community should be made well aware of the sacrificing role of the displacing community being involuntarily displaced to bring the project benefits to the host community and

many others. This message can be transferred to the host community through religious leaders, government officers and community leaders to wake up a gratitude mentality towards the migrants. Details on compensation and livelihood restoration programs can be found in the respective resettlement implementation plan.

5.2.4 Proposed mitigation measures for adverse impacts of agronomic practices

Strengthening farmer Organizations

438. Farmer organizations should be strengthened while giving them knowledge and skills required to achieve their following requirements collectively by themselves legally, transparently and conveniently at their own pace.

- Methodical distribution of irrigation water
- Protection and maintenance of irrigation system
- Providing agricultural inputs to the members on time and assist them to market their produce for a good price

Training programs in Agriculture

439. With the acquired knowledge in agriculture, working with collective effort towards community development would strengthen them against possible adverse conditions arising with the changes bring about by the Project. They should pay attention to;

- Titles that should be touched upon to drive them towards more productive cropping pattern
- Methodical Land Preparation
- Selection of seeds for a better harvest
- Establishment of plants/ seeds in the field
- Using fertilizer according to the crop needs, minimum usage of agro chemicals and establishing the practice of organic fertilizer
- Timely irrigation according to crop water requirement
- Formal methods for pest control –promoting organic and collective pest control method s
- Formal methods of harvesting & storage
- Marketing agricultural produce

Implementation of a methodical water management program

440. The minor tanks in a cascade system operate in such a way that the spillage and drainage water from the higher tank in the system reaching the next in line. This should be changed to a more efficient way because the farmers under low elevated tanks have to wait a long time to get their share of water. The Project management should intervene in the matter and arrive at a better method collectively with farmer organizations. This is an exigent matter to be taken care of.

441. After forming the above program farmer organizations should be made aware of the economic use of irrigation water and sharing depending on crop water requirements. This knowledge should be seeped to the community through them.

Formulation and implementation of a proper marketing plan

442. Once the irrigation water becomes abundant and with farmer's keenness on achieving their high productivity goals the quantity of agricultural produce reaching the market would increase. This would sometimes lead to drop in prices in an unfavorable way. That's where the project should step in and implement the following program.

- Introduce bulk purchasing institutions to farmer organizations and assist in building up connections
- Motivating farmers to produce market oriented agricultural produce
- Introduce food preserving methods (even for a short time) to be used when there is surplus production
- Paying attention to establish By Product industries for fruit & vegetable in the Project area

443. This programme should be facilitated by the Irrigation Management Division (IMD) of the Ministry of Irrigation and water Resources Management with the support of other departments like Agriculture Department, Commercial Banks, private sector etc. This is the normal programme of the IMD.

5.3 Mitigatory measures – Ecological resources

444. The project area consists of dry-mixed evergreen forest, degraded natural forest, riverine forest, home gardens, paddy fields or other agricultural lands. The partial clearing of natural vegetation would be carried out in two reservoir sites, to construct the dams and canal. The State Timber Corporation has the authority to fell the trees and transport them in government forest lands. This process is entirely controlled by the Forest Department and Government Agent.

445. Access roads to the dams, borrow area and quarry sites will be existing cart and jeep tracts. It will be necessary to widen these existing roads. The borrow areas are inside the reservoir beds. Quarry sites are outside of reservation areas. The existing roads within the sanctuary could be widened without opening new roads through the forest. Once the project activities are over temporary access roads could be restored to the previous status by carrying out a reforestation/ restoration programme using native species. However, the O&M road along the canal and reservoir embankments will be be necessary for operation and maintenance purposes. The road will be under the custody of Department of Wildlife Conservation.

446. A detailed survey should be carried out to identify the sites and extents for reforestation. Trees can be planted along the NWP canal where tree cover is absent or felled, access roads, borrow areas, quarry sites, sites of labour camps and other areas without tree cover. Degraded teak plantation in Kahalla- Pallekele Sanctuary would be suitable for enrichment planting with indigenous species.

447. A list of species suitable for enrichment planting is found in the Annex II Table 1-3. The total cost would be around Rs. 400,000 per ha for enrichment planting and the maintenance of indigenous species. The Sri Lanka Forest Department Circular No. 28/ 1998 (see Annex VI-V) gives the details of number of man days for planting, maintenance of forest plantations and nursery practices. At present the casual wages for a man day is Rs. 586.00. This rate is used for calculating the cost of reforestation/ enrichment planting programmes to be implemented in the project area.

448. It might be possible to extract some trees which are economically important timber species leaving the rest in the proposed inundated areas of two reservoirs to act as wildlife habitats (for birds of prey, birds nesting places etc.) and habitat for fish. De Silva (1988) mentioned that in Parakrama Samudraya, prior to submergence, large areas were covered by trees. These are now in various degrees of degeneration. Although the trees represent a danger to fishing gear, fishermen prefer setting the nets among trees as fish tend to congregate in such areas and this makes commercial fishing viable. He suggested to leave approximately 50 % of the forest cover of the future reservoir bed in new reservoirs, established in forested areas.[13] But, as fishing in the reservoirs inside the sanctuary is not permitted, the proponent suggest not to remove any trees inside the reservoirs.

449. The criteria for tree felling in proposed reservoirs are not formulated in Sri Lanka to decide what tree species or size classes to be removed from the inundation area before filling the reservoir. Once the reservoir is filled the 100 m reservation from the FSL will be replanted with indigenous tree species, if the forest cover is degraded or not existence.

450. The two most significant impacts that will arise due to the project include loss of habitat due to establishment of the two reservoirs, *Maha Kithula* and *Maha Kirula* within the Kahalla-Pallekele sanctuary. This will result in the inundation of several natural habitats such as dry-mixed evergreen forest, degraded dry-mixed evergreen forest and scrubland. These habitats function as rich faunal and floral repositories. The loss of habitats could be mitigated through compensatory reforestation programme, restoration and enrichment plantings.

451. Further, it is recommended that the existing electric fence is realigned to include any unused areas immediately outside the present alignment of the fence as well as any other plantation forests belong to the Forest Department that can be annexed to this complex. This will add about 300 ha to the existing sanctuary.

452. It is also recommended that the project provides funds for enrichment/replanting the area where degraded Teak plantations exist in the catchment area of the two proposed tanks within the Kahalla-Pallekele sanctuary with suitable indigenous trees to enrich the forest habitat to increase the carrying capacity of these habitats for indigenous species. Figure 5-1 shows proposed reforestation areas.

Fauna

<u>Mitigating high human-elephant conflict</u>

453. The second significant impact is the escalation of human elephant-conflict due to the loss of habitat of elephants as well as increased cropping intensities that will prevent elephants from using some of the cultivated lands that are left to fallow during the dry season. The area around Kahalla-

[13]*(Reservoir bed preparation in relation to fisheries development: an evaluation. In: Reservoir Fishery Management and Development in Asia (ed. S.S. De Silva): 121–30. International Development Research Centre. Ottawa, Canada)*.

Pallekele-Resvehera sanctuary is also identified as an area where high human-elephant conflict exists at present. Provision of irrigation water for two season cropping, along with loss of habitat can further aggravate the present conflict status. It is therefore recommended that the existing electric fence is moved to the ecological boundary between the natural habitat and human use area to compensate for the loss of habitat as well

454. The entire elephant use area should be separated from the human use area with an electric fence. The electric fence is currently maintained by the Civil Defense force who should be assisted by the local community under the coordination of the Divisional Secretary. Further, additional funds will be set aside by MIWRM to address the increased HEC due to the proposed project. MIWRM has already commissioned IUCN Sri Lanka to prepare a strategic action plan for the entire command areas coming under the NCP stage I projects.

455. Since the project involves long canals it is also recommended that the canals are design should incorporate structures at least at 500 m intervals to ensure safe passage of animals across the canal as well as to facilitate those animals that fall into the canal to exit the canal easily. (See Fig 5-2)The remaining impacts can be easily mitigated through well planned and executed environmental management plan.

5.4 Mitigatory measures for on Debris/Waste Disposal

456. All debris and waste from workers camps in the construction sites should be properly disposed by the contractors in pre identified locations approved by the engineer and local authority. Burning of plastics and polythene should not be allowed in open fire. Plastics that can be recycled should be sold to recycling industries in the District.

457. Tunnel muck and other spoil should be placed in low lying dry areas. This waste material can be used to reinstate borrow pits. However, that should never be disposed in river banks where it will be eroded. Whatever material that can be reused should be utilized. Usually, people living close to dumping places of waste soil will use it to fill their lands.

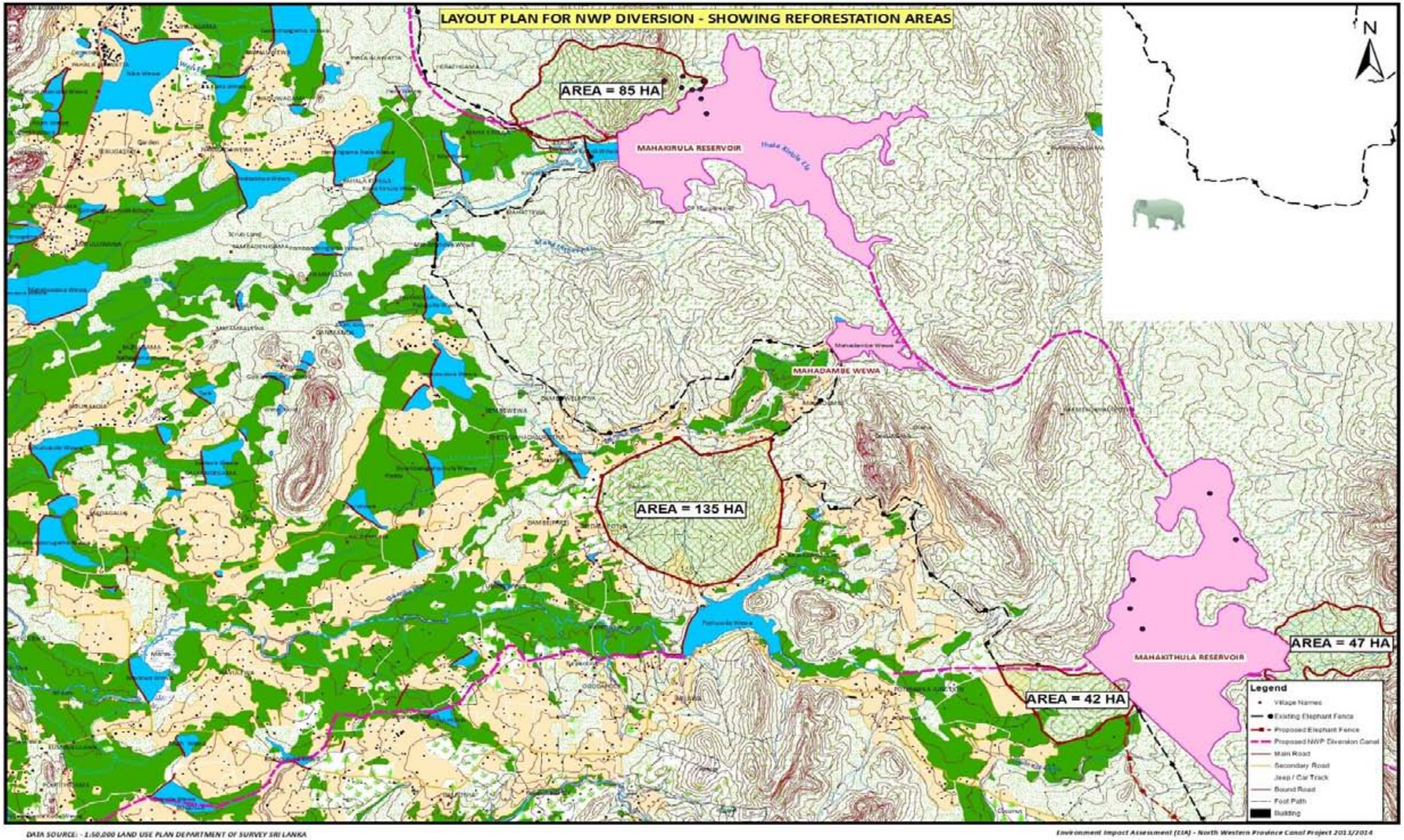


Figure 5-1 Areas proposed for reforestation

5.5 Mitigatory measures for impacts to soil and topography

5.5.1 Mitigatory measures for surface run off and erosion during construction

458. With the commencement of construction activities, lands will be cleared and soil will be exposed to elements weather. Exposed soil surfaces are prone to erosion from surface run off in almost all sites. This is an undesirable consequence of construction activities and mitigatory measures are proposed to mitigate the effects.

5.5.1.1 Dams and reservoirs

459. The project involves construction/rehabilitation of two reservoirs. These two large reservoirs are proposed in Kahalla Pallekele sanctuary. The main activity in land preparation during a dam construction stage will be clearing of lands along the entire length of the dam to s width about 100 m and gradually reduced to about 10 m both ends. Cleared lands are prone to erosion due to surface run off which will result in siltation in the downstream areas, especially in streams. Therefore, dam construction should be carried during dry season.

460. Eroded materials are transported with surface runoff and are deposited in downstream areas that will increase siltation of downstream tanks.

461. In order to prevent silt depositing in downstream tanks and streams, silt traps are suggested in the downstream water paths. Excavated soil in this operation should be taken to dumping sites outside the forest reserve which will reduce the possibility of increased erosion.

462. The dam embankments should be covered with grass turf in the downstream face and rip rap cover in the upstream face. This will reduce erosion and make dams more stable. There may be few sections which will subject to heavy erosion. These locations should be identified and runnels should be constructed to take away the water safely. Material for rip rap will be secured from tunnel excavation and from the rock quarries outside the forest reserves (see Fig. 4-3). Earth for dam construction will be borrowed from the reservoir beds.

5.5.1.2 Conveyance canals and irrigation system

463. It is recommended to turf all exposed surfaces of newly formed canals. The conveyance canal will cross Kahalla Pallekele sanctuary and in these sections flatter slopes should be allowed for safe crossing of wild life especially wild elephants.

464. Usually the side slopes of a canal are 1 on 2. For the animal crossing one side will have a flatter slope of 1 on 3 with concrete steps as shown in the figure below.

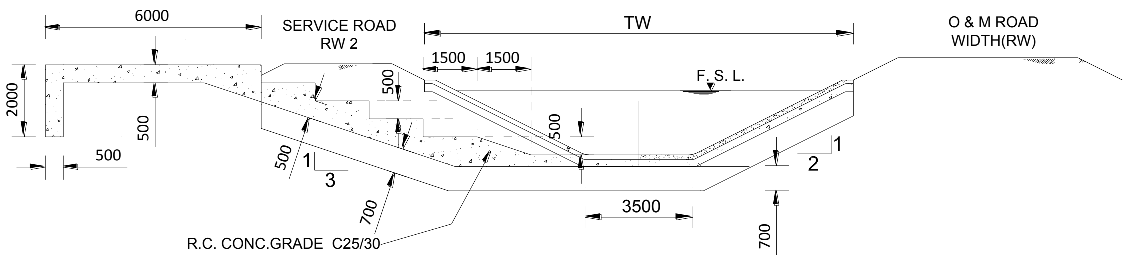


Figure 5-2 Animal Crossing

465. Rain water will cause erosion of soil particles which will be transported with water flow and end up in streams causing siltation of streams. In order to avoid this undesirable siltation it is suggested to construct several silt traps across seasonal streams. These streams are far too numerous to name. Approximately 1.5 square kilometers of lands will be cleared during the construction phase of canals. Soil tends to undergo high erosion risk once the vegetation cover is removed. Therefore, canal construction should be carried during dry season. As in the case above rain water will cause erosion of soil particles which will be deposited along the water ways. Silt traps along the stream paths are recommended to mitigate such silting. These silt traps should be regularly monitored by the construction agency.

5.5.1.3 Borrow sites and quarry sites

466. Borrow areas for two main reservoirs is proposed to be located in the reservoir bed. These will be inundated once reservoirs are impounded. The dead storage accumulated in these borrow pits will be useful for wild animals in dry season. It is recommended to rehabilitate by making the slopes flatter (say 1 on 3)on these borrow sites will be habitats of wild animals when the water levels are lower in the dry season. In the project area all borrow areas identified shall be restored by refilling and replanting. All pits shall be filled with excavated material, stable gradient on the slopes to be maintained; if necessary soil bunds and drains could be adopted. Moreover tree planting with Giliricedia, Vetiver and Citronella can also be introduced to control soil erosion. Small soil conservation bunds can be constructed.

467. It is recommended to drain out stagnant water in borrow sites to streams nearby to avoid health hazards to construction workers. It is recommended to shape the mined gravel pits to 1:3 ratio and either grass turf of rock pave to control erosion and minor slope collapses. It is also recommended to implement a tree planting programme in burrow sites where those are not inundated after the impoundment of reservoirs. Rock quarry sites have been identified for the project. Overburden is absent in the quarry sites and the rock is exposed.

5.6 Mitigatory measures for slope failures and due to establishment of reservoirs

468. In the past landslides or earth slips have not been reported in the two major reservoir areas. The two proposed reservoirs are located in Kahalla Pallekele sanctuary. When the main dams and saddle dams are connected to ridge structures, hill slopes will be disturbed during construction. There is a possibility that some of these rock slabs currently located in the hill slopes may get detached. It is recommended to identify such unstable rock fragments and remove them from ridge slopes. Hill slopes are stable at present, but when water is impounded in the reservoir, there is a possibility of losing the stability of overburden cover of hill slopes and as a result slope erosion/ minor slope collapsing may occur. The loose rock on the periphery should be removed or stabilized with stone masonry.

5.7 Mitigatory measures for dam failures

469. Dam failure issues in the project are to be addressed during planning, investigations, and design, construction and operation phases. A dam failure during the operation of a reservoir is a concern for public safety especially of people living in the downstream of the reservoir. Dams may fail due to

overtopping, excessive seepage, sliding, malfunctioning of operations and various other reservoir regime conditions. The other reason for a dam failure is due to natural disasters. A comprehensive set of standing orders should be prepared by the ID prior to commissioning of the facility.

470. Intensified foundation and soil investigation of borrow areas are essential for any dam designs. Foundation treatment as recommended by a qualified engineering geologist is essential in order to minimize seepage through the foundation. A proper dam design incorporating a core trench is essential. After the core trench excavation a qualified professional should inspect the exposed surface and map the geological details before approving the filling of the same. Though extensive exploration and testing have been carried out prior to construction, most foundations may reveal unanticipated unfavorable conditions which may require additional investigations and redesign or change the type or extent of foundation treatments.

471. Earthen dams and other related structures should be constructed following best engineering practices with proper quality assurance. Qualified professional inputs are vital at all stages of construction.

Land slide potential and slope stability

472. The proposed dam axis for Mahakiruala runs across existing Mahakirula wewa. As revealed from the preliminary investigations the banks and periphery of the reservoir mainly consist of high resistive quartzite material and overburden is also not thick. Therefore the possibility of landslides is a less concern in this site. However precautions must be taken to remove detached unstable rock fragments found if any. Similar measures should be considered in the case of other two reservoirs namely Mahadambe and Mahakitula wewa.

473. The Pothuwila tunnel which is about 700 m long runs across a ridge with maximum elevation of 20-22 m at the central part is composed of quartzite. At the inlet & outlet portals no fracture free bedrock was encountered. The overburden is thick showing gradual weathering profile, during the construction of tunnel necessary precautions shall be taken to avoid any slide /slope failures. Before opening up for construction of portals, strengthening measures will have to be taken.

474. Also denudation of the forest cover shall be kept to minimum in this area. Surface drainage should also be improved to minimize the percolation. Moreover it is recommended to do detail Geological investigation (Core Drilling) at the tunnel trace in order to do proper design of the tunnel giving due consideration to weak areas, recommend grouting & shotcreting at the inlet and outlet portal areas concrete lining and anchor bolting where ever necessary in the intermediate area. Once the above measures are adopted adverse effects on the environment will be minimal while arresting any possible leakage into the tunnel or from the tunnel, any slippage of fractured rock.

Initial Reservoir Filling

475. The initial reservoir filling and surveillance plan should be prepared by the design staff. Initial filling should be well documented, including a record of reservoir elevation and controlled water releases during filling by following dam safety rules. The surveillance record should include all information obtained from inspection of the dam, appurtenances and reservoir periphery area during initial filling. There is a danger of wild animals being marooned in the high grounds during initial filling. Precautions should be taken by ID and WLC officers.

Operation and Maintenance

476. Maintenance of completed works is a mandatory function of the Irrigation Department. Preparation of operation and maintenance plan using irrigation department guidelines for the reservoirs and canal system is one of the functions of Asset Management sub department of the Irrigation Department. Risk based maintenance practices according to guidelines should be followed. Monitoring of dam behavior at pre-determined time intervals by experts as per the guidelines is mandatory. As dam safety covers a wide range of engineering, environmental and social issues, it has to be taken as a separate key component during maintenance period.

477. Training of operation and maintenance staff on the many functions of operation is mandatory. They should be trained in recognition of conditions possibly detrimental to the safety of the dam.

5.8 Mitigatory measures for air pollution, noise and vibration

5.8.1 Air Pollution

478. During this type of major construction works, impacts on air quality may be significant. Regular monitoring of ambient air quality levels at least once a month in heavy construction locations, good housekeeping practices, and regular awareness programmes among staff and workers will help in improvement of air quality in the project area. The Table 5.1 gives some of anticipated impacts and proposed mitigatory measures.

Table 5-1 Mitigatory measures for Air pollution

Anticipated Air quality impact during operation phase.	Proposed Mitigatory Measure
Burning solid waste	Open burning of waste should not be permitted. Provide facilities to reuse recycle and dispose solid waste properly. Introduce buyers for recycled solid waste. No hazardous waste is expected to generate within the project. Plastics etc should be recycled of disposed properly.
Dust from roads and other exposed surfaces	Pave the roads where possible outside sanctuary and maintain the surfaces. Turfing exposed surfaces where ever possible Regular wetting of exposed surfaces (during construction_
Vehicle emissions	Contractors should demonstrate that Machinery used in the construction meet the emission standards by oil and filter changes at specified intervals. Use proper fuel for all vehicles. Contractor to follow Stipulated speed limits within the work sites

5.8.2 Noise and Vibration Impacts

479. Mitigatory measures for noise and vibration impacts should be adopted during the construction period where the noise of construction machinery may be high. The principal sources of noise and vibration during the construction phase will be rock blasting, tunneling operations, operation of

heavy earth moving equipment. The correct operations, maintenance and site practices of those equipment are the most effective method of mitigation. The other ways to mitigate are;

- Equipment fitted with adequately sized exhaust silencers
- Use silenced equipment whenever possible
- Use low noise equipment
- Keep equipment is good working order
- Minimize use of noisy equipment
- Scheduling activities to avoid high noise levels
- Use of temporary noise barriers
- Proper maintenance of service roads and traffic management.

480. As per the prevailing practice, it may be not possible to specify the method of construction to the contractors. But noise control and vibration control requirements of equipment should be specified in the tender documents. The night time construction operations should be avoided as far as possible. The construction noise levels could affect the wildlife in the vicinity. All possible noise reduction measures should be taken to minimize the noise levels at the boundary of construction sites to 75 dB (A) in daytime (06 00h to 21 00h) and 50 dB (A) in night time, to confirm to maximum permissible levels stipulated by CEA. However the expected noise due to construction activities within a site increase up to around 80 to 115 dB (A) depending on activities. This would cause workers at the site being exposed to high noise levels. Therefore hearing protectors should be provided to workers by the contractor. The main source of ground vibration is rock blasting. GSMB mining license should be obtained as required for quarry blasting and rock blasting are involved. All restrictions and limitations enforced by CEA, GSMB and any other regulatory authority should strictly be followed.

481. Arrangements should be made by the construction contractor to record all buildings a minimum of 250 m radius or according to GSMB requirements. He should maintain continuous monitoring of ground vibration and Air blast over pressure (ABOP) to identify ground vibration and ABOP. Pre and post crack survey for all buildings within 250 m radius of related blasting site. After considering the effects of ground vibration and ABOP, and comparing both pre and post crack survey relevant to each building, the contractor should make necessary arrangements to repair the generated cracks or compensate for repairs after valuing the damages to buildings.

482. The contractor should provide pre-warning to residents within the vicinity regarding blasting operations by using loud speakers, displaying notices etc in the public places. However to minimize the effect of ground vibration, ABOP and fly rocks, control blasting should be carried out specially in inhabitant areas under the supervision of qualified Mining Engineers with relevant experience. When Rock blasting is to be carried out in sensitive areas such as close proximity to archeological monuments it is better to adopt chemical blasting instead of control blasting. The wild animals are not affected by blasting operations as they move to other areas when they experience blasting.

5.9 Mitigatory measures for land degradation due to vegetation removal.

483. The proposed project will not open new lands for cultivation, but will increase the cropping intensity of existing lands with the supply of additional water. Lands are opened for construction of

canals and reservoirs during the construction phase. Therefore special emphasis should be given to prevent land degradation of construction sites. For reservoirs most borrow areas are located in the reservoir beds. But for borrow areas in canals erosion protection measures are necessary. Land degradation due to agricultural activities should be dealt by Agriculture Department by giving proper instructions to farmers on land preparation at proper time.

5.10 Mitigatory measures for impacts to archeological sites

484. The Department of Archaeology conducted an Archaeological Impact Assessment Study in the project area. The report was submitted to MI&WRM in February 2013. This report has identified and recommended mitigatory measures for impacted sites. The mitgatory measures that have to take to minimize the anticipated impacts of the proposed project are given below. The impact assessment conducted by archaeologist of EIA team is annexed to report as annexure VI – IV Archeology. The Department of Archeology approved the proposed project by their letter no H/EXP/EIA/NWP/2013 dated 01/08/2013.

L14. <u>Neelagama Ancient Temple</u>

485. Neelagama Ancient Temple with rock cut caves on the early ancient period is situated in a Rock Hillock within a distance of about 123 meters from the left side of the Canal. GPS Points of the site is 07^{0}N 46.677 and 80^{0}E 32.158. Although no impact will cause due to the construction of the canal, extremes precautions should be taken during the construction of the canal especially when heavy machinery is used and during the rock blasting.

L18. <u>Cairn Burial Site of Gorakapelessa</u>

486. Cairn Burial Site in an area of 100 x 100 m was identified within a distance of 100 meters from the left side of the Canal inside Kahalla Pllekele Forest Reserve. The area consists of two ancient tanks, a settlement and area consisting Iron Slugs. GPS Points of the site is 07^{0}N 49.841 and 80^{0}E 29.447. Since the site is due to be submerged with the construction of the Mahakithula Tank, direct impact of the site could be identified due to project. The site may be have been disturbed due to the teak cultivation. However, since the site is due to be submerged with the construction of the Mahakithula Tank, it is proposed to inform the Department of Archaeology and obtain instructions to record the site with an archaeological excavation.

L19. <u>Ancient Iron Slag Deposit</u>

487. An ancient Iron Slag Deposit of approximately 75 x 75 meters in the teak planted area with red ware potsherd within a distance of about 100 meters from the left side of the Canal was identified as a natural mound. GPS Points of the site is 07^{0}N 49.841 and 80^{0}E 29.447. Since the area is due to be submerged it could be investigated together with the Cairn Burial Site indicated in L18.

L20. <u>Ruined Mahakitula Tank</u>

488. Mahakithula Tank has been completely ruined and in which the ancient sluice could be identified. There are several stone slabs in the area where the sluice was. GPS Points of the site is 07^{0}N 49.908 and 80^{0}E 29.239. Since the tank is expected to be rebuild the stone slabs belongs to the sluice of the tank should be removed from the submerging area and stacked as an exhibit near the

new sluice. This is the recommendation of the Department of Archaeology in their impact assessment.

L27. Jayalthgamawewa Ancient Tank

489. Jayalathgamawewa Ancient Tank with a ruined approximately 150 m embankment is situated at GPS Points of 07^0N 55.706 and 80^0E 23.407. Since no evidences of archaeological remains were identified there will be no impact if this tank is to receive waters from this project.

L28. Nelumwewa Ancient Tank

490. Nelumwewa Ancient Tank with a ruined approximately 75 m embankment is situated at GPS Points of 07^0N 55.874 and 80^0E 23.394. No evidences of archaeological remains could be identified. Furthermore, rehabilitation of the tank is not envisaged under the project and therefore there is no impact

L29. Gorakagahawewa Ancient Tank

491. Gorakagahawewa Ancient Tank with a ruined approximately 75 m embankment is at GPS Points of 07^0N 55.935 and 80^0E 23.367. Since no evidences of archaeological remains could be identified no impact will be caused if this tank is decided to be feed from the project**.**

L30. Polgahawewa Ancient Tank

492. Polgahawewa Ancient Tank with a ruined approximately 80 m embankment is at GPS Points of 07^0N 55.994 and 80^0E 23.378. Since no evidences of archaeological remains could be identified **no impact** will be caused if this tank is decided to be feed from the project.

5.11 Mitigatory Measures during operation

493. The NWP canal and related reservoirs will be operated by ID with the water management decisions by of the conveyance canal the residents must be warned about the water flow in the canal. Proper warning boards should be erected along the canal. The fences among the populated areas must be erected and maintained. ID shall prepare standing orders appropriate for the system and operation staff shall be well informed through an awareness programme. The operation staff shall be trained of operations under extreme conditions. Occupational health and safety of the staff is another important area for the operating staff. With the increased availability of water the Cropping Intensity will be increased and as a result use of agrochemicals will be increased. Farmers shall be trained on proper use of such chemicals and also on integrated pest management, use of organic fertilizer. Such programmes are available with the Department of Agriculture. It is proposed to implement a series of training programmes for the farmers. Fishing is not permitted in the major reservoirs and fisher folk will not be affected during construction. The workers camps will be established in two locations shown in Fig 4.4. One at Polpithigama and other near Wemedilla reservoir.

CHAPTER 6

6. INFORMATION DISCLOSURE, CONSULTATION AND PARTICIPATION

494. During the project design and feasibility studies there was a continuous information disclosure engaging stakeholders at all levels. During the initial period meetings were held with Divisional Secretaries, Chairmen of Pradeshiya Sabhas and government officers were informed on the project by the feasibility team. Such meeting were held in Dambulla, Gelewela and Polpithigama Divisional Secretary Offices. In addition detailed consultations were held with the Department of Wildlife Conservation and Forest Department prior to finalizing the canal trace.

495. A workshop was held at the Galgamuwa Irrigation Training Institute on the 12th December 2013 on the proposed NWP Canal Project.

Officers representing following agencies were present.

1. Ministry of Irrigation and Water Resources Development
2. Irrigation Department
3. District Secretary, Kurunegala
4. Divisional Secretaries, Polpithigama, Galgamuwa
5. Agrarian Development Department
6. Department of Wildlife Conservation
7. Forest Department
8. Mahaweli Authority of Sri Lanka
9. Mahaweli Consultancy Bureau

496. The representatives stressed the need for water diversion as a solution to water scarcity faced by the farmers and as a preparation for the climate change. The representatives from Department of Wildlife Conservation (DWC) presented the difficulties for the wild animals which may result due to the project and other reasons. The Divisional Secretary, Polpithigama stressed the need for farmer consultation for the proposals presented by the DWC as regarding the large number of farmers who live within the sanctuary. He also mentioned the environmental threat of soil erosion resulting from illicit cultivation in Kahalla Pallekele Sanctuary.

497. A series of meetings were held with the participation of stakeholders in the villages along the canal trace at village level. A presentation on the Mahaweli Programme was presented at the outset explaining how water is diverted to NWP. Then the sociologist with the participation of stakeholders initiated a discussion. They were free to express their ideas and feelings on the project.

498. These meetings were organized by respective Grama Niladaris with the patronage of Divisional Secretaries of Dambulla, Galewela, Polpithigama and Mahava DS Divisions, which would be affected by the proposed Project. Officers of Irrigation Department, Economic Development Officers and Grama Niladaris of DS Divisions and officers of Mahaweli Consultancy Bureau attended these discussions. Representatives of ADB participated in the small group discussions held in Pannampitiya & Lenadora South GNDs.

Following table provides basic information on the meetings held for discussions.

DS Division	GN Division	Date of meeting	Venue of meeting	No of stakeholders present	No of officers present
Galewela	Pahala Bambawa and Ranwediyawa	24th March 2014 (Morning Session)	Pahala Bambawa Temple	27	9
Galewela	Danduyaya, Dambagolla and Nebadagahawatta	24th Evening	Danduyaya Temple	22	10
Polpithigama	Polpithigama, Bogolla	25th March 2014 (Morning)	DS Office	25	13
Polpithigama	Amunukole, Hathigamuwa	25th March 2014 (Evening)	Amunukole temple	50	9
Polpithigama	Bulnewa, Moragllagama	26th March 2014 (Morning)	Bulnewa temple	28	9
Polpithigama	Kattambuwawa	26th March 2014 (Evening)	Private house	38	8
Galewela	Nilagama, Aluthwewa, Pibidunugama	27th March 2014 (Morning)	Aluthwewa temple	42	9
Galewela	Hombawa	27th March 2014 (Evening)	Andagala temple	26	7
Galewela	Koapotha	28th March 2014(Morning)	Danduwagolla temple	27	6
Polpithigama	Pallekele	28th March 2014 (Evening)	SANANSA meeting hall	37	5
Dambulla	Pannampitiya	1st April 2014 (Morning)	Parakum Community hall	29	12
Dambulla	Lenadora north	1st April 2014 (Evening)	Lenadora Community hall	31	13
Dambulla	Ethabendiwewa	2nd April 2014 (Morning)	Menikdena Community hall	37	9
Dambulla	Welamitiyawa	2nd April 2014 (morning)	Welamitiyawa temple	14	7
Mahawa	Mahawa	3rd April 2014 (Evening)	Konwewa Community hall	47	13

499. The relevant views expressed by the community at the discussions are summarized below.

i. At every discussion, the community emphasized that they have no objection whatsoever regarding implementation of the proposed Project and that they are willing to give their utmost support in the Project activities.
ii. They also expressed their expectation is to see that the negative experiences associated with some other development projects are not repeated in this Project too; which are

- All activities connected with the community to be done with utmost transparency and the true scope of the project be revealed to the beneficiaries
- Decision making on behalf of the community should be done with the presence of their representatives.
- A structure should be formed to listen, discuss and provide solutions for the problems of the community with regard to the Project at Grama Niladari level.

iii. Resettlement of the displaced community should be done without incurring embarrassment to them in any way and selected resettlement areas should provide basic infrastructure facilities similar to what they enjoy at present and also in close proximity to their present abodes.

iv. The compensation should be paid in a single instalment after a fair assessment based on market prices.

v. Displaced community should be given in writing about the agreements and actions taken on their behalf.

vi. Relocation would only be done after payment of compensation.

vii. If the present livelihood is lost in displacement necessary assistance and support should be provided to begin new activities in the new area.

viii. The whole family should be involved in payment of compensation to avoid misuse of money by a single member of the family thereby avoiding family disputes.

ix. The project should be implemented with minimum damage to houses and property.

x. There should be a special programs to uplift the vulnerable displaced such as those suffering with chronic illnesses, disabled people and widows and to provide housing facilities for them.

xi. The people who have not yet received license for lands they presently occupy should be provided assistance to obtain such licenses so that they would not be deprived of compensation.

xii. Assist the community to minimize the adverse effects of the project as much as possible.

xiii. If the community is to be involved in setting out the canal they should be informed about the periods and dates beforehand.

xiv. The people who occupied and developed temple and devala lands under long lease be considered fairly and justly in paying compensation.

500. Therefore, taking into consideration the issues raised by the affected community, in assessing the value of the properties every aspect and lessons learned from other projects should be considered and arrive at a fair compensation agreeable to the displaced families and paid before commencing implementation of the Project. The Project should be continuously in rapport with the displacing should maintain consultations with the displaced community at every step of the procedure. This will be of prime importance and a major responsibility of the Project Management. A resettlement plan is currently under preparation.

501. Continuous dialog with the affected parties would be helpful to carry out the project activities without interruptions.

- Discussions should be at village level to ensure participation of all affected persons.
- The next level will be at Divisional secretary level with the participation of a representative of ID.

- The District level under Government Agent of District Land Officer level will the next level where Project Director or his/her representative will participate.

502. As an important step of information disclosure translated EIAs will be available to interested persons in Irrigation Department, Colombo, Kurunegala, Kandy and Divisional Secretary Offices of Na ula, Dambulla, Galewela, Polpithigama, Mahawa and Galgamuwa. The Central Envrionmental Authority also provides a mandatory period of 30 days of public viewing of the EIA and a public meeting if required to get views of all interested persons prior to granting concurrence.

503. In addition, the draft EIA will be made available on the ADB web site for 120 days prior to ADB Board consideration of the project.

CHAPTER 7

7. GRIEVANCES REDRESS MECHANISM

7.1 The Rationale

504. During the construction and implementation phases of any development project, a person or group of people can be adversely affected, directly or indirectly due to the project activities. The grievances that may arise can be related to social issues such as eligibility criteria and entitlements, disruption of services, temporary or permanent loss of livelihoods and other social and cultural issues. Grievances may also be related to environmental issues such as excessive dust generation, damages to infrastructure due to construction related vibrations or transportation of raw material, noise, traffic congestions, decrease in quality or quantity of private/ public surface/ ground water resources, damage to home gardens and agricultural lands etc.,

505. Should such a situation arise, there must be a mechanism through which affected parties can resolve such issues in a cordial manner with the project personnel in an efficient, unbiased, transparent, timely and cost-effective manner. To achieve this objective, a grievance redress mechanism (GRM) has been included in the overall Environmental Management framework of this project.

506. In order to ensure that any grievance that may arise is resolved in a manner that will accrue maximum benefits to both the project and affected parties, the following aspects were taken into consideration in developing the proposed GRM:

- Establish an effective communication link between the project and affected parties
- To build up productive relationships among the stakeholders including affected parties
- Provide a mechanism for the affected parties to negotiate and influence the decisions and policies of the project which might adversely affect them
- Mitigate or prevent adverse impacts of the project on the environment and produce appropriate corrective or preventive action
- To harmonize project activities with the activities of potentially affected parties to avoid grievances or disputes if possible before they arise
- Should a grievance or dispute arise, provide a forum for addressing such issues at the lowest possible level so that they are resolved as and when they occur

7.2 Complaints Management

507. All complaints regarding social and environmental issues are usually received either orally or in writing by the Project Proponent (PP) or the Construction Contractor (CC). A key part of the GRM is the requirement for the PP /CC to maintain a registry of complaints received at the respective project site offices. All complainants shall be treated respectfully, politely and with sensitivity. Every possible effort should be made by the PP or the CC to resolve the issues referred to in the complaint within their purview. However, there may be certain problems that are more complex and cannot be solved through project-level mechanisms. Such grievances will be referred to the Grievance Redress Committee (GRC, see below).

The proposed complaint handling and Grievance Redress Mechanism is illustrated in the following Figure.

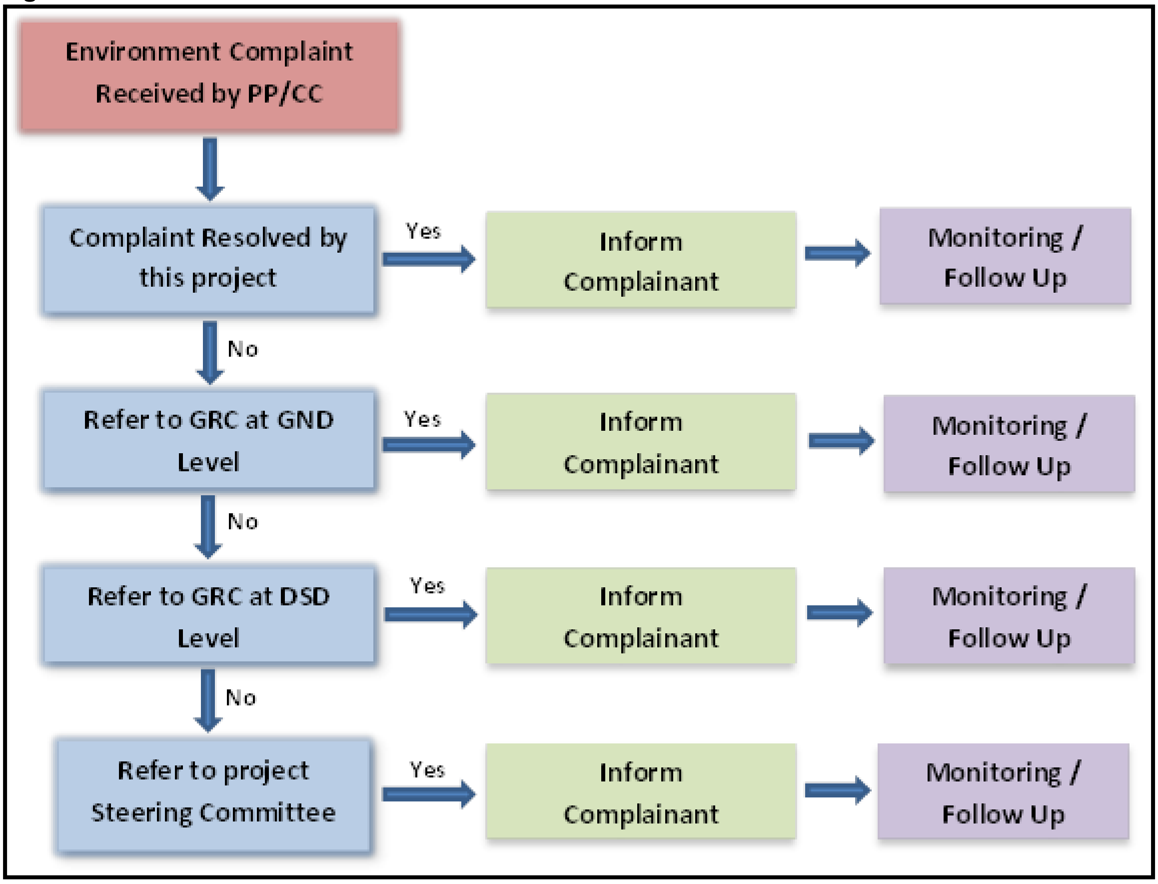


Figure 7-1 Complaint handling and Grievance Redress Mechanism

(PP= Project Proponent (Ministry of I&WRM); CC= Construction Contractors)

7.3 Grievance Redress Committee (GRC)

508. The NWP Canal Project, in keeping with the ADB and national safeguard policies, will set up Grievance Redress Committees (GRC), which will function as an independent body to find solutions to the grievances and disputes of the affected and concerned parties.

509. The appointment of the GRC will be notified to the general public by publication of a notice in national newspapers in three languages i.e., Sinhala, Tamil and English. The local community will also be informed about the grievance handling procedures of the project through Grama Niladharis of the area and displaying notices at important public places including key construction sites within the Divisional Secretariat Divisions of Na ula, Dambulla, Galewela, Polpithigama and Mahawa.

7.4 Institutional Arrangements for GRM

510. Grievance Redress Committees will be set up at two levels, the Grama Niladhari level and Divisional Secretary levels. The Grama Niladhari or the Divisional Secretary will function as the Chairperson of the respective GRC's. Members to represent the Affected Persons (AP) at the GRC will be appointed from among respected persons in the area on the recommendations of the Divisional Secretaries. Other members of the GRC shall be the Project Director (PD) or relevant officers from the PIU, representative(s) from relevant Community Based Organizations, representative(s) of the Contractor(s) and representative(s) from relevant line agencies. An officer nominated by the Project Director of the NWP Canal project will serve as the Secretary to the GRC. An honorarium will be paid to the members of the GRC and the required funds for operation of the GRC will be borne by the Project.

GR Committee at GND level

511. **Committee Structure**: Grama Niladhari, Village level government officers (agrarian services/ ID), CBO leaders, Project representative (environment and social resettlement officers). Project affected parties, Contractor or his representative and any other person/government officer if required based on the issue.

512. **Role of the Committee**: Receiving complaints and grievances pertaining to the project activities submitted by the affected person or community

513. Investigate, discuss and analyze the problems within the committee and propose fair and just solutions or remedies if possible. Otherwise, pass it to the committee at the next level with suitable recommendations.

GR Committee at DSD level

514. **Committee Structure**: Divisional Secretary**,** Grama Niladaris of relevant GNDS, Project director or his representative of PIU, CBO leaders, Contractors or his representative, relevant line agencies

515. **Role of the Committee**: Investigate, discuss and analyze the problems in broad detail within the committee and propose fair and just solutions or remedies if possible.

516. If the GR committee at the DSD level fails to resolve the issue, it will be directed to the project steering committee where it has to be resolved.

517. A regular time table should be prepared for the meetings of the relevant committees setting dates and times and a regular process should be developed to inform the committee members of the meeting dates and times.

518. At Grama Niladari level the community should be informed of the places, times and procedures of accepting and hearing grievances & complaints from the community. A minimum time period should be set to deal with the problems at each level (2 weeks maximum).

7.5 Terms of Reference of GRC

519. The GRM will be established by Irrigation Department during the pre-construction stage, so that the GRC and grievance redress procedures are in place and functioning before land acquisition, resettlement and project construction activities begin. The following is a draft ToR for the GRC, which Irrigation Department will consider and incorporate or amend as necessary:

- The GRC will examine any kind of dispute or grievance arising out of implementation of the Resettlement Plan (RP) and Environmental Management and Monitoring Plans (EMP and EMoP) and resolve such disputes and grievances in a transparent manner.
- GRC will not deal with matters that are pending in a court of law.
- The GRC will not have any jurisdiction over the amount of compensation determined by the Chief Government Valuer.
- The decision of the GRC is deemed final, although a dissatisfied complainant may seek redress through the Sri Lankan legal system, if they so wish.
- Only authorized members will be allowed to participate in the GRC meetings (including the relevant Affected Persons and their representatives).
- A decision on a particular dispute/grievance will be made unanimously or on a majority vote basis.
- The disputes and grievances will be resolved on the first day of the hearing or within 2 – 4 weeks of the first hearing where the issues may be more complicated and more information is required to arrive at a decision.
- A Hearing of certain disputes or grievances may be postponed and a new date be fixed if more evidence is required to make decisions.
- The decision of the GRC will be intimated to the Project Director and the aggrieved party in writing within a week from the meeting.

520. A suitable place and other facilities to conduct the meetings of the GRC will be provided by the Project. However, GRC meetings can also be held at any other suitable location for the convenience of the affected parties (e.g. in case of ill health or any other valid reasons).

521. The GRC is expected to meet at least once a month, although more meetings may be held depending on the number of complaints received. The GRC may make field visits where necessary and these will be facilitated by the Project.

522. **The following general conditions should also apply**: Persons who make appeals to the GRC shall attend the meetings of the GRC in person. In a case where the appellant is unable to attend the meeting on the appointed date due to sickness or other unavoidable circumstances, he/she can

nominate a close relative or other representative in writing.

523. No legal professionals are allowed to represent an appellant.

524. Appellants may request an alternative date to attend at a particular meeting of the GRC if they are physically unfit to attend the meeting or due to other unavoidable circumstances.

525. There is the need of establishment of an internal mechanism in the Ministry of Mahaweli Development and Environment (MMDE) to look into individual or collective complaints and grievances of the Project Area community pertaining to matters connected with the project activities. They should be able to analyze public grievances received to help identification of the problem areas in which modifications of policies and procedures could be undertaken with a view to making the delivery of services easier and more expeditious. They should deal with every grievance in a fair, objective and just manner and issue written reasons for every grievance rejected. This would lead to develop a finer rapport between the Project and the affected community and also reduce the hardships connected with problems the community is facing individually or collectively. This mechanism should also provide counseling and awareness on following **.**

- Awareness of the Project
- Identifying the affected families
- Payment of compensation
- Establishment if infrastructure facilities

526. The structure of the Grievance Redress Mechanism has been built in a manner that the community will be able to participate in discussions with relevant officers in solving their problems starting at the grass root level and linked to the higher level.

Grama Niladhari (Village leader) is a Sri Lankan public official appointed by the central government to carryout administrative duties in a Grama Niladhari division, which is a sub unit of a divisional secretariat. The duties of a Grama Niladhari include the reporting of issuing of permits, gathering statistics, maintaining the voter registry and keeping the peace by settlement of personal disputes. They are responsible for keeping track of any criminal activity in their area and issuing character certificates on behalf of residents when requested.

CHAPTER 8

8. Environment Management Programme

NWP Canal - Environment Management Plan (EMP)

Project Activity	Potential Environmental Impact	Mitigation Action	Monitoring Scope	Standards	Institutional Responsibility	Implementation Schedule	Cost (LKR Million)
Pre-construction							
Acquisition of homesteads	Loss of property	*Properties valued at replacement cost and Compensation paid promptly.* *Refer to section on Allocation of new lands for resettlement.* 5.2.1.3 which specifies the recommended procedure to pay compensation and to provide alternative lands and resettlement plan	Project Implementation Officers and Public complaints	Regulations of NIRP	Project will provide funds and DS Dambulla, Galewela, Polpithigama and Mahawa to follow acquisition procedure .	Prior to construction phase	212 (including monitoring and supervision costs, honorariums etc)
Acquisition of home gardens and paddy fields	Loss of agricultural productivity and income	Farmers compensated for any permanent loss of productive land, trees that need to be removed. Please refer section 5.2.1.3	Project Implementation Officers and Public complaints	Agrarian Service Act. Consultation with local authorities and design engineers	Project will provide fund and DS Dambulla, Galewela, Polpithigama and Mahawa to follow acquision procedure	Prior to construction phase	
Addressing the grievances of displaced	Displaced communities do not receive	Implement the procedures laid down in the Grievance Redress Mechanism.	Solution by the DS level committee	NIR Policy	ID, respective DS and GN at village level	Prior to construction phase	

communities	compensation in time. All grievances with respect to acquisition and compensation process.	When the problem is not solved at DS level the matter is referred to the national level Grievance Committee headed by the secretary to the MMDE.	Reconsider the solution given by the grievance committee at DS level and provide further assistance		MMDE		
Construction							
Land clearing for construction (Site clearance)	Increased soil erosion due to rain	Plan earth work in dry season. Construct silt traps in drainage paths.	Increased siltation in downstream / Public complaints	Technical specification, visual turbidity	ID to give directions and monitor Contractors to execute construction	Throughout the construction period	1.5
	Vegetation removal	Strict control on clearing activities to ensure minimal clearance as specified in contract documents (this will be decided by the design team to include only the space necessary for the structure and storage of materials and maneuvering machinery.)	Vegetation marking and clearance control (area in ha as specified in BOQ)	Clearance strictly limited to target areas	ID to supervise and Contractors implement through contract provisions	Construction period	Included in Civil Cost
	Water pollution	Construction activities involving significant ground disturbance not undertaken during the monsoon season.	Seasonal start and finish of major earthworks	Technical specification	ID and consultants for supervision and contractors will execute	Construction period	Included in Civil Cost
Provision of facilities for construction workers	Contamination of receptors (land, water, air)	Construction workforce facilities to include proper sanitation, water supply and waste disposal facilities.	Amenities for Workforce facilities	Presence of proper sanitation, water supply and waste disposal facilities	ID and consultants for supervision and contractors will execute	Construction period	Included in Civil Cost

Surplus earthwork/soil	Runoff will cause water pollution, by increased sediment deposits along water ways.	Never dump excess earth near water ways. If kept for a long time cover it properly. Dump excess soil only in designated locations approved by the engineer.	Location and amount of soil disposed. Soil disposal locations and volume	Appropriate fill disposal and dispersal locations	ID and consultants for supervision and contractors will execute	Construction period	No cost
Mechanized construction	Noise and vibration impacts	Ensure correct operation, maintenance and site practices Construction equipment to be well maintained. Use of silenced equipment when specified. Minimise use of noisy equipment Schedule activities to avoid high noise levels Use noise barriers when required. Proper traffic management in the sites Proper maintenance of equipment	Allowable noise levels in the boundary of construction sites is 75 dB in day time. Restrict night operations.	Technical specifications, safety regulations, Noise control regulations of CEA	ID and consultants for supervision and contractors will execute	Construction period	1.0
	Air pollution due to construction activities	ensure vehicles have been properly maintained Stipulate speed limits	Use proper fuel for all machinery and vehicles Speed limits imposed	Vehicle specifications Site specifications	Contractors Contractors	Construction period	No cost
	Dust from construction sites	Regular wetting of exposed surfaces Maintain road surfaces and if possible pave roads Turf exposed surfaces where ever possible	Regular watering of access roads Turfing of finished earthen structures	Contract specifications -do-	ID and consultants for supervision and contractors will execute -do-	Construction period -do-	1.0
	Burning of solid waste	Provide facilities to reuse, recycle and dispose solid waste	Contractors are encouraged at	Contract specifications	Design team review contractors implement	Final designs during construction	No cost

		properly Plastics etc should be disposed for recycling Restrict open burning. Open burning will be banned in any of the forest reserves.	bidding stage Identify solid waste recyclers in the area Burning if necessary is Only under permission of the engineer	 -do- -do-			
	Debris and waste disposal	Solid waste should be collected and disposed properly Tunnel muck and other spoil should be disposed in identified locations Reuse waste where ever possible	Site engineer	Contract specifications -do-	Design team/Consultants monitor and contractors implement	Final design and construction period	Included in civil cost
	Pollution of water due to contaminant leakage from machinery and work sites	Construct workshops of adequate size for each machinery site Use of bio degradable detergents for cleaning of machinery Waste lubricants and fuels should be collected and discharged as per contract specifications Pollution of water from solid and liquid waste from resident work camps	Monitored by the project team -do- -do- -do-	Design specifications -do- -do- For waste water SLS standards (1990) For sewage SLS standards (2004)	ID/Consultants and contractors -do- -do-	Construction period -do- -do-	Included in Civil Cost
Transportation and storage of materials	Nuisance to the general public	Transport loading and unloading of construction materials should not to cause nuisance to the people by way of noise, vibration and dust.	Water and air quality	National Environment Act Laws National	ID/Consultants and contractors	Construction period	No cost

				Emission Standards and CEA water quality standards			
Tunnel Construction	Noise and vibration in blasting Potential hazards due to weak portals and falling detached rock Disposal of muck	Limit blasting operations as specified by GSMB. Strengthening of portals. Providing safety gear to contractors Muck disposal allowed only in the designated areas	Noise and vibrations Supervision by qualified mining engineers Ensure observance of technical specifications. Ensure observance of specifications	GSMB license for rock blasting Construction specifications Construction specifications	ID/Consultants monitor and Contractors implement ID/Consultants monitor and Contractors implement ID/Consultants monitor and Contractors implement	Tunnel construction Tunnel construction Tunnel construction	Included in civil cost
Reservoir construction	Soil erosion from cleared sites	Existing drainage should not be disturbed and temporary paths should be created to avoid drainage congestion. Silt traps should be constructed to avoid siltation of downstream tanks Excess soil should be dumped only in designated dumping areas.	Turbidity of downstream water ways Public complaints	Technical specifications	ID/Consultants monitor and Contractors implement	Construction period	1.0
	Left over borrow areas	Borrow area management plan should be incorporated into the design. Borrow areas located in the reservoir bed should be	Borrow areas should not pose a threat to wildlife.	Vertical or nearly vertical faces should be flattened to a milder	ID/Consultants and Contractor	Reservoir construction	1.0

		rehabilitated for the protection of wild life.		slope (1: 3)			
	Soil erosion along slopes of finished earthen dam	Turf the downstream. Forming runnels in high erosive sections Provide rip rap along the upstream face	Heavy soil erosion will endanger the safety of the dam.	Technical specifications for the reservoir	ID/Consultants and Contractor	Reservoir construction period	Included in civil cost
	Floods	Identify all flood plains and mark the levels of critical floods. Worker awareness of flood hazards Constructions should be strategically adjusted during flood periods Close coordination with district disaster management center.	Training sessions Designate disaster management officer.		ID/Consultants Contractors ID/Consultants	Reservoir construction period	0.8
	Slope failures in the reservoir periphery	Identify unstable rock fragments and remove. Control soil erosion in the reservoir periphery Soil stability survey in the reservoir periphery	Soil stability investigations	Technical specifications for the reservoir	ID/Consultants monitor and contractors implement	Final Designs	Included in civil cost
	Dam failures	Intensified foundation and soil investigations during investigation and involvement of qualified professionals	Proper quality assurance	USBR specifications	ID/Consultants monitor and contractors implement	Final design and construction period and operations?	Included in civil cost
	Impact of archaeological sites	Take action as per the archaeological impact assessment and inform the Department of Archaeology promptly of any chance findings.	Likely effect on archaeological remains		ID/Consultants for supervision of contractors, Archaeology Department	Construction period.	1.5
Canal	Soil erosion from	Existing drainage should not be	Turbidity of	Technical	ID/Consultants monitor	Construction period	1.0

construction	cleared sites	disturbed and temporary paths should be created to avoid drainage congestion. Silt traps should be constructed to avoid siltation of downstream tanks Excess soil should be dumped only in designated dumping areas.	downstream water ways Public complaints	specifications	and contractors implement		
	Soil erosion from finished canals	Turf all exposed sections	Heavy soil erosion will endanger the safety of the finished section	Technical specifications	ID/Consultants and contractors	Construction period	Included in Civil Cost
	Wild elephants falling into the canal	Allow flatter slopes in the sanctuary For deep sections use cut and cover section of canal.	Flatter slopes (Eg 1:3 slope) would allow safer passage for wild animals at a predetermined interval	Technical specifications	ID/Consultants, Department of Wild Life Conservation and contractor	Construction period	Included in Civil Cost
	Health hazards and increased soil erosion from open borrow areas	Restore borrow areas. Replanting borrow areas with suitable species. Drain stagnant water in borrow areas. Sloping mined gravel pits to 1:3 slope and grass turfing to minimize erosion. Construct silt traps across potential drainage paths	Maintain proper gradients to minimize erosion.	Technical specifications	ID/Consultants monitor and contractors implement	Construction period	Part Included in Civil Cost. (Rs 5 m for replanting)
Constructions inside Kahalla Pallekele Sanctuary	Loss of vegetation and forest cover due to establishment of	Leave at least 50% of trees in the tank bed to provide habitats for birds and fish .	Design specifications Conversion of	 Number of	ID/Consultants/FD monitor and contractors implement	Reservoir construction period	205

	reservoirs		degraded teak plantation into a planted forest, enrichment planting of indigenous tree species	indigenous tree species established	ID/Consultants and FD ID/Consultants and DWLC		
		Replanting reservoir periphery with indigenous tree species	Compensating the loss of habitats (replanting and enrichment of 350 ha of forest after a survey of degraded forest in the sanctuary)			Reservoir construction period	
		Remaining forest and scrublands in Kahalla- Pallekele Sanctuary should be preserved by the Department of Wildlife Conservation to avoid further degradation of the habitats					
		Dense forest should be conserved to provide the natural habitats for fauna and flora and also to prevent soil erosion in the catchment				Reservoir construction period	
		Open forest and scrublands could be enriched with indigenous species so that the sites would be more useful with increasing the biodiversity in the catchment and also for soil conservation.			ID, FD and Consultants monitor and Contractors implement		
		100 m strip from the full supply level of proposed Mahakitula and Mahakirula reservoirs to be preserved as a reservation and kept under the natural vegetation cover			ID, FD and Consultants monitor and Contractors implement		
		Indigenous tree species in the area such as Kon, Kumbuk,			ID, FD and Consultants monitor and Contractors		

		Thimbiri, Mora, Burutha, Halmilla, Kolon, Helamba, Kohomba, Mee, Karaw, Makulla, Dunumadala, Malaboda, Panakka, Tammanna, Kaluwara, Ehela, Asoka, Siyambala, Wewarana, Godakaduru, Ingini, , Madan, Bakmi, Dambu, Boradaminiya, Daminiya, Godakirilla, Milla and Nebada could be planted in 100 m reservation			implement		
		100 m reservation that are under different successional stages not to be cleared for planting and allow the natural regeneration and succession to take place.			ID, FD and Consultants monitor and Contractors implement		
		Enrichment planting could be done in the openings or gaps in the sites			ID, FD and Consultants monitor and Contractors implement		
	Human Elephant conflict	Move the existing electric fence to ecological boundary between natural habitat and human use area. And implement the long term plan being prepared by IUCN.	Increase the habitat of wild life		ID, DWC and Consultants monitor and Contractors implement	Construction period	63
	Animals falling in to canals	Provide flatter slopes for canal banks. Cut and cover deep sections with concrete conduits	Lessen water related accidents to wild life	A animal crossing at least in 500 m intervals	ID/Consultants and DWLC	Construction period	Included in civil cost
	Electric fence	Local community participation	Avoid elephants	DWLC	ID/Consultants and	Construction period	10 Government

	malfunction due to maintenance problems	to support Civil Defense Force with the coordination of DS Establishment of endowment fund for the maintenance of fence	coming in to the villages	standard for the maintenance of elephant fence.	DWLC		funds
Quarry Operations	Damages to properties around the quarry site	Follow the restrictions and limitations of CEA and GSMB for operating rock quarries Pre and post crack survey for all buildings within 250m radius of blasting site. Blasting operations should be supervised by qualified mining engineers	Minimize damages to surrounding properties.	GSMB regulations	ID/Consultants and DWLC	Construction period	Included in civil cost
Construction near archaeological sites	Disturbance to archaeological monuments	Extreme precautions when constructing canals and structures near such sites using heavy machinery and blasting. Special attention given to each of 8 sites mentioned in section 5.10 of chapter 5. Department of Archaeology has to be informed and execution has to be done under their supervision.	Monuments should not be affected by the construction operations		ID, Department of Archaeology monitor and contractors implement	During construction time	1.0
Operation and Maintenance Phase							
Initial reservoir filling	Surveillance during initial filling	Keep all records during as directed in the design technical notes Inspect the reservoir periphery and appearances		final design notes	ID/Consultants	Initial filling of the reservoirs.	
Awareness of community along the canal	Safety of community	Safety awareness Erection of warning signs for canal			ID/ Consultants monitor Contractors implement	Operation phase	2.0

		Maintenance of fence.					
Water management of the system	Inadequate water delivery to some of the outlets	Prepare a water delivery plan for the whole system Liaison with MASL to obtain required quota of water			ID	Annually	
Maintenance of the system	Degradation of the system	Ensure utilization of a proper maintenance gang for regular maintenance		ID guidelines	ID	Annually	
Agricultural extension	Increased use of agrochemicals	Training programmes to minimize agrochemical usage. • Land preparation • Establishment of seeds/plants in the field • Using fertilizer according to crop needs • Minimum usage of agrochemicals • Practice of organic fertilizer • Formal methods of pest control Methods of harvesting and storage	Reduction of agrochemical usage		ID, Department of Agriculture and consultants	Operation phase	15
Injuries caused by operation and maintenance practices	Safety and security of communities	Workers be given a training on safety procedure of operations prior to assigning work	Reduces no of accidents		ID	Operation phase	No cost
Operation of the system under extreme events	Damages to property, crops and community	Preparation of standing orders and training of personnel.	Reduction of flood damages and water stress during drought.	ID guidelines	ID	Operation phase	Annual O&M estimates of ID

8 (i) ENVIRONMENTAL MONITORING PLAN

8.1 Soil and Topography

	Mitigation Activities and Method of monitoring environmental Changes	Location / timing of sampling	Parameters to be monitored	Frequency of monitoring	Institutional framework for mitigation of impacts	Responsibility	Responsible agency/agencies of monitoring	Cost of monitoring
8.1.1 Construction Phase								
1	Surface Run-off, soil erosion, slope failures from hill slopes, collapsing of detached rock slabs from hill slopes	Dam Axis (Mahakithula and Mahakirula & saddle), and diversion and supply Canal Traces	Soil erosion from cleared ground sections along dam axis and canal traces	Every 2 weeks	Check whether the action proposed is implemented properly to minimize soil erosion	Project Proponent	Monitoring Committee	Funds will be allocated by the Project Proponent Expertise for monitoring will be available at the respective institutes 72 visits x 14,000/= per visit = 1,008,000/=
			Soil Erosion from cleared hill slopes of dam abutments	Every 2 weeks	Check whether the action proposed is implemented properly to minimize soil erosion	Project Proponent	Monitoring Committee	
			Possible slope failures from cleared hill slopes of dam abutments	Every 2 weeks	Check whether the action proposed is implemented properly to control slope failures	Project Proponent	Monitoring Committee	
			Possible collapsing of detached & fractured rock slabs	Every 2 weeks	Check whether the action proposed is implemented properly to control collapsing of fractured & detached	Project Proponent	Monitoring Committee	

					rock slabs			
			Disposal of excavated unusable soil materials and construction wastes	Every 2 weeks	Check whether the action proposed is implemented properly	Project Proponent	Monitoring Committee	
			Soil erosion from excavated soil materials along canal traces	Every 2 weeks	Check whether the action proposed is implemented properly to dump excavated soil materials in identified dumping sites	Project Proponent	Monitoring Committee CEA and NWP Env. Authority	
2.	Excavation of Borrow pits, soil erosion in excavated surface of burrow pits, disposal of unusable soil from burrow pits	All borrow pits	Soil erosion from excavated surface of borrow pits	Every 4 weeks	Check whether the action proposed is implemented properly to control soil erosion	Project Proponent	Monitoring Committee	36 visits @ 12,000 = Rs 430,000
		All Borrow Pits	Disposal of unusable soil materials	Every 4 weeks	Check whether the action proposed is implemented properly to dump unusable soil materials in identified dumping sites	Project Proponent	Monitoring Committee	
3.	Soil erosion & slope collapsing from quarry sites	Quarry sites	Soil erosion from quarry sites	Every 8 weeks	Check whether the action proposed is implemented to minimize soil erosion	Project Proponent	Monitoring Committee	18 visits @ 12,000 = 216,000
			Slope collapsing from quarry	Every 8 weeks	Check whether the action proposed is	Project Proponent	Monitoring Committee	

			sites		implemented properly to control slope failures			
			Disposal of excavated overburden cover	Every 8 weeks	Check whether the action proposed is implemented properly to dump excavated overburden materials in identified dumping sites			
8.1.2 Operational Stage								
1.	Surface Run-off, soil erosion, slope failures from hill slopes, collapsing of detached rock slabs from hill slopes	Dams and Canal Traces	Soil erosion from cleared ground sections (un-lined sections) along dam axis and canal traces after construction	Every 4 weeks for 1 year period	Check whether the action proposed is implemented properly to minimize soil erosion	Project Proponent	Monitoring Committee	12 visits @ 14,000 = Rs 168,000
			Soil Erosion from cleared hill slopes (open) after construction	Every 4 weeks for 1 year period	Check whether the action proposed is implemented properly to minimize soil erosion	Project Proponent	Monitoring Committee	
			Possible slope failures from cleared hill slopes of dam abutments after	Every 4 weeks for 1 year period	Check whether the action proposed is implemented properly to control slope failures	Project Proponent	Monitoring Committee	

			construction					
			Possible collapsing of detached & fractured rock slabs after construction	Every 4 weeks for 1 year period	Check whether the action proposed is implemented properly to control fractured & detached rock slabs	Project Proponent	Monitoring Committee	
2.	Hill slope erosion / minor slope collapsing due to fluctuation of reservoir water level	Hill slopes in the periphery of reservoirs	Possible hill slope erosion and slope collapsing in high hill slopes in the periphery	Once a month for 1 year period after commissioning	Check whether the action proposed is implemented properly to control slope failures	Project Proponent	Monitoring Committee Geologist.	12 visits @12,000 = Rs 144,000
3	Borrow Areas Development	All Borrow Areas	Possible erosion and slope collapsing from mined outside slopes of burrow sites	Every 4 weeks for 1 year period	Check whether the mined outside slopes are shaped in 1:3 ratio and allow to grow plants like “Mana” on the side slope.	Project Proponent	Monitoring Committee Forest Department – RFO	

8.2 Ground Water Quality

	Mitigation Activities and Method of monitoring environmental Changes	Location / timing of sampling	Parameters to be monitored	Frequency of monitoring	Institutional framework for mitigation of impacts	Responsible agency/agencies of monitoring	Availability of funds, expertise and facilities	Cost of monitoring
	Trans basin diversion of water	Changes in ground water quality	Ph, EC, dissolved chemicals,	Hydraulic, physical and chemical		ID and Provincial environment authority	Start 6 months before diversion and continue for	Cost included in 9.2.1 and 9.2.2

			heavy metals (Cadmium, Arsenic, Lead)	properties.			4 years	
8.2.1 During Construction Phase								
	Study of groundwater level in the area along channel trace, **Method of monitoring**-Water level indicators	Existing wells along channel trace (5wells), dam axis (2 wells), agricultural (3 wells) The locations of wells will be finalized by the Project Director. **Timing**-Starting three month before the operation.	Groundwater level	Monthly interval.		PMU to outsource it to a suitable organization such a s Water Resources Board	**Experts**-Hydro geologist **Facilities**-Equipment for water level recorders.	. The tentative cost for month is Rs 100,000.00. Yearly cost=Rs 1,200,000.00
8.2.2 During Operational Stage								
	Study of changes in groundwater level in the area along channel trace area closer to dam axis, proposed agricultural area,	Existing wells along channel trace (5wells), dam axis(2 wells), agricultural(3 wells) **Timing**-Starting three month before the construction.	Groundwater level	monthly		Water Resource Board (WRB).	**Experts**-Hydro geologist **Facilities**-Equipment for water level recorders.	To be conducted by WRB. For seven years after the construction phase. The tentative cost for month is Rs 75,000.00, Total for 7 years is Rs 7.0 million

8.3 Surface Water Quality

	Mitigation Activities and Method of monitoring environmental Changes	Location / timing of sampling	Parameters to be monitored	Frequency of monitoring	Institutional framework for mitigation of impacts	Responsible agency/agencies of monitoring	Availability of funds, expertise and facilities	Cost of monitoring
8.3.1 During Construction Phase								
	Measurement of surface water quality at Hakwatuna Oya, Mi Oya and selected minor irrigation tanks up stream downstream of Mi Oya.	Up and down stream of dam of Hakwatuna Oya and Mi Oya (2 samples), Minor irrigation tanks in Irrigable Analyses of two water samples(upstream and downstream of Hakwatuna Oya and Mi Oya) for Fertilizer and pesticide residue **Timing**-Starting three months before the construction	Physical and chemical water quality (pH, colour, turbidity, TDS, EC, hardness, calcium, nitrate, nitrite, chloride, fluoride, iron, sulphate, phosphate, and total alkalinity). **Fertilizer and pesticide residue** Nutrients band heavy metals in the ground water	Every six months Yearly		Water Resource Board (WRB WRB	**Experts**-Geochemist **Facilities**-field Equipment and lab facility. **Experts**-chemist **Facilities**-field Equipment and lab facility.	Cost - To be conducted by WRB The tentative cost for year is Rs 120,000.00 Samples to be analyzed at ITI. Yearly cost is Rs 100,000.00

8.3.2 During Operational Stage								
	Measurement of surface water quality at Hakwatuna Oya, Mi Oya and minor irrigation tanks at upstream and downstream , pool areas at downstream of Hakwatuna Oya.	Hakwatuna Oya reservoir (one sample), Mi Oya (one sample), minor irrigation tanks in up and down stream (six samples), Water pool area (one sample). Analyses of two water samples(Agricultu ratral area) for Fertilizer and pesticide residue **Timing**-Starting six month before the construction	Physical and chemical water quality (pH, colour, turbidity, TDS, EC, hardness, calcium, nitrate, nitrite, chloride, fluoride, iron, sulphate, phosphate, and total alkalinity). **Fertilizer and pesticide residue** Nutrients band heavy metals in the ground water	Every six month for period of ten years. Yearly		Water Resource Board (WRB) WRB	**Experts**-chemist **Facilities**-field Equipment and lab facility. **Experts**-chemist **Facilities**-field Equipment and lab facility.	Cost - To be conducted by WRB The tentative cost for year is Rs 120,000.00 Samples to be analyzed at ITI. Yearly cost is Rs 100,000.00

8.4 Engineering Aspects

	Mitigation Activities and method of monitoring environmental changes	Location/timing of sampling	Parameters to be monitored	Frequency of monitoring	Institutional framework for mitigation of impacts	Responsible agency/ agencies of monitoring	Availability of funds, expertise and facilities	Cost of monitoring (Rs)
8.4.1 During Construction Phase								
Item 1: Mobilization of works, temporary roads, contractors camps, water supply, electricity and other services								
	Avoid soil erosion, sanitation facilities, sewerages, drainages, facilities	Locations as per accepted plans	Soil erosion, drainage and sewerage monitoring works as per specifications	Once a month		ID and contractors	Allowed in the construction estimate	100,000
Item 2: Removal of trees, shrub jungle and vegetative cover								
	Avoid excessive soil erosion, observation of erosion	Camp areas, borrow area, Dam axis and saddle dams Monthly water quality tests	Soil erosion rate and water quality for accepted standards	weekly		ID	Estimated in the construction estimates	100,000
Item 3: Foundation excavation of main dam axis, and saddle dams, spillway								
	Avoid excessive soil erosion, embankment protection by shoring works, earth and rock excavations and removal methods, control blasting arrangements, pumping of water logged areas	Dam foundation areas, borrow areas, and spillway foundation areas	Adequate shoring works, pumping rates.			ID and Contractors	Estimated in the construction estimates	100,000

Item 4: Earth filling of dams including clay core and rip rap								
	Systematic removal of earth/rock from borrow areas, transportation, placing as per designs and compaction	Borrow areas and embankment dam areas	Placing by heavy machinery, compaction tests	Throughout construction period		ID, and contractors	Estimated in the construction estimates	100,000
Item 5: Road construction, safety facilities and other E & M works								
	Placing earth, gravel, rock, metals, compaction and bitumen placing as per specifications. Erection of safety walls, passages, fences as per drawings	Final road network and areas need to protect and public safety	Road construction as per drawings and specifications	during the construction period		ID and contractors	Estimated in the construction estimates	100,000

8.5 Irrigation Activities

	Mitigation Activities and method of monitoring environmental changes	**Location/timing of sampling**	**Parameters to be monitored**	**Frequency of monitoring**	**Institutional framework for mitigation of impacts**	**Responsible agency/ agencies of monitoring**	**Availability of funds, expertise and facilities**	**Cost of monitoring**
8.5.1 During Operational Stage								
Environment protection								
	Demarcation of reservations and its preservation by land	Canal reservation areas	Usual canal reservation as per ID	Six months	O&M staff of ID	ID	Annual O&M estimates	Included in annual O&M estimates

	marking. Planting tress where necessary according to a program		guidelines					

8.6 Fauna, Flora & Habitats

	Mitigation Activities and Method of monitoring environmental Changes	Location / timing of sampling	Parameters to be monitored	Frequency of monitoring	Institutional framework for mitigation of impacts	Responsible agency/agencies of monitoring	Availability of funds, expertise and facilities	Cost of monitoring
8.6.1 During Construction Phase								
	Control of invasive alien species	Storage areas, vehicle parking and cleaning areas, areas where vegetation is cleared for land preparation	Establishment of invasive alien species	Once in three months, especially after rainy season during both construction and operation stage		Irrigation Department with assistance from Forest Department	To be provided by the Irrigation Department	Rs. 1.5 Million
	Avoid / reduce disturbances to the adjacent natural	Natural habitats/ forest patches	Forest structure, species	Once in 3 months	Project office	Project office/ Forest Department.		Rs. 1 Million

	habitats due to the	surrounding the	composition,					
	construction of dams, and other project interventions Minimize habitat fragmentation in natural forests	proposed reservoirs, access roads to the dam sites, canal trace and access roads to the canal trace, borrow areas, quarry areas	endemic and threatened plants/ tree species					
	Removal of trees in dry-mixed evergreen and riverine forests	dam construction sites of Mahakirula and Mahakitula proposed reservoirs	Number of trees/ species	One time survey during the construction of access roads, reservoir and other project activities	Project office	Project office/ Forest Department, CEA		Rs. 1 million
8.6.2 During Operational Stage								
	Reforestation activities	The reservoir reservation (a 100 m strip from the HFL demarcated by	Reforestation of the reservoir reservation and	Once in three months		Central Environmental Authority	To be provided by the Irrigation Department	Rs. 3 Million

		the Irrigation Department), areas demarcated for reforeatation and degraded teak plantation. The total approximate area is 400 ha	enrichment planting/ restoration of degraded teak plantations/ habitats					
	Restoration/ Reforestation programme	Dam sites, other project sites, access roads, along canals, borrow areas	Extent in ha Number of trees/ shrubs	Once in three months during the first three years after planting	Forest Department	Forest Department, CEA		Rs. 3 Million

8.7 Sociological Aspects

	Mitigation activities &method of monitoring environmental change	Location /timing of sampling	Parameters to be monitored	Frequency of monitoring	Institutional frame work for mitigation of impacts	Responsible agency/agency of monitoring	Availability of funds	Cost of monitoring (Rs.)
01	Monitor the land acquisition processes and payment of compensation	At the project area & Random 10% sample during the process	-Existing types of land -extent of lands -Land tenure -Eligibility for new lands -Compensation	During the process once a month	-Formation of a Steering committee organize by the (MI&WM)at national level -Project coordination committee at project level with participation of all stake holder agencies	-Irrigation department -Project Director -Relevant DS -Community Leaders	-Should be formulate attractive compensation packages based on the guidance of NIRP	200,000.00
02	Monitor the resettlement process	At the resettlement sits	-Suitability of resettlement site -Land allocation procedures -Infrastructure facilities -Livelihood development program - Payment of	During the process once a month	Formation of a Steering committee organize by the (MI&WM)at national level - coordination committee at relevant DSD level with	-Irrigation department -Project Director -Relevant DS -Community Leaders -	Should be provide to reasonable package of computations to construct houses & develop lands on household basis -Allocate	300.000.00

			compensation		participation of all stake holder agencies		reasonable allocation for infrastructure development	

8.8 Air, Noise & Vibration

	Mitigation Activities and Method of monitoring environmental Changes	Location / timing of sampling	Parameters to be monitored	Frequency of monitoring	Institutional framework for mitigation of impacts	Responsibility	Responsible agency/ agencies of monitoring	Cost of monitoring
8.8.1 During Construction Phase								
1	Ground Vibration Foundation Failures during rock blasting for dam construction (Abutments), canal construction and rock quarrying	Dam Abutments, Canal traces , identified quarry sites	Ground Vibration during rock blasting in dam construction	Once in every 2 weeks	Check the action proposed is implemented properly to control ground vibration and foundation failure	Project Proponent	Irrigation Department, GSMB,CEA	Monitoring charges per one day for one monitoring team is about Rs.15,000/= Total cost for 3 years = 1.2 million
			Ground vibration during rock blasting in canals and rock quarries	Once in every 2 weeks				
2	Effects to identified Archaeological sites due to dam and canal construction and quarry operations	Identified locations along canals and Mahakithula dam site	Any physical damage to Archeological sites	Once in every 2 weeks	Check whether the action proposed is implemented properly to avoid any physical damage to Archaeological sites	Project Proponent	GSMB,CEA, Department of Archeology, Irrigation Department	Monitoring charges per one day for one monitoring team is Rs.15,000/=

3	To mitigate the noise effect to the adjoin residential areas	Most suitable locations depending on the situation	Noise level measurements	On complaint basis	Irrigation Department, CEA, Contractor	Project Proponent	Irrigation Department, CEA, GSMB	Investigation for one location is Rs.10,000/=
4	To mitigate the Ground Vibration(GV) & ABOP effect to residential areas surrounding the rock blasting locations	Most suitable locations depending on the situation or situation or nearest building to the blasting location.	Effects of GV & ABOP due to rock blasting	Continuous monitoring until rock blasting activities completed at each and every location	Irrigation Department, GSMB,CEA,NWP Env Authority and Contractor	Project Proponent	Irrigation Department, GSMB,CEA	For one monitoring team for one month is Rs.300, 000/= all included.
5	To mitigate the dust effect to the Environment	Most suitable locations depending on the situation	Particular Matter less than 10µm (PM_{10}) for 24hrs period	Once a month	Irrigation Department, CEA, Contractor	Project Proponent	Irrigation Department, CEA	Investigation for one location is Rs.30,000/=

8 (ii) Summery of Mitigaiton and Monitoring Cost

1. Environment monitoring cost

	Mitigation activities	Cost (LKR m)
1	Surface Run-off, soil erosion, slope failures from hill slopes, collapsing of detached rock slabs from hill slopes	1.008
2	Excavation of Borrow pits, soil erosion in excavated surface of burrow pits, disposal of unusable soil from burrow pits	0.430
3	Soil erosion & slope collapsing from quarry sites	0.216
4	Surface Run-off, soil erosion, slope failures from hill slopes, collapsing of detached rock slabs from hill slopes	0.168
5	Hill slope erosion / minor slope collapsing due to fluctuation of reservoir water level	0.144
6	Changes in ground water quality during construction	1.2
7	Changes in ground water quality during operation phase	7.0
8	Measurement of surface water quality during construction	0.480
9	Analysis of water samples	0.4
10	Measurement of surface water quality during operational stage	1.2
11	Analysis of water samples for fertilizer and pesticides	1.0
12	Control of invasive alien species	1.5
13	Avoid / reduce disturbances to the natural habitats due to the construction	1.0
14	Reforestation activities	3.0
15	Restoration/ Reforestation programme	3.0
16	Monitoring the land acquisition processes and payment of compensation	0.85
17	Monitoring of the resettlement process	0.85
18	Ground Vibration, Foundation Failures during rock blasting for dam construction (Abutments), canal construction and rock quarrying	1.2
19	Effects to identified Archaeological sites due to dam and canal construction and quarry operations	0.6
20	Mitigate the noise effect to the adjoining residential areas	0.4
21	Mitigate the Ground Vibration(GV) & ABOP effect to residential areas	3.0
22	mitigate the dust effect to the Environment	0.3
	Total monitoring cost	28.946
	Additional surveys for environmental mitigation	28.8
	Total monitoring cost	57.746

2. Budget for environmental Impact Mitigation

No	Description	Cost (LKR million)
1	Acquisition of homesteads and home gardens and paddy fields including all overheads such as honorarium for village level committees	212.0
2	Minimizing soil erosion due to rain	1.5
3	Controlling noise and vibration impacts	1.0
4	Controlling dust from construction sites	1.0
5	Controlling Soil erosion from cleared sites	1.0
6	Dealing with left over borrow areas	1.0

7	Flood awareness and related measures	0.8
8	Minimizing impacts on archaeological sites	1.5
9	Control of soil erosion	1.0
10	Dealing with Health hazards from increased soil erosion	5.0
11	Reforestation and enrichment of forest to compensate loss of vegetation and forest cover due to establishment of reservoirs and canals	205.0
12	Human elephant conflict – Shifting and erection of Elephant fence and provision of facilities to DWC	67
13	Endowment fund for maintenance of elephant fence	10
14	Disturbance to archaeological monuments	1.0
15	Programmes for reduction of use of agrochemicals	15.0
16	Erection of warning signs at appropriate locations	2.0
	Total	525.8

Total budget for environmental management

	Item	Cost (LKR million)
1	Environment mitigation cost	525.8
2	Environment monitoring cost	57.7
	Total	583.5

8(iii) Implementation Arrangements

527. The executing agency is the MMDE. A project managemeng unit (PMU) is to be established at the head office and PIUs for each of the three sub proejcts under the MWDSIP. In order to ensure proper and timely implementation of proposed environmental mitigation and monitoring plan, an environment unit in PMU and PIU are essential. The PMU and PIU will will be staffed with an environmental officer in each and will be responsible for monitoring and the contractor will be responsible for the execution of the mitigatory measures. The bidding documents will include a BOQ and other relevant documents for an environment management plan. The Project Management and Design consultancy team includes two specailists (international and national) to support in environmental management and reporting. These two consultants will guide and train the PMU and PIU staff. The contractor will submit his Contractor's EMP (CEMP). This will be reviwed by the consultant. The consultant, PMU and PIU will have experienced officers for environment monitoring and reporting to higher levels at appropriate time intervals.

528. Training and building capacity of PMU and PIU staff on environmental management, supervision, reporting, and monitoring of implementation of EMPs will be conducted by the consultant. In addition, orientation of contractors on implementation will aslo be done by the consultants.

529. The following tasks will also handled by the consultants

I. Monitoring implementation of the EMP and recommending any corrective actions on any unforeseen environmental impacts.

II. Taking the lead in preparing bi-annual environmental monitoring reports on behalf of the PMU, for ADB and CEA.

530. The CEMP will present detailed implementation plan based on the Contractor's actual construction methodologies, work schedule, type/specifications and number of construction plants to be used. The CEMP shall be consistent with the project EMP and prepared based on the Contractor's activities and corresponding locations.

531. Contractors EMP will include following,

I. Contractor's organizational structure showing the implementation, supervision and reporting and responsibilities of key personnel;
II. The project program and work activities;
III. The Contractor's specific plans as follows:
    a. Utilities regarding positioning of required (to minimize/avoid disruption of services such as power, water supply, etc.)
    b. Facilities Management Plan (detailed designs, methodologies and installation locations of all construction-related facilities such as access roads, workers' camps, storage areas, equipment maintenance areas, casting yards, cement batching plants, quarries and crushers, borrow areas, etc. as well as pollution control facilities, such as drainage channel, settling tank/ponds, septic tanks, temporary noise barrier, etc.) to manage impacts due to operation of various facilities.
    c. Air Pollution (dust and gaseous emissions) Control Plan
    d. Noise and Vibration Control Plan
    e. Waste Management Plan (solid, liquid, hazardous)
    f. Spoil Disposal Plan
    g. Drainage Management Plan
    h. Erosion and Sedimentation Control Plan
    i. Traffic Management Plan
    j. Chemicals and Hazardous Materials Management Plan
    k. Workers and Public Safety Plan
    l. Emergency Response Plan

Annex VI-I provides a description of the overall organization for the entire program. And the following chart provides the organizational structure for the PIU responsible for this project..

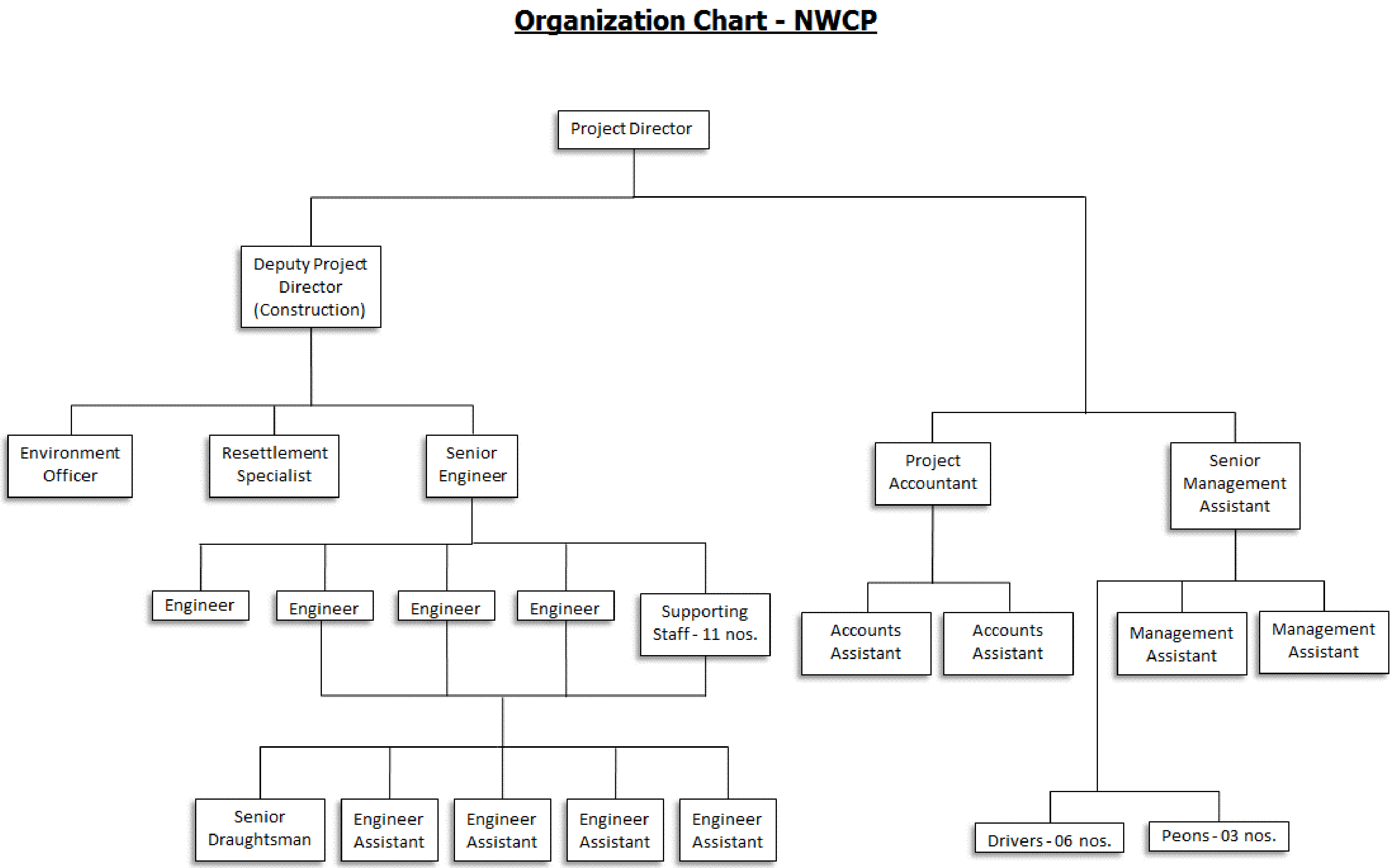


Figure 8-1 Organization chart of PIU of NWPC Project

CHAPTER 9

9. CONCLUSION AND RECOMMENDATION

532. This environmental impact assessment has carefully appraised the social and environmental as well as economic impacts of the proposed initiative to reviving the North Western Province Canal Project (NWPCP) to provide water to Hakwatuna Oya reservoir in the Deduru Oya Basin and the minor reservoir systems and medium level reservoirs in the Mi Oya basin. Based on the findings, it can be reasonably stated that the project interventions which will be implemented in two stages, will have both positive and negative socio economic and environmental impacts. While it will be necessary to enhance and build on the positive impacts, it is necessary that all negative impacts be addressed so that the impacts can be mitigated, if they cannot be avoided.

533. As had been identified during the EIA, the project on completion of its construction, can lead to enhancing the economic gains in terms of improving cropping intensity (CI) from present 1.2 to 1.7 and above in a command area of 12,000 ha of existing paddy lands. The sub projects shall provide a source of increased access to drinking water to Polpithigama area in Kurunegala District whereas the inundation of water and their reservoirs are expected to enhance the ground water table in the area that will increase the productivity of home gardens and coconut lands. In terms of the number of people directly been benefitted from the project, there will be over 124,000 persons living in nearly in 393 GN Divisions in 7 DS Divisions.

534. Economic and social benefits to be accrued to the project not only fulfil the desired objective of the project but will align well with the overall national development vision as pronounced in 'Mahinda Chinthana'. The EIA team has been convinced that the project is therefore of national importance and that it can provide multiple benefits that help to raise the living standard of the people in an areas which is already water stressed. A description of such social and economic benefits has been included in the relevant sections of the report.

535. Project alternatives have also been carefully analyzed based on the given options, including the no project option. As it is observed in section 2.1 of the EIA Report, the analysis of alternatives has revealed that the lay out of the project (in option 3) contains subproject which are most feasible from investment and environmental sustainability points of view. Socio economic as well as environmental considerations have been made to analyze advantages and disadvantages of each of the options. In general all the options had implications on costs as against benefits, option (Number 3) will provide wider social & economic benefits subject to proper mitigation of environmental impacts. The Mi Oya basin which is critically in need of additional water source will receive water as a result of implementing alternative (3).

536. The project is planned at a cost of nearly Rs 14.45 billion which is to be financed through a loan from the Asian Development Bank.

537. In terms of adverse environmental social impacts, the EIA report has carefully appraised all the environmental and social factors that may have long term as well as short term adverse impacts. These impacts have been analyzed for their intensity and magnitude and have been articulated in the Environmental Management plan (EMP).

538. The main impact anticipated in these natural habitats includes the habitat degradation, fragmentation and loss of habitat. There will not be a total loss of habitat for any animal or plant species in the project area. The most significant impact that will arise due to the project include loss of habitat due to establishment of the two reservoirs, *Maha Kithula* and *Maha Kirula* within the Kahalla-Pallekele sanctuary. Loss of habitat due to establishment of the two reservoirs, *Maha Kithula* and *Maha Kirula* within the Kahalla-Pallekele sanctuary will impact on dry-mixed evergreen forest, degraded dry-mixed evergreen forest and scrubland.

539. The flora survey had revealed that a total of 133 plant species (77 trees, 17 shrubs, 10 herbs, 28 climbers or creepers and 1 epiphyte) belongs to 112 genera and 47 families were recorded in all habitats in the project area. Four plant species recorded during the field survey are listed as Nationally Threatened species with none of the recorded plant species being unique or restricted to the project area. Although there will be fragmentation of habitat to some extent, the proposed Reservoirs that would be created inside Kahalla Pallekele sanctuary (Makithula and Mahakirula) could act as habitats for wild life in the sanctuary. The tanks could also supply the water demands of Elephants and other wild animals especially during dry season. It may indirectly lead to reducing human elephant conflict.

540. No specific migratory paths or routes were identified within the project area. The area is also utilized by migratory bird species. The proposed development will not have an impact on important flyways of migratory birds. While the proposed project will impair animal movements in the project area, it will not have a significant impact on any known critical animal migration paths.

541. In terms of mitigation of any adverse impact on archeologically important sites along the proposed path of the canal, the Department of Archaeology engaged an Archaeological consultant who was part of the EIA team. Taking into consideration the antiquarian, historical or archaeological aspects or value of a land to be developed or on any antiquities upon such land, the canal alignment was re-routed with the consent of the design team such that the adverse impacts on archeologically important sites of the project influence area could be minimized.

542. In terms of landslide potential that may affect the slope stability of the proposed reservoirs, it has been observed that the possibility of land slide is a less concern. Precautions must be taken to remove detached unstable rock fragments found if any when excavating for the reservoirs. The geology of the project (specially the tunnel area) is found good though at the inlet & outlet portals of the proposed Potuwila tunnel no fracture free bedrock had been encountered. During the construction of tunnel necessary precautions shall be taken to avoid any slide /slope failures.

543. In terms of social impacts, it is estimated that twenty two (22) families residing in in 08 GNDs situated in the area of the proposed canal (30 m strip) will be partially affected. . The approximate length of the diversion canal is about 78.6 km and, it will traverse about 66.2 km through villages, while the balance 12.4 km through Kahalla Pallekele sanctuary. Impacts will be significant owing to changes in lifestyles and livelihood patterns as well as their future plans. Social issues that may arise due to land acquisition because of a portion of land of the affected household will be lose and also partially damage to their houses. A suitable compensation package will offer to the affected party to their satisfaction. Facilities will be provided to resettled them in the remaining portion or close proximity to their lands

544. Where the canal passes through human settlements villagers will need bridges for safe movements across the canal. The EIA team was informed that location of these bridges will be finalized only after the discussions with beneficiaries during the detailed design stage.

545. During the EIA, extensive consultations have been undertaken with key stakeholders. The communities in the project influence areas were considered the most important. In terms of state agencies, consultation was also undertaken among others, with the official of the Mahaweli Authority and the official of the Department of Wildlife Conservation. One of the key features of all the community consultation meetings had been the overall willingness of the communities that the project should be implemented. The necessity of payment of compensation, transparency and community involvement in making vital decision pertaining to the project during its implementation have been considered important as far as the communities were concerned.

546. Section (7) of the report provides a comprehensive description of the consultations carried out and the major observations during the consultations. With a view to ensuring that the grievances of the communities will be duly addressed, a grievance committee and a grievance management procedure has been proposed in the report, based on the suggestion made by the communities themselves. It is expected that the procedure will be complied with by the contractors during the implementation of the project.

547. During the construction phase, especially during core trench excavation and back filling there will be short term impacts by way of soil erosion, dust and noise pollution. The use of heavy machinery and other human activities may disturb the wildlife whereas the construction crew will face health and safety issues during excavation, felling of trees and related activities. The deep excavations envisaged may pose safety threats unless appropriate safety measures are adopted.

548. The EIA Report has analyzed carefully the referenced impacts and proposed a set of mitigation actions which are provided in the Environmental Management Plan given in Section (9). The social impacts arising from land acquisition can be mitigated by providing compensation. In this regard necessary suggestions have been proposed. The actions proposed need to be taken prior to commencement of construction activities. Irrigation Department should work hand in hand with the Divisional Secretaries in order to implement resettlement and compensation measures. It is also presumed that timely action will be taken to establish a functional grievance committee.

549. During the construction phase it will be necessary to take all the measure to mitigate constructional impacts such as pollution, soil erosion and health and safety issues. Adequate precautions should be taken during the construction of the tunnel and during the deep excavation of the trenches. Required technical expertise should be received during the construction phase and if necessary additional investigations should be undertaken in areas of tunnel excavation and excavation of areas with weak geological zones. An important consideration has been made in respect of clearing the trees in Kahalla Pallekele Forest are. It calls for saving at least 50% of the tree cover along the tank bed. Therefore tree felling should be carefully planned and should be monitored. A programme to replant the trees in the denuded areas will be a requirement that need to be followed up During the operational and maintenance phase, the Irrigation Department will be required to comply with the mitigation actions as suggested in the EMP. Subject to above, it is the professional view of the EIA Preparers that the EIA can be approved enabling the developer to implement the project activities.

LIST OF ANNEXURES

Annexure I Terms of Referance

TERMS OF REFERENCE

(It also includes requirements to fulfill ADB's Safeguard requirements. Please refer to ADB's Safeguard Policy Statement 2009 available on www.adb.org for more details.)

This ToR is valid only for one and half years from the date of issue.

Project Name : Project for construction of NWP Diversion canal from Bowatenna Reservoir to divert Mahaweli water to Hakwatuna Oya reservoir in Deduru Oya basin and Upper Mi Oya Basin in Kurunegala District

Project Proponent : Ministry of Irrigation & Water Resources Management

Project Approving Agency : Central Environmental Authority

Report requirement : EIA

Report format :

Executive Summary

1. Introduction
2. Description of the Project and reasonable alternatives
3. Description of the existing environment
4. Anticipated environmental impacts of proposed project
5. Proposed mitigatory measures
6. Cost - Benefit Analysis
7. Information, disclosure, consultation and participation
8. Grievance Redress Mechanism
9. Environmental Management Programme
10. Conclusion and Recommendation

ANNEXTURES

I Terms of Reference
II References

III Sources of data & information

IV List of preparers including their work allocation and time schedules

X Comments made by the public NGOs and other agencies during the formal and informal scoping meetings held by the EIA Team

VI Complete set of relevant maps, tables, charts, layout plans and other details

Executive Summary

The summary should be a brief, non-technical summary of the justification of the proposed project, description of the salient features of the project and alternatives considered, the existing environment of the project sites and its environs, key environmental impacts, the measures proposed to mitigate the environmental impacts, monitoring programme and conclusions. A one page summary table indicating the significant impacts and proposed mitigatory measures should be presented.

1. INTRODUCTION

- Background of the project
- Objective of the proposed project and justification of the project
  (Summarize the need or problem been addressed by the project and how the proposed project is expected to resolve the problem or the issue)

- Objective of the EIA report
  (Specify the objectives of the assessment and the relationship of the results to project design and implementation)

- Methodologies and technologies adopted in EIA report preparation
- Policy, Legal, and Administrative Framework – should describe national and local legal and institutional framework within which the EIA is carried out. Also should identify any project relevant international environmental agreements to which SL is party to.
- Preliminary approvals needed for the project and any conditions laid down by state agencies in granting preliminary clearance for the project. Ex. Forest Dept., Dept. of Wildlife Conservation etc.
- Conformity with other development plans in the area

2. DESCRIPTION OF THE PROPOSED PROJECT AND REASONABLE ALTERNATIVES

2.1 Evaluation of Alternatives

Describe reasonable alternatives considered and the basic environmental, engineering and economic parameters used in their investigation and evaluation.

Compare alternatives in terms of potential environmental impacts, mitigatory measures, capital and operating costs, reliability, etc.

Comparison of the alternatives considered and recommendations should be given.

Include the no action alternative, in order to demonstrate environmental conditions without it.

2.2 Description of the proposed project

- Location, indicating the Divisional Secretariat Division/s and the Pradeshiya Sabha area/s within which the project site falls. The location map **indicating** should be given the general location of the project site and exact location with clear coordinates. Clear coloured and readable maps together with diagrams and photographs to be provided for reviewer to get a clear understanding of the project area and the location of all the project components.
- State the present ownership of the project site/s. If state owned, please submit a letter of consent from the relevant state agency/agencies.
- The layout plan of the project at appropriate scale. This should indicate all the project components and reservation and conservation area/s to be maintained.
- A contour map should be provided indicating the land use of the inundation area at HFL of the reservoirs (new and existing).

Provide a full description of the relevant information including the following.

- Description of all project components relevant to the proposed project.

a) Irrigation infrastructure (proposed reservoir/s dam/s, tunnels, spillways, transfer canals, feeder canals, existing and new irrigable area, (protective mechanism proposed to prevent falling animals and human beings), reservation area/s to be kept etc) schematic diagrams to indicate the directions of flow and conveyance may be included for clarity

b) Other Infrastructure developments such as roads (Existing roads improvements new roads developments and alterations to be done to the existing road systems etc) water supply and sanitation etc.

c) Resettlement, Farm land allocation and proposed conservation programme.

d) Power generation which has been linked with Bowatenna diversion (tunnel/s, head race canal, fore bay tank, tail race canal power house surge tank etc.)

e) Raw material requirement (quantity, source) and debris disposal <u>- describe the land use of these potential sites</u>

Size, capacities and extent of each component should also be described.

- Give details on pre-construction, construction activities, phased implementation schedule <u>(Please discuss the phasing being proposed if funded under ADB)</u>, staffing and support facilities and services.
- Methodology of operation <u>of project components</u> and maintenance activities, infrastructure facilities required/provided by the project.
- Project cost, investment and funding sources.
- Phased implementation plan.

3. DESCRIPTION OF THE EXISTING ENVIRONMENT

STUDY AREA

The study area for the assessment shall include the following;

i) Project site
ii) Locations affected by construction activities
iii) Any area beyond the project sites, where there is potential for environmental impacts (including sites identified as borrow, quarry and disposal sites)

Assemble, evaluate and present available baseline data on the relevant environmental characteristics of the study area.

This chapter should provide information on physical, biological socio-economic, archaeological and cultural aspects of the environment likely to be affected by any activity of the project during and after the project. Information should be presented in a comprehensive format using tables, maps and diagrams where appropriate. The methods used to collect data should be clearly stated under each category. All technical terms should be clearly defined. The existing environment should be described under following;

3.1 Physical environment

Topography, Geology & Soil, climate and Meteorology, Hydrology, sources of water pollution, receiving water quality

3.2 Biological Environment:

- Presence of Wildlife Reserves National Parks, Sanctuaries, Elephant Corridors, Wetlands and Forest Reserves in the directly affected area and study area
- An assessment of the present ecological status including the biodiversity of the area. The survey team should identify and map the existing habitats of fauna and flora and their distribution in the study area. Information on endangered, rare, migratory commercially important flora and fauna and species with potential become nuisances, and vector or dangerous should be given. Identify if the habitat is modified, natural or critical habitats. (please refer to ADB's SPS 2009- Appendix 1 on conditions to be met for each of these habitats)
- The study should identify (both in the immediate and wider area around the project site) habitats that will be affected, the range and status of the main species groups that live in the area, the status of protected areas or other important areas for biodiversity.
- Ecosystem benefits/services from the area to be affected and their links with sustenance of wildlife and livelihood of local people.
- Baseline studies and data collection may need to consider seasonal factors such as species migration.
- Describe if the Kahala Pallakele forest area has a management plan and if so what are the key features of the management plan and state if the proposed activities in line with the management plan.

3.3 Social cultural environment (include both present and projected where appropriate)

- Settlements, present water supply and water uses including existing irrigation schemes
- Existing economic activities including income sources
- Availability of services and infrastructure
- Cultural, historical, protected resources and archaeological aspects/considerations
- Existing health and other social issues

4. ANTICIPATED ENVIRONMENTAL IMPACTS OF PROPOSED PROJECT

This chapter should show the overall effects of the project on the individual environmental components. Impacts should include the direct and indirect, long and short-term positive and negative effects. Significance of impacts should be assessed using appropriate techniques. When describing the impacts indicates which are irreversible or unavoidable and which can be mitigate to the extent possible. Impacts should be quantified wherever possible.

Impacts should be discussed in the order of severity

Impacts shall include project – environment interactions (Impacts of the project activities on the environment) and environment – project interactions (Impacts of the environment on project activities)

Potential impacts of climate change on proposed investments. Impacts at borrow sites, quarry pits, disposal sites too should be discussed. Cumulative impacts too should be assessed.

Special attention should be given to;

- Hydrological changes in Mahaweli / Amban Ganga basin due to diversion and resulting impacts.
- Hydrological changes in Mi Oya and Hakwatuna Oya basin and resulting impacts.
- Impacts on existing water users due to proposed diversion
- Impacts on ecology due to hydrological changes
- Impacts on habitats, biodiversity
- Development of new lands for agricultural purposes
- Relocation and Resettlement [issues (if any)]
- Socio-economic impacts including impacts on occupational health and safety, community health and safety, vulnerable groups and gender issues, impacts on indigenous communities (if any) and on livelihoods.
- Stability of slopes /tunneling area
- Increased Human Elephant Conflict
- Pollution aspects (Air, Noise / Vibration and waste disposal**)**

5. PROPOSED MITIGATORY MEASURES

This chapter should set out the proposed measures to minimize the impacts identified in Chapter 4 to acceptable levels including conformity to Sri Lankan standards. Alternative methods of mitigation should be discussed and the effectiveness of the proposed measures that are to be provided should be stated. Mitigation methods should be defined in specific practical terms. A rationale should also be presented for selection of chosen mitigatory measures.

Given that the canal will traverse through protected areas belonging to the FD and DWC, the projects should propose (in consultation with the DWC and FD) additional programs as appropriate, to promote and improve the conservation aims of the protected areas.

The design of mitigatory measures should take into consideration the following.

i) Since the project is in a sensitive ecosystem, the project should be designed in a manner consistent with any national land use, resource use, and management criteria (including Management Plans, National Biodiversity Action Plans or similar documents). This will entail securing the necessary approvals from the responsible government agencies, and consulting with protected area sponsors and the local communities, including communities of Indigenous Peoples (if applicable), and other key stakeholders; and

ii) Consult protected area sponsors and managers, local communities, and other key stakeholders on the proposed project.

Mitigation measures should be designed to achieve at least no net loss of biodiversity. Therefore, post project restoration of habitats, offset of losses through creation of effective conservation of ecologically comparable areas may be considered.

6. COST – BENEFIT ANALYSIS (Excluded for submission to ADB as this is covered in a separate report on financial and economic analysis)

Quantify the cost and benefits of the project. The cost of the proposed remedial and mitigation measures, to protect the environment must be included in the project cost.

7. INFORMATION DISCLOSURE, CONSULTATION AND PARTICIPATION

Should describe

(i) The process undertaken during project design and preparation to engage stakeholders, including information disclosure and consultation with affected persons and stakeholders

(ii) Summarize comments and concerns received and describe how these comments have been addressed in project design and mitigation measures, with special attention paid to the needs and concerns of vulnerable groups, including women, the poor, and indigenous peoples; and

(iii) Describe the planned information disclosure measures (including type of information to be disseminated and method of dissemination) and the process for carrying out consultation with affected people and facilitating their participation during project implementation

8. GRIEVANCE REDRESS MECHANISM

This section describes the grievance redress framework (informal and formal channels) setting out the time frame and mechanism to resolve complaints about environmental performance.

9. ENVIRONMENTAL MANAGEMENT PROGRAMME

A suitable Environmental Management Programme (EMP) should be submitted summarizing significant possible impacts that may occur during implementation of the project, proposed mitigation for adverse impacts and a monitoring plan to monitor the changes of environmental implementation of mitigation measures.

The EMP should include the following;

(i) Mitigation

- Identifies and summarizes anticipated significant adverse environmental impacts and risks
- Describes each mitigation measure with technical details, including the type of impact to which it relates and conditions under which it is required, together with designs, equipment descriptions, and operating procedures as appropriate
- Provides links to other plans such as resettlement, indigenous peoples, or emergency response as required

(ii) Monitoring

A suitable monitoring programme should be submitted to monitor the changes of environment and implementation of mitigatory measures. This plan should include the following;

- Parameters to be monitored
- Frequency of monitoring, detection limits and definition of thresholds that will signal the need for corrective action
- Location / timing of sampling
- Institutional framework for mitigation of impacts
- Responsible agency / agencies of monitoring
- Describes monitoring and reporting procedures to ensure early detection of conditions that necessitate particular mitigation measure and documents the progress and results of mitigation

(iii) Implementation arrangements

- Specifies the implementation schedule showing phasing and coordination with overall project implementation
- Describes the institutional framework, namely who is responsible for carrying out the mitigation and monitoring, which may include, additional topics to strengthen environmental management capability, technical assistance programs, training programs, organizational changes etc,
- Identify the capital and recurrent costs to implement mitigation and monitoring measures described above. Identify the availability and source of funds to implement the measures.

10. CONCLUSION AND RECOMMENDATION

The environmental acceptability of the proposed project and key findings and recommendations of the assessment should be clearly stated. The consultants should make a firm recommendation on one of the alternatives based on available information.

Any programme to improve general environmental conditions can also be stated here.

Annexure II References

<u>References:</u>

Acres Model Simulation Results, Run Time A10A, by WMS (MASL)/MCB.

Antiques (Amendment) Act, No. 24 of 1998 Socialist Republic of Sri Lanka, Department of Government Printing, Sri Lanka, Archeological Department

Bambaradeniya, C.N.B. (Ed.), 2006. Fauna of Sri Lanka: Status of Taxonomy, Research and Conservation. The World Conservation Union, Colombo, Sri Lanka & Government of Sri Lanka. viii + 308pp

Bedjanic, M., Conniff, K. & G. de S. Wijeyeratne (2007) Dragonflies of Sri Lanka. Jetwing Eco holidadays.248p.

d' Abrera B., (1998), *The Butterflies of Ceylon,* wildlife Heritage trust, Sri Lanka

Das, I. & Anslem de Silva. 2005. *Photographic guide to snakes and other reptiles of Sri Lanka.* New Holland Publishers, UK.Ltd.144 pp.

Dissanayake, R. B. (2013) Archeological Impact Assessment Report (Wayamba Province Water Diversion Project), Past, Preserve Archeological Services, Pannipitiya

Goonatilake, S. de A. (2007) *Freshwater Fishes of Sri Lanka.* (Sinhala text) Biodiversity Secretariat, Ministry of Environment and natural Resources. 134p.

Harrison, J. 1999. *A Field Guide to the Birds of Sri Lanka*.Oxford University Press.

Historic Mathale, Department of Cultural Affairs - Department of Government (1984) Printing, Sri Lanka

IUCN (2013).The list of threatened species. WWW.IUCN.redlist.org

Kotagama S. & Fernando, P. (1994) A field guide to the Birds of Sri Lanka. WHT Publications, Sri Lanka.224 pp.

Malkanthi L.M.C. (2006) úydryskak ms<suf.hs mqrdúoHd jákdlu ms<sn| fy<sorõ lsÍu" National Archeological Conference

Manamendra-Arachchi, K. and Pethiyagoda, R. (2006).*Amphibians of Sri Lanka*. (text in Sinhala). Wildlife Heritage Trust of Sri Lanka.440p.+ 88pls.

MOE 2012.The National Red List 2012 of Sri Lanka; Conservation Status of the Fauna and Flora.Ministry of Environment, Colombo, Sri Lanka.Viii 476pp.

Panabokke and Perera 2005 - Ground water aquifers in Sri Lanka

Phillips, W.W.A. 1935. *Manual of the Mammals of Ceylon*. Ceylon Journal of Science, Dulau and Company, London.

Premathillake, P. L. (1985) Nalanda Gedige, Central Cultural Fund

Resource profile for Kurunegala District-2011 District Policy Planning Office, Kurunegala

Resource profiles for Galewela and Dambulla - 2011

Resource Profiles of Galevela & Dambulla DS Divisional Secretariats 2011

Silva, E.I.L, 2004. Quality of irrigation water in Sri Lanka- Status and trends. Asian Journal of Water, Environment and Pollution. Vol1. No.1&2. Pp.5-12

Statistical Handbook 2011, Statistics section, Kurunegala District Office

Wayamba Puthra PrasadiniI, Central Cultural Fund (2005) - Pelican Printers (Pvt.) Ltd., Nedimala, Dehiwala, Sri Lanka

Wijeyeratne, G, De S. (2008) A Photographic guide to Mammals of Sri Lanka. New Holland Publishers (UK) Ltd. 128p.

Annexure III Sources of Data and Information

Sources of Data and Information

1. Resource profile for Kurunegala District-2011 District Policy Planning Office, Kurunegala
2. Resource profiles for Galewela and Dambulla - 2011
3. Resource Profiles of Galevela & Dambulla DS Divisional Secretariats 2011
4. Statistical Handbook 2011, Statistics section, Kurunegala District Office
5. Wayamba Puthra Prasadini, Central Cultural Fund (2005) - Pelican Printers (Pvt.) Ltd., Nedimala, Dehiwala, Sri Lanka
6. Historic Mathale, Department of Cultural Affairs - Department of Government (1984) Printing, Sri Lanka
7. NWP Canal feasibility report
8. Divisional Secretaries, Dambulla, Naula, Galewela, Polpithigama and Mahawa
9. Regional Director Irrigation, Kurunegala
10. Irrigation Engineers, Galgamuwa, Dambulla
11. Irrigation Department, Colombo
12. Agrarian Development Department, Kurunegala
13. Divisional Officers of Agrarian Development Department, Mahawa, Polpithigama, Dambulla, Galewela.

Annexure IV List of prepares

No.	Name	Designation	Work allocation
1	Prof. B M P Singhakumara	Team leader/Flora Ecologist	Team leader and Flora Ecologist
2	Eng. K R P M Mullegamgoda	Deputy team leader/Civil Engineer	Deputy team leader and infrastructure engineer
3	Eng. Ms Lalani Imbulana	Irrigation Engineer	Irrigation Engineer
4	Mr. H M Jayathilaka	Sociologist	Social and resettlements aspects
5	Mr. P W Weerakkody	Agronomist	Agriculture
6	Eng. S P P Gamage	Geologist/Tunnel Engineer	Geological aspects including tunnel
7	Eng. U Pmbulana	Hydrologist	Water allocation and hydrological concerns
8	Prof. Devaka Weerakoon	Fauna Ecologist	Fauna ecology and human elephant conflict
9	Prof. P.B. Mandawala	Archaeologist	Impact of the project on archaeological monuments
10	Dr. (Ms.) U.A.D.P. Gunawardena	Resource Economist	Extended economic analysis

Annexure V Comments made by public, NGOs and others agencies

Workshop held in Galgamuwa Irrigation Training Institute on 12th December 2013 with government agencies involved in the project.
Venue: Meeting room of the Galgamuwa Irrigation Training Institute

Date and time: 12th December 2013. 8.30 am

The meeting was chaired by Eng R M W Rathnayaka, Director Water Resources Developmet in the Minsitry of Irrigation and Water Resurces Management (MI&WRM).

Officers representing following agencies were present.

- Ministry of Irrigation and Water Resources Development[14]
- Irrigation Department
- District Secretary, Kurunegala
- Divisional Secretaries, Polpithigama, Galgamuwa
- Agrarian Development Department
- Department of Wildlife Conservation
- Forest Department
- Mahaweli Authority of Sri Lanka
- Mahaweli Consultancy Bureau

At the outset Eng R M W Rathnayaka explained the importance of securing water in the context of impending climate change.

Eng D W C Dayarathna made a presentation on the proposed NWPC.

Eng W L H M T Bandara explained the importance of Kurunegala District in the production of paddy. But if the district faces a water shortage the position of the District as a major rice producing area will face a challenge. The forest in the catchment areas in the district were damaged due to wrong cultivation practices. It is necessary to protect these sensitive environment with appropriate corrective measures. The human elephant conflict should be minimized by an appropriate programme involving all relevant agencies. Under the proposed project major irrigation projects will provide water to small tank cascades in the area. Therefore, it is important to suitable water management plan involving experienced officers from Irrigation Department and Agrarian Development Department.

Eng B A S S Perera, Regional Director of Irrigation, Kurunegala stressed the importance of enforcement of law to avoid problems that might impede the progress of work. He also explained the progress of investigations under the project.

Mr Majula Amararathna, Deputy Director, Department of Wildlife Conservation said that Elephants in Kahalla Pallekele Sanctuary are confined to a relatively small area and with the project may further confine the available space for elephants. Therefore he suggested to open a corridor up to Hakwatuna Oya Reserve. He also suggested to erect elephant fence to protect the cultivated lands.

The proposed reservoirs in the sanctuary should fulfill the water requirements of wild elephants in the sanctuary especially during dry periods. Further the structures should be designed to facilitate

[14] In January 2015 the Ministry was renamed as the Ministry of Mahaweli Development and Environment

migration patterns of wildlife. Mr Majula also suggested to enrich or replant the appropriate locations where the forest cover is absent. It is necessary to remove invasive plants in the sanctuary.

Mr W G W Wanasingha, Divisional Secretary, Polpithigama said that the unplanned vegetable cultivation in Kahalla Pallekele area has increased soil erosion in the area and a soil conservation is necessary. The proposed elephant corridor should be discussed with the farmer organizations in the area. There are about 150 ha of illicit vegetable cultivation in the proposed elephant corridor.

Series on meeting were held with the stake holders

DS Division	GN Division	Date of meeting	Venue of meeting	No of stakeholders present	No of officres present
Galewela	Pahala Bambawa and Ranwediyawa	24th March 2014 (Morning Session)	Pahala Bambawa Temple	27	9
Galewela	Danduyaya, Dambagolla and Nebadagahawatta	24th Evening	Danduyaya Temple	22	10
Polpithigama	Polpithigama, Bogolla	25th March 2014 (Morning)	DS Office	25	13
Polpithigama	Amunukole, Hathigamuwa	25th March 2014 (Evening)	Amunukole temple	50	9
Polpithigama	Bulnewa, Moragllagama	26th March 2014 (Morning)	Bulnewa temple	28	9
Polpithigama	Kattambuwawa	26th March 2014 (Evening)	Private house	38	8
Galewela	Nilagama, Aluthwewa, Pibidunugama	27th March 2014 (Morning)	Aluthwewa temple	42	9
Galewela	Hombawa	27th March 2014 (Evening)	Andagala temple	26	7
Galewela	Koapotha	28th March 2014(Morning)	Danduwagolla temple	27	6
Polpithigama	Pallekele	28th March 2014 (Evening)	SANANSA meeting hall	37	5
Dambulla	Pannampitiya	1st April 2014 (Morning)	Parakum Community hall	29	12
Dambulla	Lenadora north	1st April 2014 (Evening)	Lenadora Community hall	31	13
Dambulla	Ethabendiwewa	2nd April 2014 (Morning)	Menikdena Community hall	37	9
Dambulla	Welamitiyawa	2nd April 2014 (morning)	Welamitiyawa temple	14	7
Mahawa	Mahawa	3rd April 2014 (Evening)	Konwewa Community hall	47	13

Small group discussions were organized by respective Grama Niladaris with the patronage of Divisional Secretaries of Dambulla, Galewela, Polpithigama and Mahava DS divisions which would be affected by the proposed Project. These discussions were attended by officers of Irrigation Department, Economic Development Officers and Grama niladaris of DS divisions and officers of Mahaweli Consultancy Bureau. Even representatives of ADB participated in the small group discussions held in Pannampitiya & Lenadora South GNDs. (Photographic evidence and attendance sheets of these meetings are provided in the annexure VI – III.)

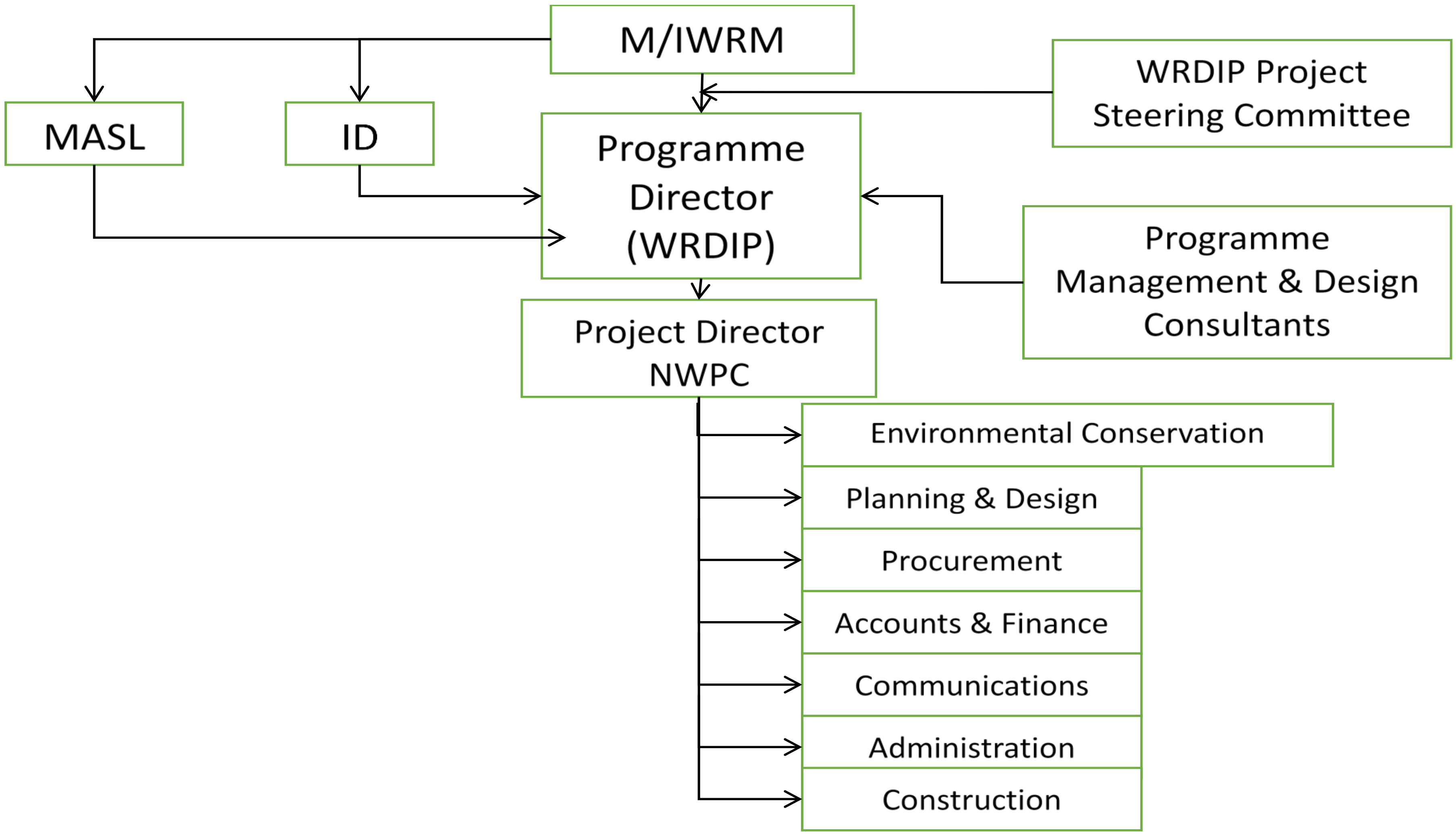
Above table provides basic details of the meetings held for discussions.

The relevant views expressed by the community at the discussions are summarized as follows.

At every discussion the community emphasized that they have no objection whatsoever regarding implementation of the proposed Project and that they are willing to give their utmost support in the Project activities.
They also expressed their expectation is to see that the bitter experiences associated with other development projects are not repeated in this Project too; which are
All activities connected with the community to be done with utmost transparency and the true scope of the project would not be concealed from the beneficiaries
Decision making on behalf of the community should be done with the presence of their representatives.
A structure should be formed to listen, discuss and provide solutions for the problems of the community with regard to the Project at Grama Niladari level.
Resettlement of the displacing community should be done without incurring embarrassment for them in any way and select resettlement areas having basic infrastructure facilities similar to what they enjoy at present and also in close proximity to their present abodes.
The compensation should be paid in a single installment after a fair assessment based on market prices.
Displacing community should be given in writing about the agreements regarding actions taken on their behalf.
Evacuation would only be done after payment of compensation.
If the present livelihood is lost in displacement necessary assistance and support should be provided to begin new activities in the new area.
The whole family should be involved in payment of compensation to avoid misuse of money by a single member of the family thereby avoiding family disputes.
Implementation of the Project with minimum damage to houses and property.
There should be a mechanism to uplift the Displacing people suffering with chronic illnesses, disabled people and widows and to provide housing facilities for them.
The people who have not yet received license for lands they presently occupy should be provided assistance for obtaining such license so that they would not be deprived of compensation.
Assist the community to minimize the adverse effects of the project as much as possible.
To get the assistance of the community in setting out the canal they should be informed about the periods and dates beforehand.
The people who occupied and developed temple and devala lands under long lease be considered fairly and justly in paying compensation.
Therefore, taking into consideration the points raised by the affecting community, in assessing the value of the properties every aspect and lessons learned from other projects should be considered and arrive at a fair compensation agreeable to the displaced families and paid before commencing

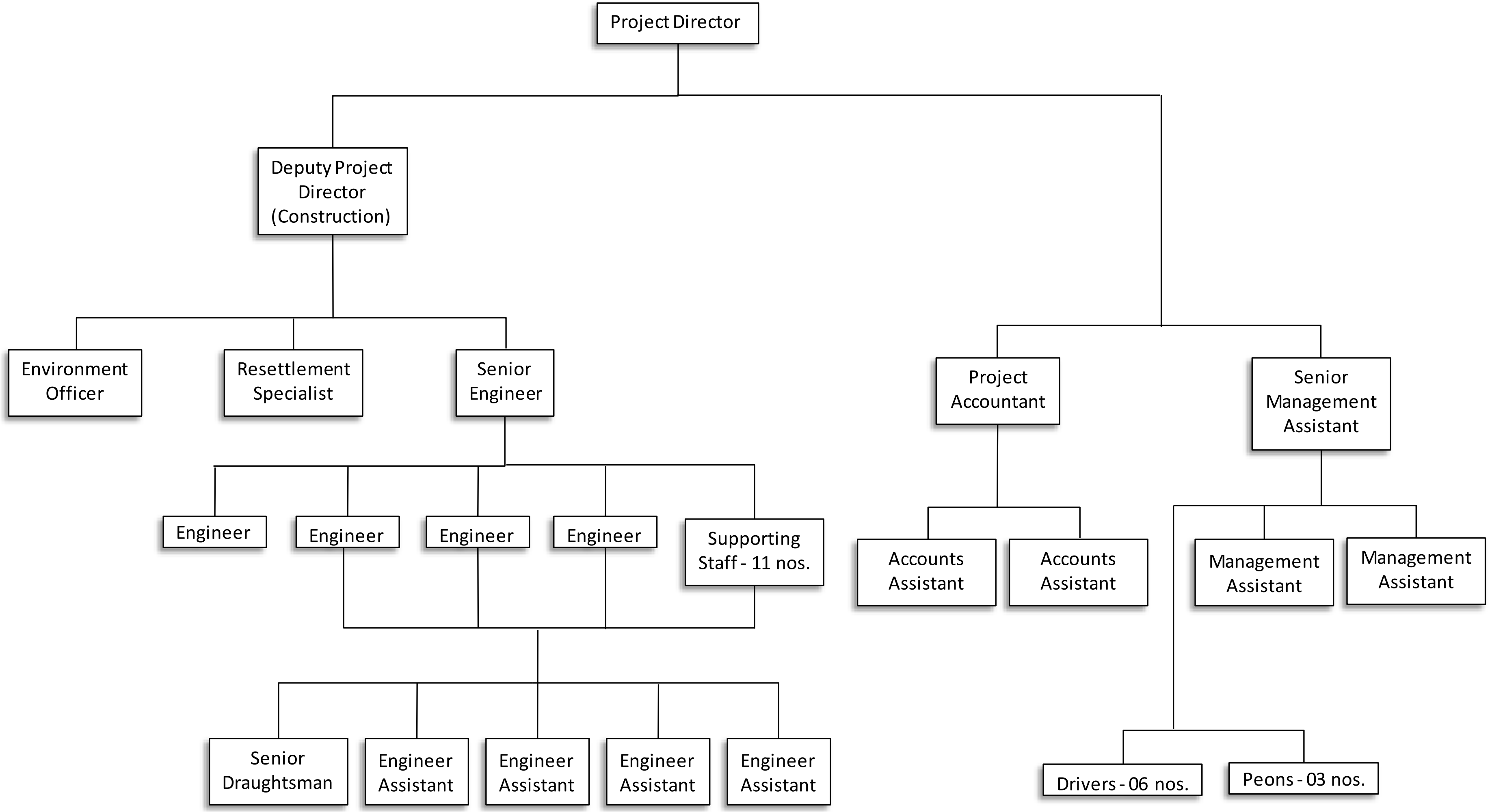
implementation of the Project. The Project should be continuously in rapport with the displacing community at every step of the procedure.

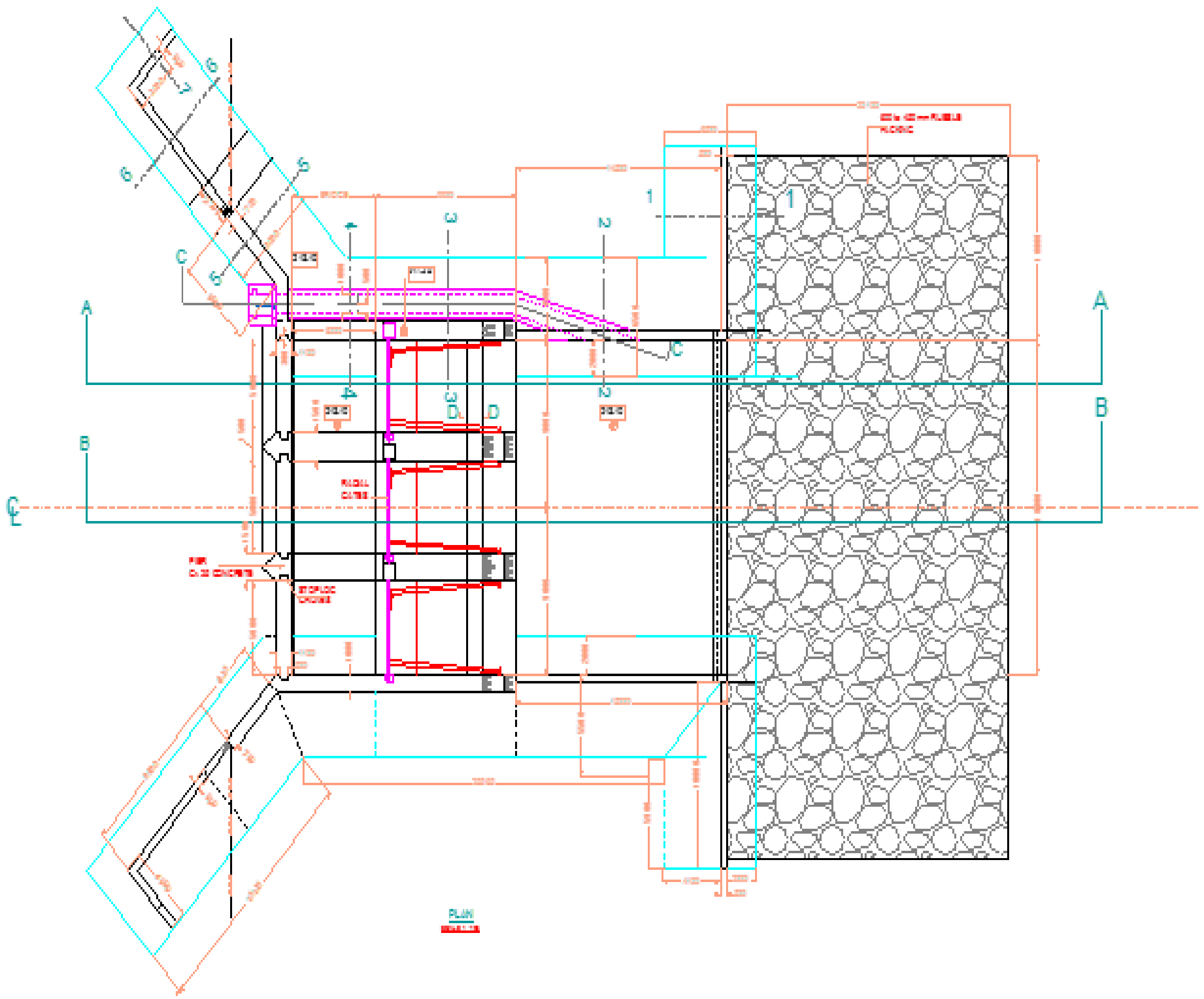
Annexure VI – I Details of Infrastructure and Borrow Areas and staffing of the project



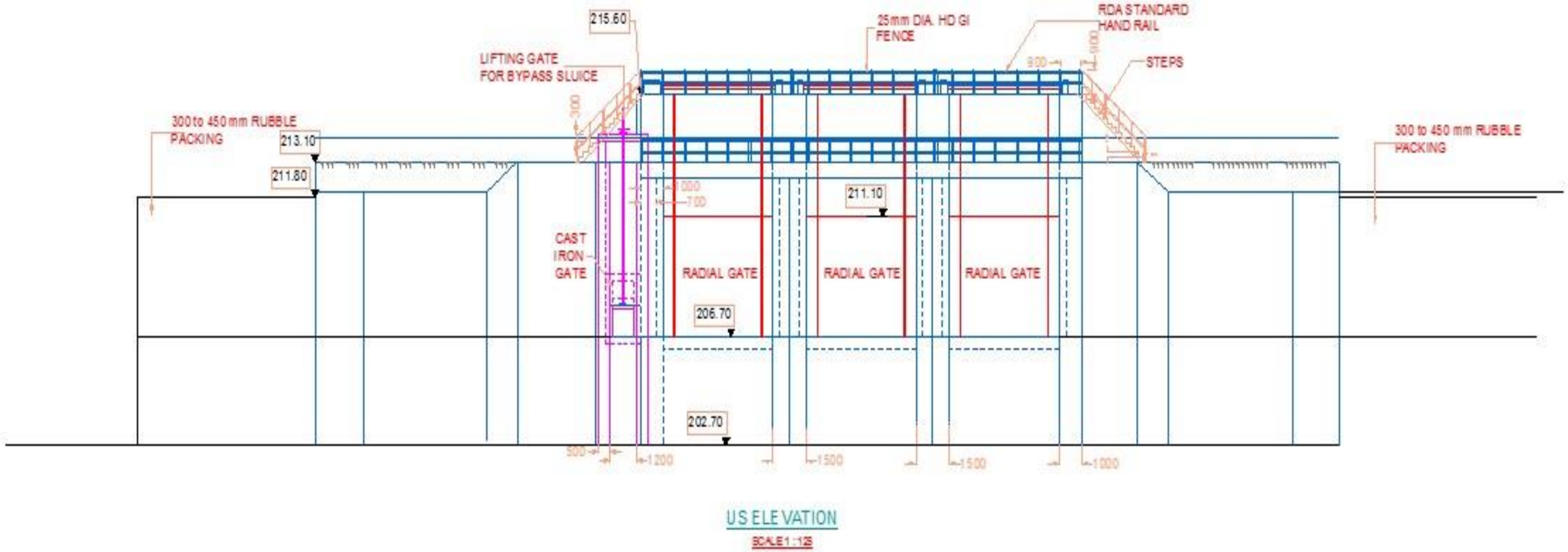
<u>Implementation arrangement of PMU</u>

Organization Chart - NWCP

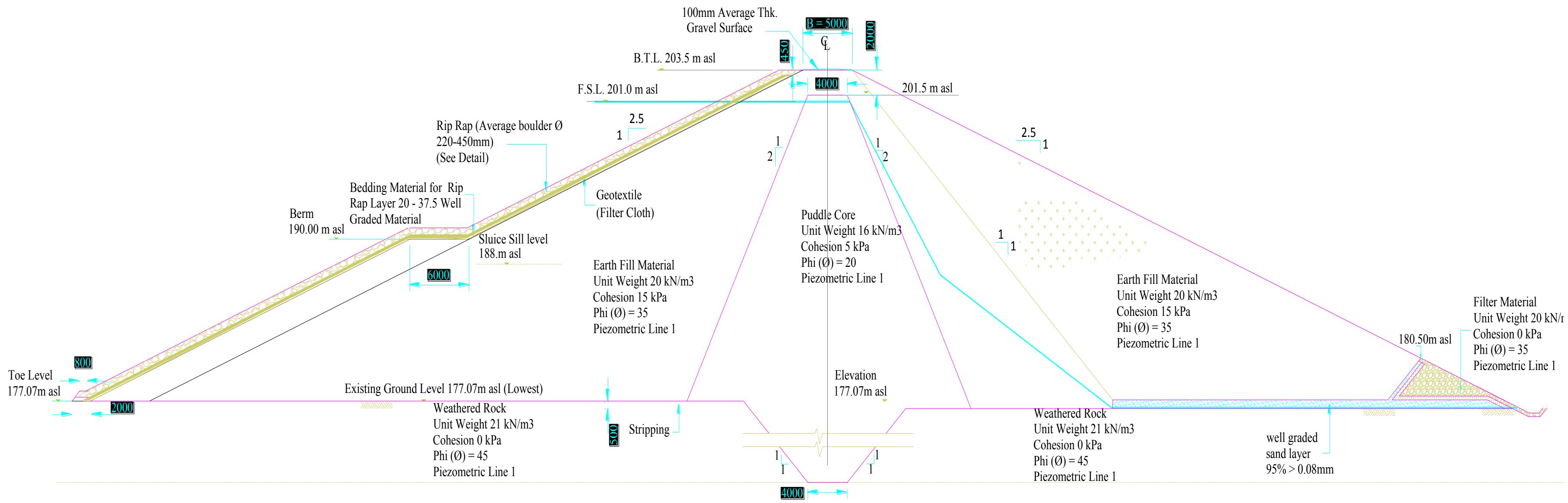




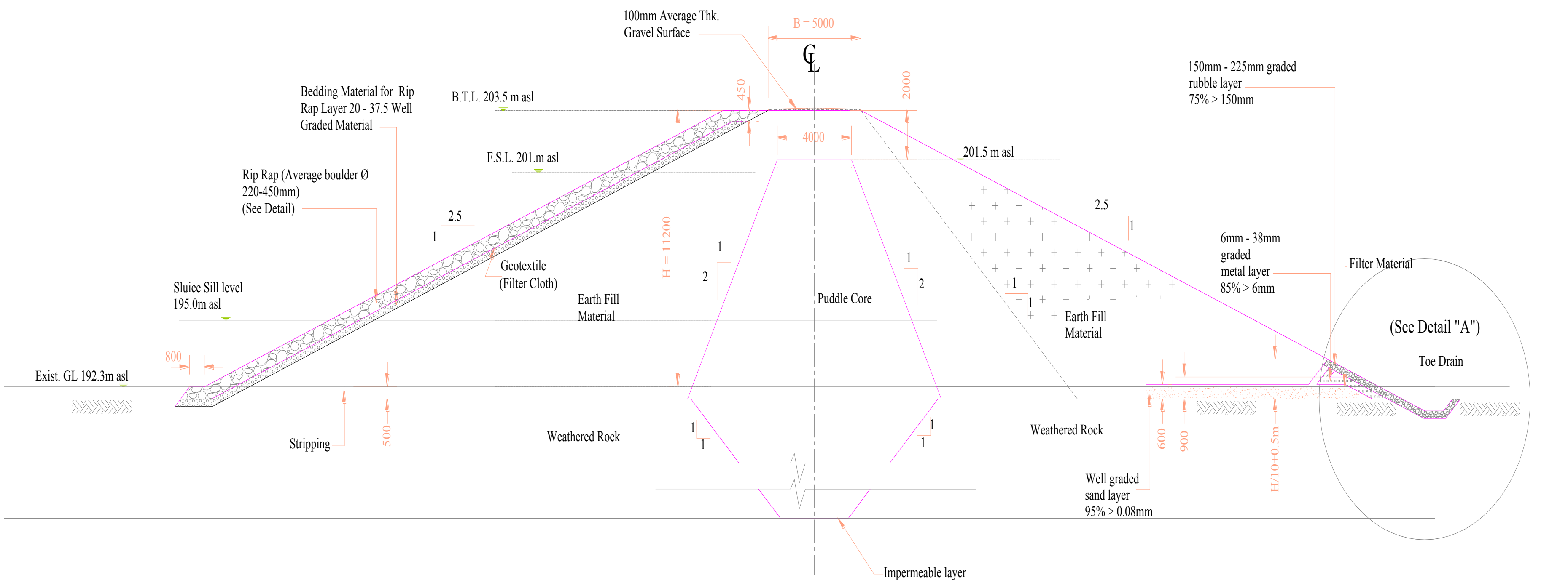
Plan of Diversion Weir - Dambulu Oya



Upstream Elevation of Diversion Weir – Dambulu Oya

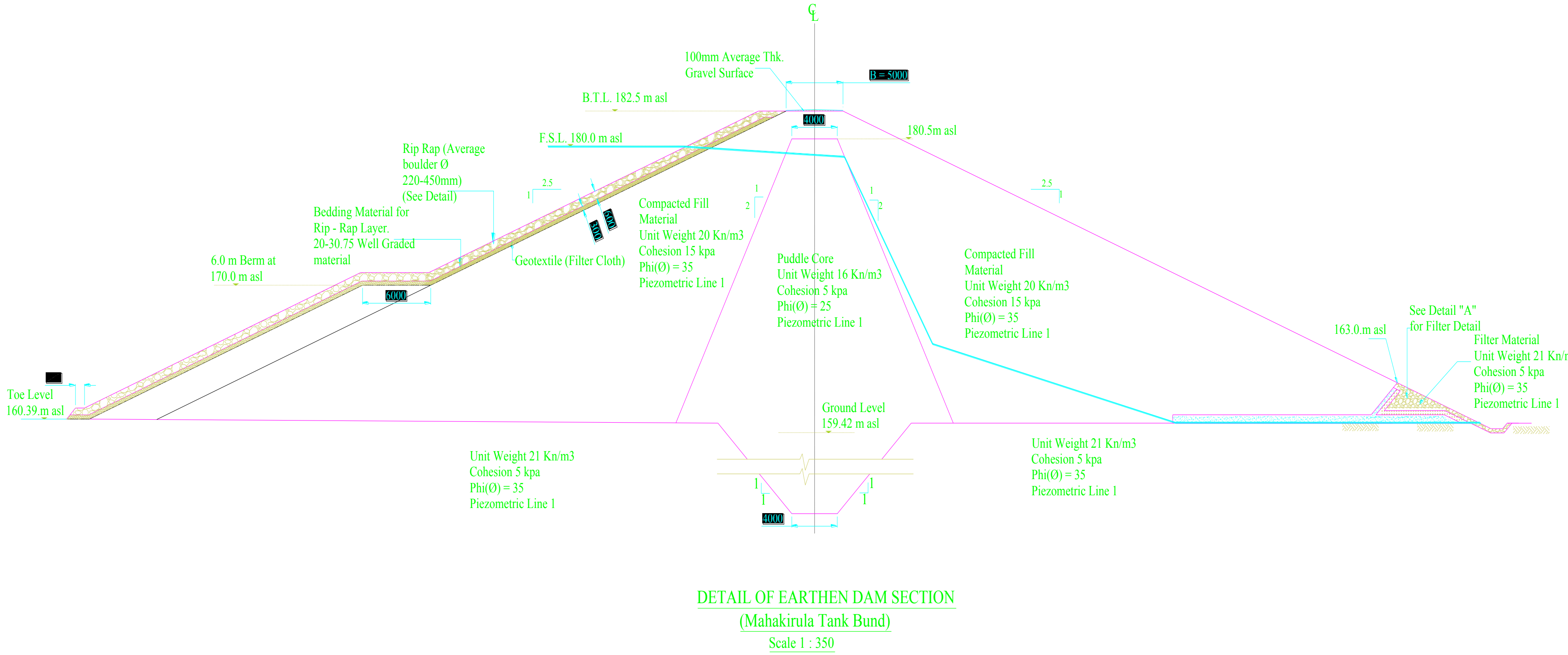


Mahakitula Main Dam - Cross Section



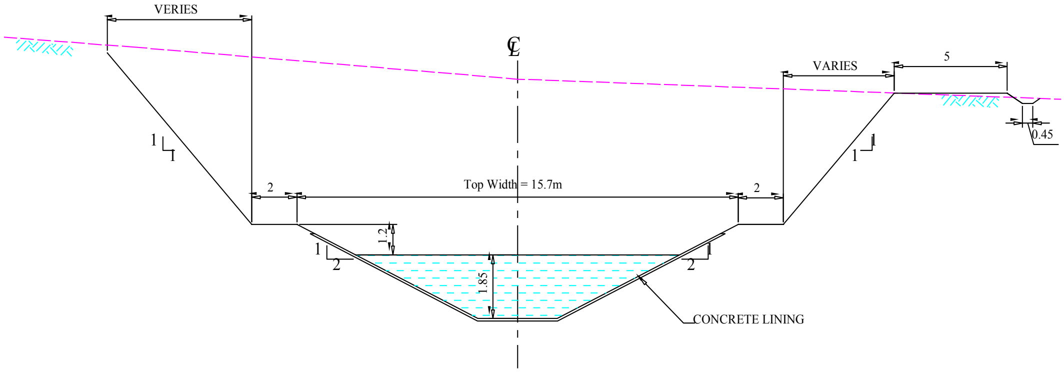
DETAIL OF EARTHEN DAM SECTION
(Mahakithula Tank Saddle Bund)
Scale 1 : 100

Mahakithula Saddle Dam – Cross Section



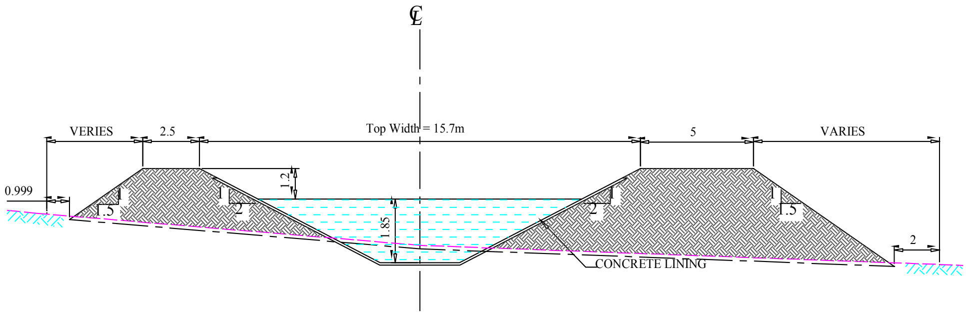
Mahakirula Dam – Cross Section

Canal Sections from Diversion weir at Dambulu oya to Mahakirula Reservoir



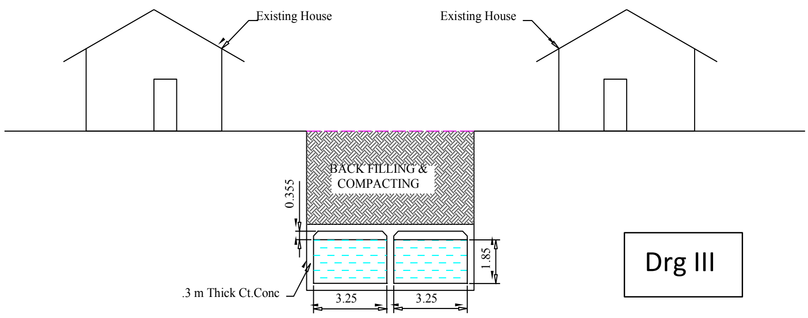
DEEP CUT SECTION

Drg I



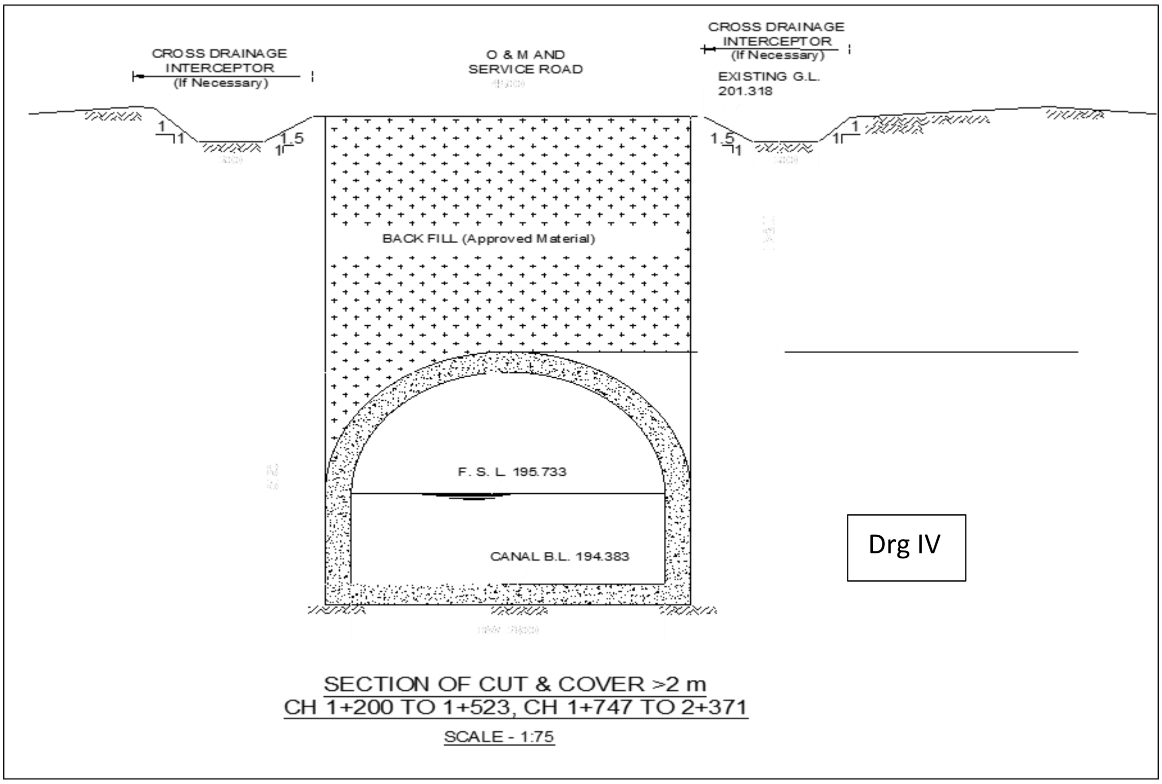
CUT & FILL SECTION

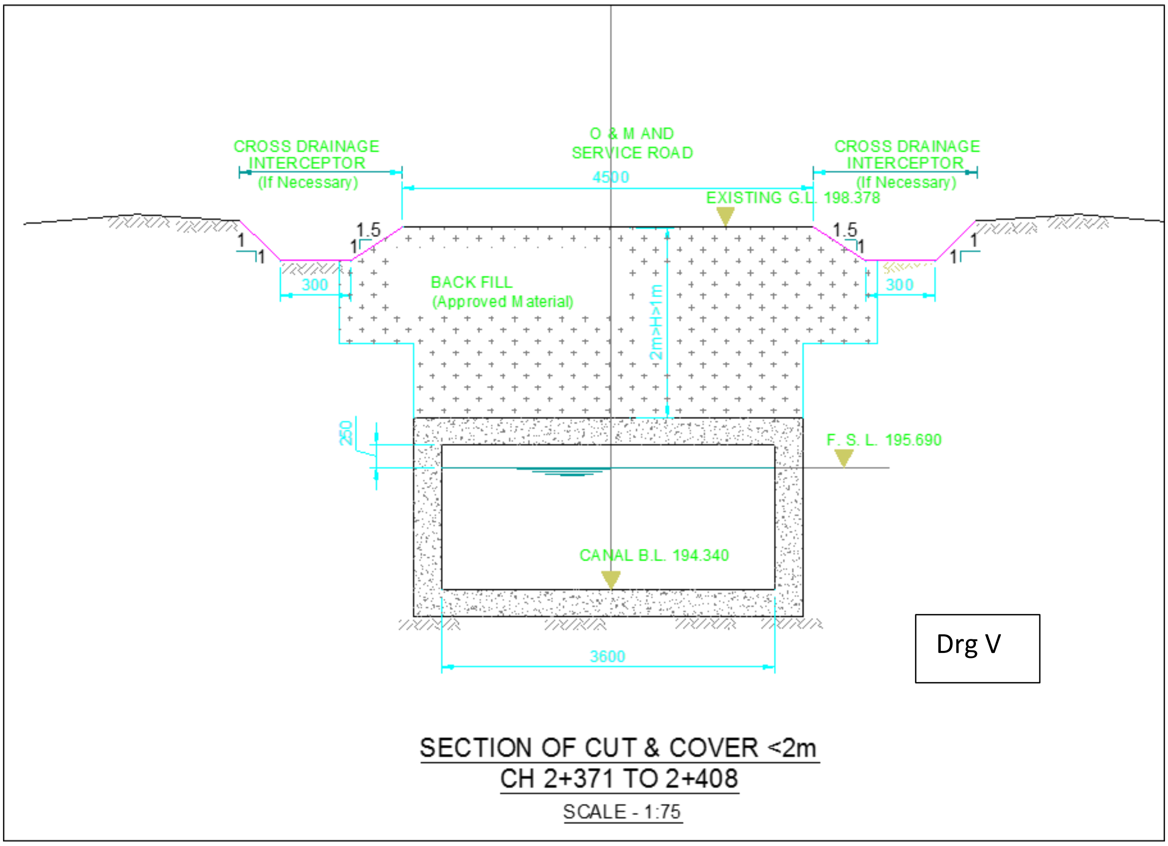
Drg II

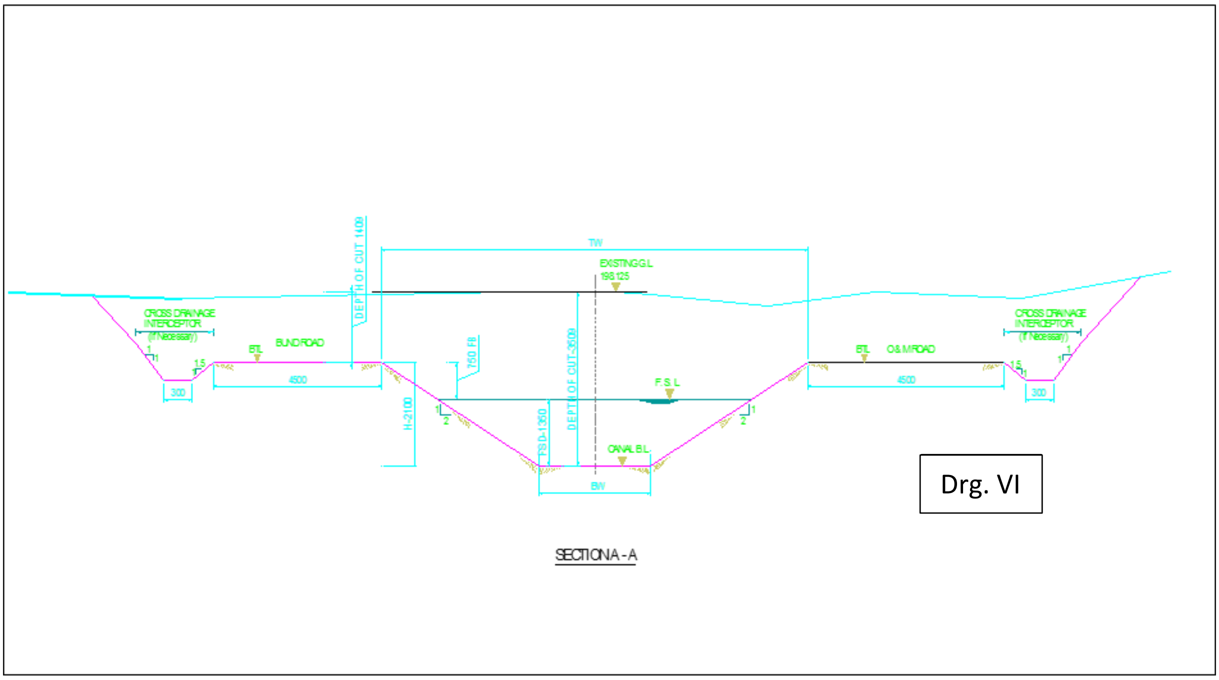


Drg III

CUT & COVER SECTION
(BETWEEN EXISTING HOUSES)


CROSS DRAINAGE
INTERCEPTOR
(If Necessary)
O & M AND
SERVICE ROAD
CROSS DRAINAGE
INTERCEPTOR
(If Necessary)
EXISTING G.L.
201.318
BACK FILL (Approved Material)
F. S. L 195.733
CANAL B.L. 194.383
Drg IV
SECTION OF CUT & COVER >2 m
CH 1+200 TO 1+523, CH 1+747 TO 2+371
SCALE - 1:75


CROSS DRAINAGE
INTERCEPTOR
(If Necessary)
O & M AND
SERVICE ROAD
4500
CROSS DRAINAGE
INTERCEPTOR
(If Necessary)
EXISTING G.L. 198.378
300
BACK FILL
(Approved Material)
2m>H>1m
300
250
F. S. L. 195.690
CANAL B.L. 194.340
3600
Drg V
SECTION OF CUT & COVER <2m
CH 2+371 TO 2+408
SCALE - 1:75



Cross Section of Earthen Canal

(Between Mahakirula and Mahakithula Reservoirs)

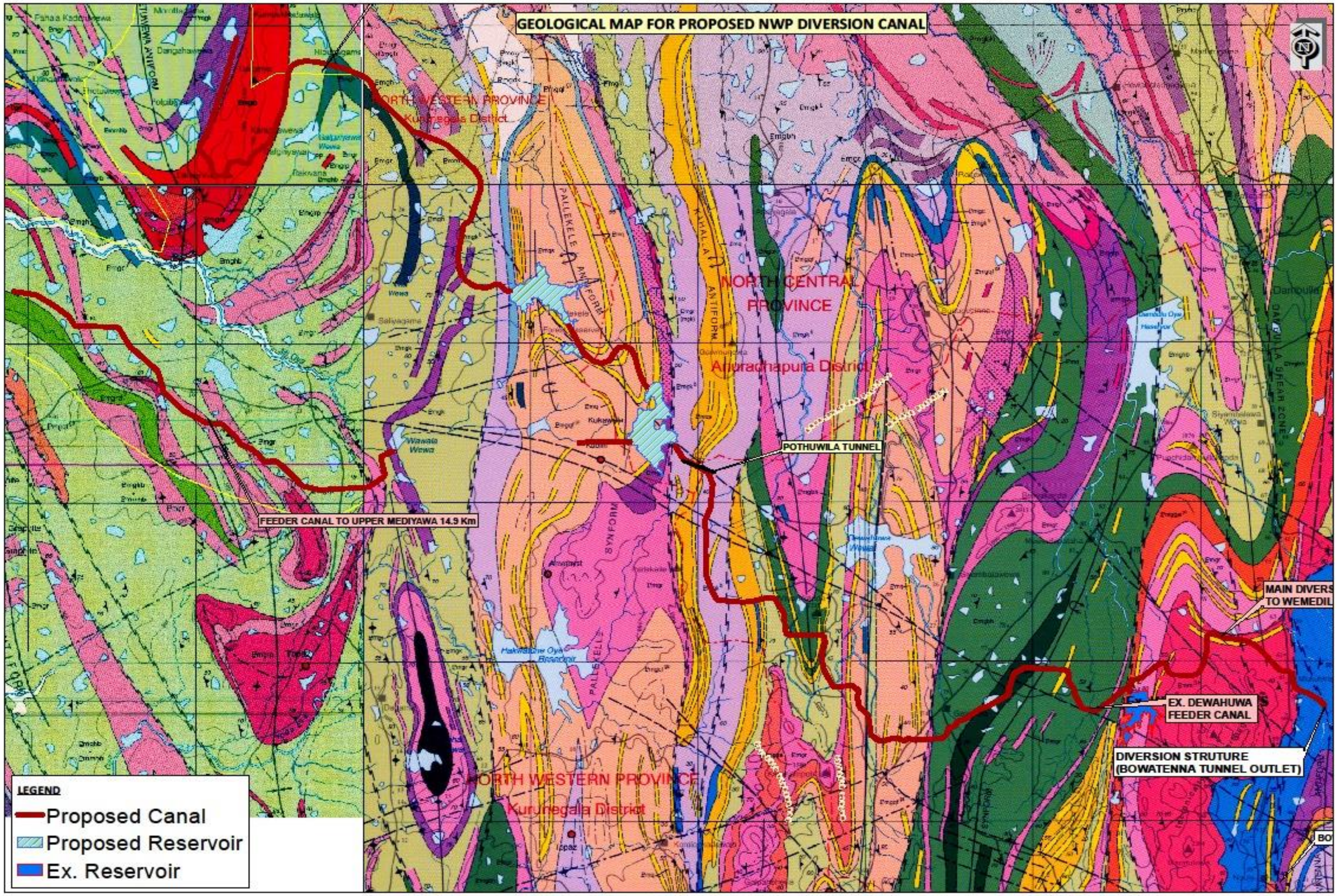
Note: Please refer the table below for usage of sections shown in Drg I to VI in different chainages of the canal.

Canal sections from Diversion weir at Dambulu Oya to Mahakirula Reservoir

Chainage (km+m)		Length (m)	Type of Structure / Canal Section	Drawing (see above)
From	To			
0+000	0+030	30.00	Main Diversion Structure across the Dambulu Oya & Intake Gate	
0+030	7+602	7572.00	Trapezoidal Concrete lining	Drg. II
7+602	7+738	136.00	Cut & Cover Section	Drg. V
7+738	7+855	117.00	Trapezoidal Concrete lining	Drg. II
7+855	7+881	26.00	Walamitiya Oya Aqueduct	
7+881	8+590	709.00	Trapezoidal Concrete lining	Drg. II
Wemedilla Crossing				
0+000	0+145	145.00	Existing Trapezoidal lining	
0+145	1+423	1,278.00	Trapezoidal Concrete lining	Drg. II
1+423	1+497	74.00	Malawa Oya Aqueduct	
1+497	5+250	3,753.00	Trapezoidal Concrete lining	Drg. II
5+250	6+200	950.00	Nabadagahawatte Level Crossing	
6+200	6+300	100.00	trapezoidal Concrete lining	Drg. II
6+300	6+340	40.00	Cut & Cover Section	Drg. V
6+340	6+680	340.00	Trapezoidal Concrete lining	Drg. II
6+680	6+790	110.00	Cut & Cover Section	Drg. V
6+790	6+920	130.00	trapezoidal Concrete lining	Drg. I
6+920	7+040	120.00	Cut & Cover Section	Drg. V
7+040	7+127	87.00	Trapezoidal Concrete lining	Drg. II
7+127	7+172	45.00	Cut & Cover Section	Drg. V
7+172	7+300	128.00	Trapezoidal Concrete lining	Drg. II
7+300	7+500	200.00	Cut & Cover Section	Drg. V
7+500	7+800	300.00	Trapezoidal Concrete lining	Drg. II
7+800	7+840	40.00	Syphon	
7+840	8+390	550.00	trapezoidal Concrete lining	Drg. II
8+390	8+600	210.00	Cut & Cover Section	Drg. V
8+600	8+800	200.00	trapezoidal Concrete lining	Drg. II
8+800	9+200	400.00	Cut & Cover Section	Drg. IV
9+200	9+770	570.00	trapezoidal Concrete lining	Drg. II
9+770	9+900	130.00	Syphon	

Chainage (km+m)		Length (m)	Type of Structure / Canal Section	Drawing (see above)
From	To			
9+900	12+165	2,265.00	trapezoidal Concrete lining	Drg. II
12+165	12+230	65.00	Syphon	
12+230	13+185	955.00	trapezoidal Concrete lining	Drg. II
13+185	13+195	10.00	Cut & Cover Section	Drg. V
13+195	13+390	195.00	trapezoidal Concrete lining	Drg. I
13+390	13+396	6.00	Cut & Cover Section	Drg. V
13+396	13+770	374.00	trapezoidal Concrete lining	Drg. II
13+770	14+140	370.00	Concrete Trough	
14+140	14+300	160.00	Nilagama Level Crossing	
14+300	22+529	8,229.00	trapezoidal Concrete lining	Drg. II
22+529	23+100	571.00	Tunnel	
23+100	23+642	542.00	trapezoidal Concrete lining	Drg. II
Mahakithula Reservoir				
0+000	0+040	40.0	Sluice - Saddle Dam - Mahakithula	
0+040	0+147	107.0	trapezoidal Earthen Canal	Drg. VI
0+147	0+226	78.5	Cut and Cover Section	Drg. V
0+226	0+351	125.0	trapezoidal Earthen Canal	Drg. VI
0+351	0+601	250.2	Cut and Cover Section	Drg. V
0+601	0+761	160.0	trapezoidal Earthen Canal	Drg. VI
0+761	1+523	762.3	Cut and Cover Section	Drg. V
1+523	1+700	177.0	trapezoidal Earthen Canal	Drg. VI
1+700	2+446	746.0	Cut and Cover Section	Drg. V
2+446	2+700	254.0	trapezoidal Earthen Canal	Drg. VI
2+700	2+977	277.0	Stream	
2+977	3+450	473.0	Level Crossing - Mahadambe Reservoir	
3+450	3+660	210.0	trapezoidal Earthen Canal - **Mahakirula Reservoir**	Drg. VI

Annexure VI-II **Geological Maps**




GEOLOGICAL MAP FOR PROPOSED NWP DIVERSION CANAL
PROTEROZOIC METAMORPHIC ROCKS (no stratigraphic order implied)
Lithologies principally (but not exclusively) of the Vijayan Complex
Microcline gneiss: fine-grained, quartz-rich, massive gneisses (alkali feldspar granite composition); with biotite only; characteristically with myrmekite textures
Granodioritic gneiss: massive to weakly layered rocks with quartz, plagioclase; biotite > hornblende
Lithologies principally (but not exclusively) of the Wanni Complex and associated Kadugannuwa Complex
Granite gneiss: massive leucocratic quartzo feldspathic gneisses, quartz >20%, few mafics
Pegmatitic granitoid gneiss: distinctive quartz-rich, leucocratic, white or pink, pegmatite-layered gneiss produced by deformation, usually ridge-forming
Hornblende-biotite gneiss: massive to compositionally layered grey gneiss with quartz >20% plagioclase and garnet; tonalite composition
Hornblende-biotite migmatite: compositionally layered grey gneiss typically with white pegmatoid leucosomes
Biotite-hornblende gneiss: medium to dark grey gneiss, plagioclase > K-feldspar; quartz <15%; quartz monzodiorite to leucodiorite composition
Biotite hornblende migmatites: medium to dark grey migmatite; plagioclase > K-feldspar; often white pegmatoid leucosomes; quartz <15%
Hornblende gneiss or amphibolite: mafic orthogneisses and schists, quartz generally <10% plagioclase; diorite to gabbro composition (may contain small amounts of garnet and clino- and orthopyroxene)
and other dense mafic orthogneisses, garnet often present
Lithologies principally (but not exclusively) of the Highland Complex
Quartzofeldspathic gneiss: leucocratic, gneiss weakly compositionally layered, granoblastic, orthogneisses
Quartzites: pure coarse-grained ridge-forming kaolinised feldspar or biotite
Impure quartzites and quartz schists: with interlayered with biotite-bearing quartz rich quartzofeldspathic gneisses
Garnetiferous quartzofeldspathic gneiss (formerly 'garnet granulite'): leucocratic quartz-feldspar gneiss with abundant pink garnets; residual deposits
Garnet-sillimanite-biotite gneiss + graphite: pelitic schist or gneiss
Garnet-sillimanite-biotite gneiss ± graphite formerly 'khondalite'
Tectonically layered charnockitised biotite-hornblende gneiss with thin quartzites
Marble, usually coarse-grained and dolomitic, locally high calcite marble present
Calc gneisses and / or granulites: calc silicate gneisses with very variable mineralogy
Cordierite gneiss: granoblastic, with cordierite + sillimanite, garnet usually present
Undifferentiated calc-gneisses: variable sequences of well layered gneisses with interlayers of biotite gneiss or quartzofeldspathic gneiss
Biotite gneiss: massive or compositionally layered, pale grey gneiss; contains quartz, feldspar and >10% biotite; generally composition, biotite rich (>20%) variants generally paragneisses
tectonically interlayered garnet-sillimanite-biotite paragneiss and biotite-hornblende (±) opx orthogneiss. Variably migmatised with abundant potash melts in paragneissic lithologies
Undifferentiated charnockitic biotite gneisses: extensive sequences of charnockite-looking grey gneisses usually lacking hypersthene, though commonly with boudinaged orthopyroxene-bearing mafic layers; but may include some paragneisses
chamockitised black & white layered (TTG) orthogneisses, mainly tonalite-quartzdiorite composition; charnockitic biotite-gneisses abundant with late monzogranitic pegmatite veins common
Charnockitic gneisses: restricted outcrops, often ridge-forming; typically coarse-grained with characteristic brown or green greasy in situ charnockites as well as partially retrogressed, bleached 'ex-charnockites', stipple indicates local charnockitisation
Undifferentiated paragneisses: well-layered, sillimanite, ± cordierite
Late stage intrusives (in general younger than 550 Ma)
Quartz-syenite pegmatite: very large (up to 30 cm), ovoid, microcline or perthite, with (except on intrusion margins) with hornblende and biotite and accessory zircon and apatite (formerly 'augen gneiss')
Pegmatites: simple quartz-feldspar pegmatites with magnetite and/or allanite
Serpentinite: pale green altered ultramafics (mainly dunite from east of Mahaweli river)
Vein quartz: usually transparent to milky, high-purity, massive to lenticular
EXPLANATION OF LINE AND STRUCTURAL SYMBOLS
boundary or contact
Geological boundary, between superficial
Geological boundary, concealed
(tick shows downthrow side)
Shear zone, inferred from air photographs (arrows denote shear sense where known)
Axial trace of antiform, and plunge
Axial trace of synform, and plunge
Overturned antiform
Overturned synform
to compositional layering)
230 / 15
Azimuth and plunge of lineation
Azimuth and plunge of minor fold
Plunge of minor synform
Structure, form or trend lines, from air photographs
Fault, fracture or major joint, from air photographs
Thrust or shear with thrust sense probable
Thrust inferred
Mineral occurrence
Extent of mineral resource, i.e. silica sand, principal gemming area, gravel (or limits of patchy gravel spread)
Mine, abandoned
NOTES ON MAP COMPILATION AND NOMENCLATURE
SHEET 01 OF 01

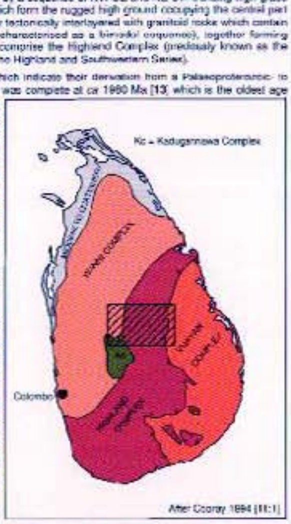
GEOLOGICAL MAP FOR PROPOSED NWP DIVERSION CANAL

GEOLOGICAL SETTING

Nine-tenths of the Island of Sri Lanka is underlain by Proterozoic gneisses, with Phanerozoic sediments being restricted to the coastal regions. Recent Nd model ages, high-precision U-Pb zircon ages [11:6,7,8] and new Rb-Sr age dates indicate that Sri Lanka's evolution during the Proterozoic was essentially by the tectonic assembly of three distinctive crustal units into one 'package' representing a small portion of the Gondwana supercontinent, probably lying adjacent to Madagascar, Mozambique and Antarctica (in their Neoproterozoic configuration).

The oldest rocks of the island are distinguished by a sequence of NW-SE and NE-SW trending high-grade metasediments and granulitic orthogneisses which form the rugged high ground occupying the central part of Sri Lanka. The metasediments are intimately tectonically interlayered with granitoid rocks which contain subordinate metabasic intrusives (chemically characterised as a bimodal sequence), together forming some 50 per cent of the sequences that now comprise the Highland Complex (previously known as the Highland Series, Central Granulite Belt, and/or the Highland and Southwestern Series).

These metasediments have Nd model ages which indicate their derivation from a Palaeoproterozoic- to Archean-age continental mass. Sedimentation was complete at ca 1960 Ma [13] which is the oldest age determination for rocks intrusive into the metasediments. The common occurrence of thick quartzites and carbonates (dolomitic marbles and calc-silicate gneisses) suggests a general correlation with other Mesoproterozoic shelf sequences. In the southwestern part of the Island the metasedimentary sequence is dominated by Al-rich (often cordierite-bearing) pelitic paragneisses [11:12], locally migmatitic, and also includes wollastonite-bearing calc-gneisses. This southwestern sequence may be either a facies variant of the main quartzite-carbonate sequences or part of another basin. Although the two lithological groups appear to be distinct and share few common lithologies, they have a similar structural and metamorphic history.



Structures within the ***Highland Complex*** are dominated by metre-scale layering with an internal fabric showing evidence of ductile deformation, including transposition of layering, coupled with extreme flattening and stretching [11:7][7:2,4,5]. The intense tectonic interlayering brings into contact adjacent lithologies that include both granulite-grade metasediments and charnockitic gneisses (many originally orthogneisses). At outcrop there is no indication of either the relative ages of the two lithologies or the original mechanism of intrusion of the orthogneisses. At least three major phases but probably up to six including minor phases of deformation are known [7:5].

This older, strongly tectonised, mixed ortho- and paragneissic granulite unit structurally overlies amphibolite-grade rocks of the ***Vijayan Complex*** (formerly the Eastern Vijayan) to the east and southeast [11:1]. Structures, metamorphic grades and P-T estimates [11:15], shear-sense indicators [7:4] and gravity data [12][7:6], together with the presence of large klippen (the latter at Buttala and Kataragama lying well to the southeast of the main outcrop), are interpreted by many workers to indicate that sub-horizontal thrusting is likely to have been responsible for the emplacement of the Highland Complex over the structurally lower Vijayan complex. The most abundant rock type in the Vijayan Complex is a hornblende biotite bearing sequence of granodioritic to granitic orthogneiss of I-type origin [7:9]. The presence of abundant, though minor, metabasic dykes representing dyke-swarms, and of positive Nd characteristics, show that rocks of the Vijayan Complex were derived from a typical LREE depleted mantle derived precursor, and that this tonalite-trondhjemite-granodiorite sequence is probably similar to present-day igneous complexes at the base of volcanic arcs.

The actual contact between these two complexes is difficult to locate precisely, but there is much evidence for a tectonic thrust-contact between the two units. Kinematic indicators, principally stretching lineations, give evidence for movement parallel to the zone as well as orthogonal to it. Locally the zone is marked by discontinuous slivers of serpentinised rocks in some areas with elevated levels of Cr and Ni and possibly hosting gold and PGE.

The relationship of the structurally highest complex, the ***Wanni Complex*** (formerly the West Vijayan), to the Highland Complex, is equally difficult to determine at the present time. The Wanni Complex is characterised by thick (though probably tectonically repeated) sequences of orthogneisses comprising amphibolite-grade migmatitic granitic and granodioritic gneisses and, at lower structural levels, dioritic orthogneisses with minor gabbros. In the northeast, granulite-grade variants are common (the informally named Vavuniya granulites, which include both charnockitic rocks and minor granulite grade metasediments). In the westernmost part of the Wanni Complex, common late-stage events include the pervasive introduction of pink potash feldspar rich crustal melts and syenites, locally occurring as discrete syn- to post-tectonic bodies. The structurally lowest levels of the Wanni Complex — those juxtaposed with the Highland Complex — are considerably more mafic and lithologically similar to gneisses described below (the Kadugannawa Complex). It is possible that there is an intrusive relationship between these mafic orthogneisses and the migmatitic paragneisses of the structurally uppermost Highland Complex, though the zone is extensively modified by late-stage tectonism.

The Wanni Complex sensu lato tends to be poorly exposed but is potentially of economic importance due to the large number of undersaturated peralkaline and alkaline rocks of different ages within it. At least some of these must represent late-stage continental extensional-type magmatism linked to uplift and cooling. Locally, rocks of unusual compositions are present. These include the carbonatite at Eppawala with economic quantities of phosphate in the form of very large apatite crystals (up to a metre long). Ages for the Wanni Complex are ca 1000 Ma, the maximum age of sedimentation, with a cluster of Neoproterozoic intrusive ages for orthogneisses around 770 Ma [11:8].

The smallest complex, the ***Kadugannawa Complex***, comprises supracrustals and hornblende-biotite gneisses of calc-alkaline affinity, principally tonalite and granodiorite. Minor layered mafic and ultramafic rocks are more tholeiitic. This Complex has young Nd model ages of ca 1100 Ma, with emplacement ages of ca 900-1000 Ma [11:6,7,8]. The Kadugannawa Complex shares the latter stages of the structural history of the Highland Complex, with these competent lithologies being deformed into distinctive NNW-SSE trending 'boat-shaped' doubly plunging synforms [4][7:5]. The present mapping demonstrates that these more mafic lithologies are not restricted to the synforms, but extend to the northwest and northeast forming the structurally lower levels of the Wanni Complex.

Principal structural and metamorphic events include an early phase of intense deformation at medium and lower crustal levels [9] producing the strong transposition layering so typical of these granulites. The widespread nature and intensity of this deformation make it likely that as yet unrecognised very large scale repetitions of crustal slices are present within the three most intimately tectonically juxtaposed complexes, the Highland, the Kadugannawa and the Wanni. Despite the wide range of Nd model ages in the various crustal sub-provinces, the most important period of regional granulite metamorphism is indicated to have occurred late in the evolutionary history of the Island (in the Neoproterozoic), between 610 and 560 Ma [11:6][13], and is accompanied by Pb loss and new zircon growth. Available evidence shows that this high-grade event predates the south-to-southeastern apparent overthrusting of the Vijayan Complex by the Highland Complex. Subsequent events include E-W shortening and linked NNW-SSE to N-S shearing, which was in general responsible for widespread retrogression to amphibolite grade, and produced the characteristic fold pattern presently recognisable on air photographs and satellite imagery. Variations in fold type and amplitude are primarily a reflection of the contrast in competence between the lithological packages in the discrete Complexes and, in particular, between the Highland and Kadugannawa Complexes [7:5]. The long time gap between protolith intrusive ages and the age of granulite-grade metamorphism is not well explained at present and is at variance with events known from other, possibly contiguous, crustal fragments of mutually similar ages (cf Madagascar, Mozambique). An indication of the polymetamorphic evolution of the rocks is the presence of regional, though more minor, Pb loss at about 1100 Ma, and again at the start of high-grade metamorphism at 600 Ma [13].

This regional granulite terrain attained maximum temperatures ranging from 700° to over 900°. Palaeopressures vary systematically from ca 4 Kb in the west, to >10 Kb at the southeastern margin of the Highland Complex [11:14,15,16] and in the discrete thrust klippen.

Garnet containing kyanite which encloses sillimanite needles, and other relicts of both sillimanite and staurolite predating kyanite, indicate a prolonged history for high-grade metamorphism [7:4,5][11:2,13,14]. Granulite grade was attained in at least two of the crustal packages prior to the well demonstrated clockwise P-T-t paths which are recorded in the southern and southwestern parts of the Island. If kyanite is the mineralogical evidence of a crustal doubling event, then the age of such an event, and of the earlier high-grade metamorphic episodes, are still not known. Areas of high palaeopressures are associated with gem corundum mineralisation (sapphire, ruby). Subsequent to the 550 Ma event which involved major lead loss, and appears to be the start of retrogression due to fluids passing through the crust, many of the mineralogical sequences describe a near-isobaric cooling path, which is later modified by isothermal decompression reactions. Uplift and cooling continue until about 450 Ma (the limit of argon loss on hornblende). This period of decompression and uplift is important in the generation of economic mineral deposits in Sri Lanka. The early stages are marked by spectacular, well-studied examples of in situ charnockitisation [8][9] often linked to ductile shearing at all scales. This event is dated younger than 550 Ma. Many of the graphite veins are emplaced by hydraulic fracturing into favourable dilational structural zones and date to these latter stages of uplift and cooling, where they are associated with fluids rich in Na, CO_2, Cl and F amongst others, and locally overprint decompression coronas on garnet.

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Other potentially economic occurrences are of banded magnetite ore (± apatite, ± barytes) at Panirendawa and Wilgadera, calc-silicate gneisses with magnetite and, locally, copper at Seruwila. Abundant late-stage pegmatites (including some rapakivi-like syenitic rocks and other graphic-textured granites) contain magnetite and allanite. Other minor intrusives of probable similar age and structural setting contain potentially economic deposits of feldspar, mica (primarily muscovite and phlogopite), topaz and high-purity vein quartz, amongst other minerals. Extensive NW-SE trending dolerite dykes, some dated to 150 Ma, extend across the Island but are most visible in the eastern part where they cut the Vijayan Complex. They apparently intrude reactivated Late Proterozoic/Early Phanerozoic fracture systems which had been linked to post-Proterozoic uplift. 26

Offshore of the northwest coast of Sri Lanka there are assumed to be present, at depth, rocks of undoubted Jurassic age, similar those found locally onshore in fault-bounded basins — the '***Tabbowa beds***' (generally arkosic sandstones) and the '***Andigama beds***' (arkosic sandstones and carbonaceous shales with thin coals). Rocks of both Jurassic and Cretaceous age (with hydrocarbon potential) are known from drill-cores just offshore in the Palk (Mannar) Straits between Sri Lanka and India, but do not crop out on the Island itself. In the north and northwest the Jurassic sediments are unconformably overlain by an extensive sequence of sandstones and limestones of Miocene age (important regional aquifers), the ***Mannar Sandstone*** and the ***Vanathavillu Limestone*** (formerly the Jaffna Limestone) the latter being a major source of raw material for cement manufacture. On the southeast coast an undated sequence of fossiliferous shales and limestones overlain by coarse continental clastics ('red beds') comprises the '***Minihagalkande beds***'. 25

A thick and varied sequence of Quaternary deposits mantle the broad, low-lying coastal plains around much of the perimeter of the Island. Some Late Pleistocene deposits are related to worldwide changes in ocean base-level, and the characteristic morphology of the coast is produced by very active longshore drift from south to north, coupled with very low tide ranges. Onshore winds during the two monsoons (one from the northeast and one from the southwest) redistribute sand inland as large dunes, a climatic pattern that is at least as old as the Late Pleistocene. Beach sands and dune sands, contain potentially economic deposits of mineral sands, in which the dominant minerals are ilmenite, rutile, zircon, magnetite, garnet and monazite. The broad spread of reddened paleo-beach and -dune sands lying at 0-60 m above MSL, and extending across the lowlying northern third of the Island, acts as an important secondary host providing heavy minerals for further concentration on the present day beaches of the northeast and northwest coasts, and may itself have the potential as a very large-scale mineral sand resource.

Sri Lanka has abundant clay deposits. Those derived primarily from feldspar-rich gneisses consist of the full range from kaolin-rich ceramic clays to refractory ball clays, the clay mineral type being determined by the amount and distribution of rainfall. Clay for bricks and tiles is obtained from recent floodplain deposits associated with the principal rivers of the western part of the Island. Several hot springs are present (with subsurface temperatures of about 200°C), mainly located close to the structural contact between the Highland and the Vijayan Complexes, a zone which also contains high levels of fluorine in the groundwater. 25
On the south coast, in situ and reworked coral deposits, together with shell beds presently situated some metres above mean sea level, testify to at least three minor sea-level rises in the last 6,000 years BP. Offshore carbonate-cemented sands (beachrock) are evidence of lower levels (down to -24 m), probably during or after the Late Pleistocene.

SELECTED REFERENCES

These marginal notes include a brief list of journal publications and volumes covering important, recent and accessible work on Sri Lankan geology. Papers within volumes are cited as in this example: [11:6] refers to Milisenda et al. 1994, i.e. the sixth paper in the volume *Precambrian Research* **66** of 1994, which is listed as no. [11] below.

[1] Vitanage, P.W. 1960. Geology of the country around Polonnaruwa. *Cey. Geol. Surv. (Dept Mineral.) Mem.* **1**.

[2] Cooray, P.G. 1961. Geology of the country around Rangala. *Cey. Geol. Surv. (Dept Mineral.) Mem.* **2**.

[3] Berger, A.R. and Jayasinghe, N.R. 1976. Precambrian structures and geochronology in the Highland Series of Sri Lanka. *Precamb. Res.* **3**: 559-576.

[4] Almond, D.C. 1991. Arena Gneiss and Kandy Gneiss: a proposed subdivision of the Highland Series around Kandy, and its significance. *J. Geol. Soc. Sri Lanka* **3**: 41-50.

[5] Burton, K.W. and O'Nions, R.K. 1990. The time-scale and mechanism of granulite formation at Kurunegala, Sri Lanka. *Contrib. Mineral. Petrol.* **106**: 66-89.

[6] Hansen, E.C., Janardhan, A.S., Newton, R.C., Prame, W.K.B.N. and Ravindra Kumar, G.R. 1987. Arrested charnockite formation in southern India and Sri Lanka. *Contrib. Mineral. Petrol.* **96**: 225-244.

[7] Kröner, A. (ed.). The crystalline crust of Sri Lanka. Part I. Summary of Research of the German-Sri Lankan Consortium. *Sri Lanka Geol. Surv. Dept Prof. Pap.* **5**. [19 papers with refs].

[8] Voll, G. and Kleinschrodt, R. 1991b (eds). The crystalline crust of Sri Lanka. Part II: Excursion guide. *Sri Lanka Geol. Surv. Dept Prof. Pap.* **6**.

[9] Harris, N.B.W. and Jackson, D.H. 1991. Incipient granulite formation of Late Archaean and Pan-African age in South India and Sri Lanka. *J. Geol. Soc. Sri Lanka* **3**: 56-61.

[10] Santosh, M. and Radhika, U.P. 1994. Carbonic metasomatism and charnockitic alteration. *J. Geol. Soc. India* **45**: 101-100.

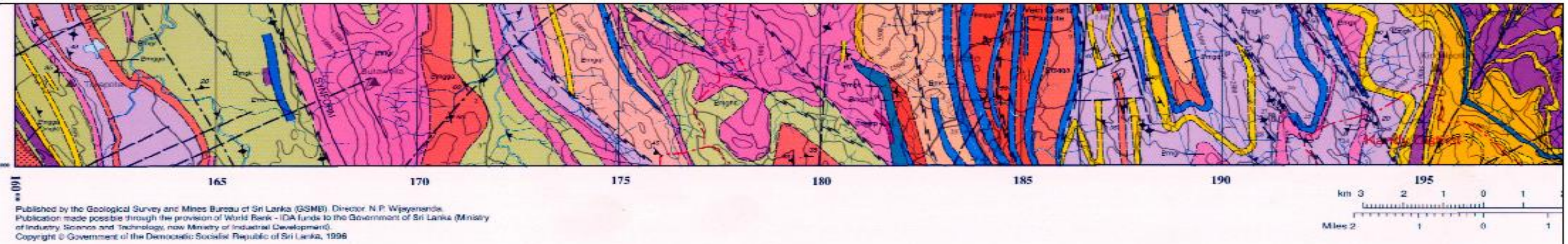
[11] Raith, M. and Hoernes, S. 1994 (eds). Tectonic, metamorphic and isotopic evolution of deep crustal rocks, with special emphasis on Sri Lanka. *Precamb. Res. Special Issue* **66**. (Preface and 20 papers with refs).

[12] Hatherton, T., Pattiaratchchi, D.B and Ranasinghe, V.V.C. 1975. Gravity Map of Sri Lanka, 1:1,000,000. *Sri Lanka Geol. Surv. Dept Prof. Pap.* **3**.

[13] Baur, N., Kröner, A., Todt, W., Liew, T.C. and Hofmann, A.W. 1991. U-Pb isotopic systematics of zircons from prograde and retrograde transition zones in high grade orthogneisses in Sri Lanka. *J. Geol.* **99**: 527-545.

01 OF 03

GEOLOGICAL MAP FOR PROPOSED NWP DIVERSION CANAL



Published by the Geological Survey and Mines Bureau of Sri Lanka (GSMB). Director N.P. Wijayananda.
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BRIEF DESCRIPTION OF THE GEOLOGY OF THE DAMBULLA-PALLEGAMA AREA

This area comprises high grade, lithologically and isotopically distinct, Proterozoic metamorphic rocks of three crustal complexes juxtaposed and metamorphosed in the Neoproterozoic/early Phanerozoic. From west to east these are: the Wanni and associated complexes; the Highland Complex; and the Vijayan Complex. Approximately half the map area (that is, the eastern part) is underlain by rocks of the Highland Complex, with the Wanni Complex present in the western part, and the Vijayan only in the extreme eastern fifth of the map area.

Geography

The area lies virtually at the centre of Sri Lanka and forms part of the strongly dissected northern 'spine' of the central highlands. The topography is rugged, and rises to over 2500 m in the Knuckles range in the southern part of the map area. The area lies across the central drainage divide separating the Kala Oya, Mi Oya and Deduru Oya drainage basins in the northwest from the broad, lowlying Mahaweli basin which occupies the eastern half of the map area.

Rain falls all year round in this, the 'Intermediate' zone, the eastern part showing stronger seasonality of rainfall from both monsoons. The northern part receives between 1500 and 2000 mm of rain a year, but the southeastern third receives more than 2500 mm with isolated peaks in the Knuckles range locally receiving more than 4000 mm a year. The vegetation reflects the general rainfall pattern. Extensive forest is limited to the eastern part of the area, with moist semi-evergreen forest dominating in the south and in the Knuckles range, and moist deciduous (secondary) forest in the north. Paddy fields are cultivated within the irrigated lands of the Mahaweli Project in the southeast. In the western half of the area there are scattered patches of mainly moist deciduous forest in the deeply dissected hill country; and coconut, rubber and garden crops (cardamom and pepper) are grown. Extensive tea plantations occur in the south-central part of the area (the northern slopes of the Knuckles).

Population density is higher in the western part (200-400 people per km²), but reduces rapidly in the drier Mahaweli basin (<200 and often <100 per km²) to the east. The main Kurunegala-Dambulla road and the Kandy-Matale-Dambulla-Anuradhapura road provide access to the western half; access to the eastern part is by minor roads through Matale and Rattota towards Pallegama, or from Naula to Elahera and onwards to Giritale and Polonnaruwa. Elahera and Nalanda are the important archaeological sites within the map area.

Proterozoic metamorphic rocks

The oldest rocks in the area are the mainly paragneissic lithologies of the Highland Complex that crop out over much of the eastern part of the map sheet [1]. Here a sequence of paragneisses — dolomitic marbles, quartzites and quartz-schists, biotite-bearing quartzofeldspathic rocks, and garnet-biotite-sillimanite-graphite gneisses (formerly termed 'khondalites') — is interlayered with each other and with more massive charnockitic gneisses probably of both para- and orthogneissic origin. 'Charnockitisation' is indicated to be of more than one age. These high-grade rocks have Nd model ages between 2.0-2.8 Ga for their protoliths, and attained metamorphic temperatures approaching 900°C much later, between 610 and 560 Ma [7:13,18].

Lithological variation coupled with tropical weathering has given rise to a strongly featured topography of ridges and valleys, generally striking N-S and often highlighting map-scale folds within the metasediments. Ridge-forming rocks — those used particularly to trace the regional structures — depend on the percentage of quartz, with quartzites, quartz-rich layer-parallel pegmatites and quartz-rich granitoids being the most resistant. The least resistant rocks are the dolomitic marbles, garnetiferous biotite-sillimanite gneisses, and hornblende-bearing gneisses, which form negative features and are usually very poorly exposed in the valley bottoms. Lithological layering is everywhere parallel to foliation, with abundant evidence of extreme flattening and stretching of individual compositional layers. Tight to isoclinal intrafolial folds are common, and the whole sequence of these gneisses has a strong easterly vergence and westerly dip. All indications are that, as elsewhere in Sri Lanka [3][7:2,4,5][11:2], the 'stratigraphy' is tectonic, being produced primarily during D_1 and D_2 deformation. A uniform and powerful sub-horizontal stretching lineation is defined by flattened quartz ribbons, mafic mineral aggregates and small fold-hinges.

The map-scale outcrop pattern strongly supports the hypothesis that locally (and perhaps regionally) the marbles and calc-silicates act as weak zones (possibly even detachment zones [4]) focusing ductile deformation and producing large-scale folds of the intervening lithologies. There is a remarkable continuity of lithological units along strike [1], e.g. the Sudukande quartzite ridges. Along strike, north of the Anuradhapura-Polonnaruwa map area, fold closures indicate repetition of Highland Complex rocks by isoclinal folding, with very thin limbs apparently continuous for up to 100 km. These limbs outline the major folds and structures of the pervasive D_2 compositional layering which can be traced far beyond this map sheet. Shear sense indicators are poor, suggesting that the rocks behaved as a Newtonian material. Lithological repetitions are most probably present, with duplication of units along thrusts or shears propagated in the low-strength marbles [4].

This evidence of extreme ductility indicating a middle to lower crustal environment is confirmed from geothermometry and geobarometry, which show that peak metamorphic conditions were in the range of 800-900°C [7:18], with pressures locally in excess of 9 Kb [7:14,15] between ca 600-560 Ma.

The eastern margin of the Highland Complex rocks comprises black-and-white layered charnockitic gneisses and charnockitic biotite-hornblende gneisses, with boudinaged mafic layers and pods here interpreted as dykes. These sequences of tonalite-trondhjemite-granodiorite orthogneisses give a U-Pb on zircon age for emplacement of 670 Ma, again with Pb loss at 550 Ma. Structurally beneath these orthogneisses is a poorly exposed, flat-lying, easterly-verging sequence of impure marbles (both calcite- and dolomite-rich), calc-gneisses, and coarse skarn-like diopsidic rocks, all interlayered with flaggy, tectonised, biotite-bearing quartzofeldspathic gneisses. These are assumed to be in tectonic contact with the structurally lower, isotopically younger and lower-grade (amphibolitic) rocks of the Vijayan Complex, which are found only along the eastern margins of the map sheet.

The gneisses of the Highland Complex which in general trend NNE-SSW are folded into an antiform-synformal pair of large-amplitude folds, the Talagoda antiform and Elahera synform, with upright N-S trending axes. This repeats a conspicuous marble horizon which is traceable southwards from Minneriya in the north (beyond the map sheet), which is likely to act as a weak zone, possibly of detachment. A large gemming area is located along the Amban Ganga and its tributaries where it cuts this marble. Further to the east of the Elahera synform and structurally lower, are two N-S oriented ridges which are continuous with the Sudukande ridges from the Anuradhapura-Polonnaruwa map area. The latter are N-S trending and show none of the large-amplitude folding present to the west. In the upper structural levels of the Highland Complex two other marbles, the uppermost being the thickest and most extensive, both continuous from near Habarana in the north, sweep round to trend almost E-W and broaden their outcrop just south of Kandalama tank, extending southwards to floor the complex strike valley just east of Naula and Nalanda. Here the outcrop of the marbles outlines a tight antiform-synform pair (Bowatenna antiform, Ambana synform) which is strongly sheared. Widely dispersed in the marble matrix are numerous angular tectonic fragments mainly of an iron-rich biotite gneiss. As in the map area to the north, these marbles act as weak zones of extreme ductility, probably thrusts or shears with a thrust sense.

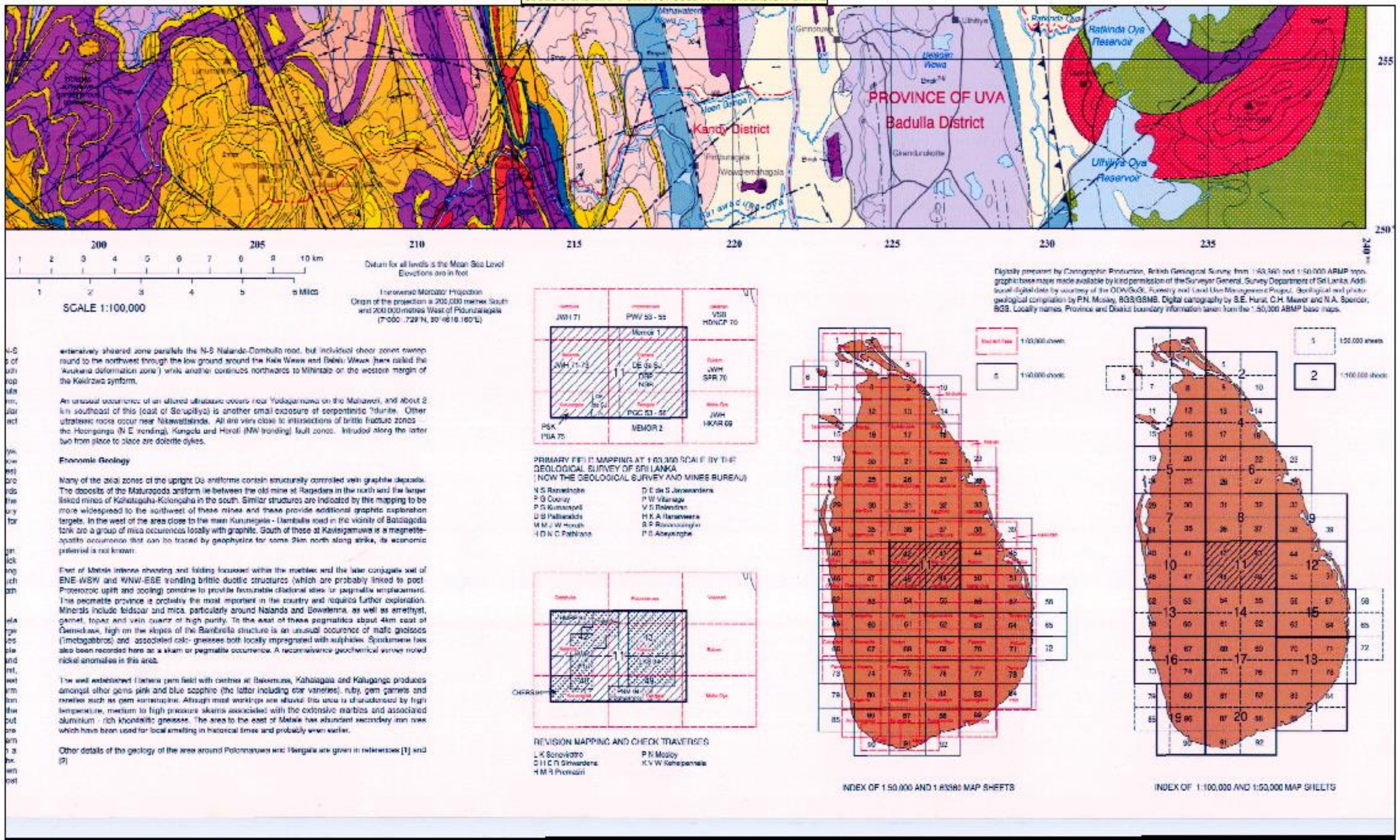
Structurally immediately above these marbles rise the steep escarpments at Tittawelgolla, Menikdeniya, Kadigala and Nalanda formed by the extension of the Dambulla-Habarana gneisses. These scarps show a complex mixture of migmatised paragneisses (predominantly garnetiferous biotite-sillimanite gneisses) together with tonalitic and dioritic orthogneisses with large boudinaged metagabbroic intrusives, and are lithologically identical to the sequence exposed around Kandalama tank, through Sigiriya and northwards to Habarana. They mark the transition zone between the structurally lower Highland Complex and the higher Wanni Complex. Field relationships plus single-zircon evaporation ages detail a complex history involving at least two phases of deformation and five phases of intrusion between ca 800 and 550 Ma for the rocks of this zone [11:2].

Predominantly paragneissic sequences lie west of this zone and extend close to the western map margin. Along the western map boundary and extending into the Battulu Oya-Kurunegala map area, is a thick sequence (probably tectonically repeated) of more competent orthogneisses which are continuous along strike with the mafic gneisses in the synforms of the Kadugannawa Complex. These gneisses show much broader complex folds which appear to include refolded folds (folds of D_2 axes) and large-scale sheath folds in the adjacent map sheet.

Structurally above the transitional Dambulla-Habarana gneisses lies the large Yattawatta or Galewela synform [7:5], 6.5 km wide and more than 25 km from south to north — typical of the scale of the large folds in the western part of the map area. The structurally lowest part of the synform comprises paragneisses (garnetiferous biotite gneisses; cordierite gneisses; and a thick sequence of multiple quartzites — three or four purer, ridge-forming quartzites in a sequence of quartz schists and quartzofeldspathic biotite gneisses). In the core of the synform, underlain by a distinctive pink granite unit, is a sequence of mafic gneisses with at least one coarse grained metagabbroic layer [7:5]. To the west and parallel to the synform is a complementary tight antiform-synform pair [7:5] (the Maturagoda antiform and Dodangaslanda synform). These are very tight structures extending northwards to a fold culmination close to the edge of the map area at Benawekanda and Elawewa. Other upright folds to the west (e.g. the Pallekelle antiform, the Kahalla antiform) are often overturned to the east, with reduced or sheared out synforms, showing that these are probably repeated by shears or thrusts, some localised in the more ductile calc-gneisses, with other ductile zones apparently extensively charnockitised. The outcrop pattern of these large N-S trending folds indicates that many of the limbs are thinned and folded, many with a dextral shear sense. Limited field checks confirm high-strain shear fabrics within the thinned fold limbs. Although these upright folds comprise similar lithologies to the Highland Complex, their ages are unknown and they could be correlated either with the Highland Complex or the Wanni Complex. The most

SHEET 02 OF 03

GEOLOGICAL MAP FOR PROPOSED NWP DIVERSION CANAL



extensively sheared zone parallels the N-S Nalanda-Dambulla road, but individual shear zones sweep round to the northwest through the low ground around the Kala Wewa and Balalu Wewa (here called the 'Avukana deformation zone') while another continues northwards to Mihintale on the western margin of the Kekirawa synform.

An unusual occurrence of an altered ultrabasic occurs near Yodagannawa on the Mahaweli, and about 2 km southeast of this (east of Serupitiya) is another small exposure of serpentinitic ?dunite. Other ultrabasic rocks occur near Nikawattalanda. All are very close to intersections of brittle fracture zones — the Hoorganga (N E trending), Kangala and Heradi (NW trending) fault zones. Intruded along the latter two from place to place are dolerite dykes.

Economic Geology

Many of the axial zones of the upright D3 antiforms contain structurally controlled vein graphite deposits. The deposits of the Maturagoda antiform lie between the old mine at Ragedara in the north and the larger linked mines of Kahatagaha-Kolongaha in the south. Similar structures are indicated by this mapping to be more widespread to the northwest of these mines and these provide additional graphite exploration targets. In the west of the area close to the main Kurunegala - Dambulla road in the vicinity of Batalagoda tank are a group of mica occurrences locally with graphite. South of these at Kavisigamuwa is a magnetite-apatite occurrence that can be traced by geophysics for some 2km north along strike, its economic potential is not known.

East of Matale intense shearing and folding focussed within the marbles and the later conjugate set of ENE-WSW and WNW-ESE trending brittle ductile structures (which are probably linked to post Proterozoic uplift and cooling) combine to provide favourable dilational sites for pegmatite emplacement. This pegmatite province is probably the most important in the country and requires further exploration. Minerals include feldspar and mica, particularly around Nalanda and Dewahuwa, as well as amethyst, garnet, topaz and vein quartz of high purity. To the east of these pegmatites about 4km east of Gammaduwa, high on the slopes of the Bambrella structure is an unusual occurrence of mafic gneisses (?metagabbros) and associated calc- gneisses both locally impregnated with sulphides. Spodumene has also been recorded here as a skarn or pegmatite occurrence. A reconnaissance geochemical survey noted nickel anomalies in this area.

The well established Elahera gem field with centres at Bakamuna, Kahalagala and Kalugange produces amongst other gems pink and blue sapphire (the latter including star varieties), ruby, gem garnets and rarities such as gem kornerupine. Although most workings are alluvial this area is characterised by high temperature, medium to high pressure skarns associated with the extensive marbles and associated aluminium - rich khondalitic gneisses. The area to the east of Matale has abundant secondary iron ores which have been used for local smelting in historical times and probably even earlier.

Other details of the geology of the area around Polonnaruwa and Hengala are given in references [1] and [2]

SHEET 03 OF 03

Annex VI - III

Photographs of workshops held for people who will be displaced by the construction of the canal

i. Workshop in Pahala Bambawa GN Division in Galewela DS Division

ii. Workshop in Welamitiyawa GN Division in Dambulla DS Division

.Workshop in Lenadora South GN Division in Dambulla DS Division .iii

Bamunugama GN Workshop in Ihalagama, Pahalagama, Konwewa, Yaddigama and .iv
Divisions in Mahawa DS Division

v. Workshop in Amunukole and Hathigamuwa GN Divisions in Polpithigama DS Dvision

Annexure VI – IV Archaeological Assessment

Approval letter for NWP Canal project issued by Director General Archaeology.

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தொல்லியல் திணைக்களம்

DEPARTMENT OF ARCHAEOLOGY

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இலங்கை சனநாயக சோசலிசக் குடியரசு

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Sir Marcus Fernando Mawatha, Colombo 7.

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<u>මී ඔය හක්වටුනා ඔය ගංගා දෝණි වලට මහවැලි ජලය හැරවීමේ ව්‍යාපෘතියේ පුරාවිද්‍යා බලපෑම් ඇගයීම පරීක්ෂණය සම්බන්ධවයි.</u>

ඉහත කරුණ සම්බන්ධයෙන් ඔබ විසින් ඉදිරිපත් කරන ලද 2012.01.20 දිනැති ලිපියට හා සබැඳේ.

02. මී ඔය හක්වටුනා ඔය ගංගා දෝණි වලට මහවැලි ජලය හැරවීමේ ව්‍යාපෘතියේ පුරාවිද්‍යා බලපෑම් ඇගයීම [illegible] (ඔබ වෙත [illegible] දැනුම් දී ඇත)

03. [illegible] N11/4/1/2/7/17 II හා 2013.06.10 දිනැති ලිපියෙන් දන්වා ඇත. ඒ අනුව අදාළ ව්‍යාපෘතිය සඳහා අනුමැතිය [illegible] දන්වා සිටිමි.

කොන්දේසි :-

I. අදාළ ව්‍යාපෘතිය ආරම්භයේ දී පුරාවිද්‍යා අධ්‍යක්ෂ ජනරාල් දැනුවත් කිරීම කළ යුතුය.

II. ව්‍යාපෘතිය ක්‍රියාත්මක කිරීමේ දී යම් පුරා සාධකයක් හමුවුවහොත් නොපමාව ඒ පිළිබඳව පුරාවිද්‍යා අධ්‍යක්ෂ ජනරාල් හෝ සහකාර අධ්‍යක්ෂ (ප්‍රාදේශීය) දැනුවත් කළ යුතුය.

III. මෙම දෙපාර්තමේන්තුවේ නිලධාරීන්ට [illegible] හැකියාව තිබිය යුතුය.

IV. අදාළ ස්ථානයේ [illegible] ව්‍යාපෘති ක්‍රියාත්මක නොකළ යුතුය.

Mr. Sunil [illegible] F.[illegible] 8/19

ආචාර්ය සෙනරත් දිසානායක
පුරාවිද්‍යා අධ්‍යක්ෂ ජනරාල්.

පිටපත් :

01.	ප්‍රාදේශීය ලේකම්, ප්‍රාදේශීය ලේකම් කාර්යාලය, [illegible]	- දැන ගැනීම සඳහා
02.	ප්‍රාදේශීය ලේකම්, ප්‍රාදේශීය ලේකම් කාර්යාලය, [illegible]	- දැන ගැනීම සඳහා
03.	ප්‍රාදේශීය ලේකම්, ප්‍රාදේශීය ලේකම් කාර්යාලය, [illegible]	- දැන ගැනීම සඳහා
04.	ප්‍රාදේශීය ලේකම්, ප්‍රාදේශීය ලේකම් කාර්යාලය, [illegible]	- දැන ගැනීම සඳහා
05.	ප්‍රාදේශීය ලේකම්, ප්‍රාදේශීය ලේකම් කාර්යාලය, [illegible]	- දැන ගැනීම සඳහා
06.	ප්‍රාදේශීය ලේකම්, ප්‍රාදේශීය ලේකම් කාර්යාලය, [illegible]	- දැන ගැනීම සඳහා
07.	ප්‍රාදේශීය ලේකම්, ප්‍රාදේශීය ලේකම් කාර්යාලය, [illegible]	- දැන ගැනීම සඳහා
08.	සහකාර අධ්‍යක්ෂ (වයඹ)	- දැන ගැනීම සඳහා

[illegible] Numbers 011-2692840 / 011-2592841
Police Unit – Prevention of Destruction and Theft of Antiquities
General 011-2694727
Hot Line 011-7 222 333

ARCHAEOLOGICAL ASSESSMENT OF NWP CANAL PROJECT FOR ENVIRONMENTAL IMPACT ASSESSMENT

1. OBJECTIVES OF THE ARCHAEOLOGICAL STUDY

According to the statues of the country Environmental Impact Assessment (EIA) survey to be carried out to assess the consequences upon the antiquarian, historical or archaeological aspects or value of a land to be developed or on any antiquities upon such land. Since the proposed project is to carryout a multipurpose project aimed to construct two dams, two reservoirs, a hydropower plant and to irrigate new land, areas affected by the entire project to be investigated in order to assess the impact that will be created on the antiquarian, historical or archaeological aspects or value of a land to be developed or on any antiquities upon such land. Therefore the responsibility of the Archeologist is –

- to identify the surface and subsurface archeological remains in the area
- to identify the impact on the archeology of the area under concern
- to propose suggestions and alternatives for the protection of identified archeological remains

2. METHODOLOGY OF THE ARCHAEOLOGICAL STUDY

Historical analysis of the Area will be carried out by searching literature evidences, studying old records, research in the museums, studying new documents, studying different folk stories and studying maps, plans and photographs.

Identification of the archaeology of the entire area would be mainly carried out through non destructive methods such as study of Arial photographs, field walking, collection of samples, etc. All identified archeological remains would be graphically and photographically recoded and presented by way of location maps with GPS coordinates, plans, sections, elevations, and details drawing where necessary. All artifacts would be recorded to identify there location and analyzed. The investigation methodology adopted in this survey is to evaluate the site in order to test for the extent and character of strata, assemblage, artefacts and ecology. During this survey investigations were to be carried out also to identify and physical archaeological remains. The evaluation was carried out by surface field Surveys.

The method of systematic field walking was used to explore the entire area systematically. Collection of samples, establishment of marks, taking photographs, preparation of plans was carried out at the site during the survey. The maps, plans, binoculars, cameras, compos, GPS equipment, portable computer and stationery such as CR books, field note books, labels, polythene bags, drawing equipments, tapes and voice recorders were used during the survey. The area was extensively investigated to identify all historical developments in the area as well as to identify the visible archaeological remains.

The available data with regard to the site mainly provided by the Uma Oya Multipurpose Project office will be studied. The Archaeological Impact Assessment Report submitted by the Department of Archaeology will be used as a base for the Archaeological Study.

3.HISTORICAL CONTEXT

The proposed project covers two administrative districts in Sri Lanka namely, matale and Kurunegala. According to the modern administrative areas in the Island of Sri Lanka, the northern part of the Central Province is identified as Matale. During the pre-historic era, this area has been the habitatian of the 'Yaksha' tribe. Archaeological findings unearthed so far show that the people of this country belonging to that era lived as tribes separately and not collectively. They lived separately, beside hilly ranges, dispersed in various localities in the country. It is seen that certain tribesmen dwelt in the plains of the North specially in the northern and the eastern sectors of the Matale settlement could be seen a number of hills like Sigiriya, Dambulla, Dambawa, Nikula, Erevula, Nuweragala and Laggala, rising abruptly from the plains and located far apart from one another. It could be presumed that all these were the habitations of the Yaksha tribesmen.

An earthen container holding a corpse and a capper rod was found in Ibbankattuwa at the foot of the Dambulugala are more than 3,000 years old. They are considered to be the tombs of tribal chiefs. It is the accepted view of modern historiographers that Lankapura, the capital city of the world-renowned King Ravana, who ruled Lanka during that era, 4,000 years ago was situated in Lagla in Matale. Place names such as Ravanagala, Ravana-ela, Sitagala, Sitalena, existing even today in the Pallesiya Pattuwa in Laggala, lead us to presume that such a historical connection existed between the Ravana era and the Matale settlement.

Prince Pandukabhaya established the Kingdom of Anuradhapura introduced a system of administration through the village councils and urban council administration system in this country. The settlement which was thus entrusted to the uncle or 'mat hula 'derived the in the name Mathula settlement which is the present settlement of Matale.

The guidance of the order of Sinhala monks set up by Mahinda to patronize the nation had to a great extent influenced Matale. It could be mentioned that it is due to the Buddhist awakening that had set in amongst the people of this area then that the Theravada Buddhist doctrine in its purest form survives in the world today. The extent to which the Buddhist awakening had set in here then could be ascertained from the fact of Aluvihare in Matale being selected as the most appropriate place for committing into writing the doctrine that and till then been brought down orally.

The settlement of Matale became a principal district of the the Kandyan kingdom after King Wijayapala left the country. Ethipola Nilame was appointed to the post of Maha Disapathi of Matale by King Rajasinghe II, in 1658. Thenceforth, till 1815 the settlement of Matale was administered, during the intervening 177 years, by the Chieftains. appointed by the Kings of Maha Nuwara (Kandy). Even after the up-country areas were ceded to the administration of the British in 1815, (County Chieftains) Doollewa and Aluvihare Rate Mahattayas were in charge of the Matale district till 1819.

According to the deed of donation available at the Handunmankadulla Sri Wijarama Viharaya the donated land is registered on the 05th September 1871 which had been donated to the Maha Sanga on the 01st October 1881. As such the present settlements in the site may have established during the era of Kandyan kingdom and the Buddhist temple has been established in 1881.

North Western Province of Sri Lanka known as Wayamba is formulated by the districts of Kurunegala and Puttalam. Its capital is Kurunegala, which has a population of 28,571. The province is known mainly for its numerous coconut plantations. Other main towns in this province are Chilaw (24,712) and Puttalam (45,661), which are both small fishing towns. (Please refer the Map of Sri Lanka in Figure 10) The majority of the population of Wayamba province is of Sinhalese ethnicity. There is also a substantial Sri Lankan Moor minority around Puttalam and Sri Lankan Tamils in Udappu and Munneswaram. Fishing, prawn farming and rubber tree plantations are other prominent industries of the region. The province has an area of 7,888 km^2, and a population of 2,184,136.

History of the Wayamba province begins when Dambadeniya, about 30 km south-west of Kurunegala, became prominent in the mid-13th century. It was selected as the capital of the kingdom of Sri Lanka by King Vijayabahu III (1232–36). The sovereignty of the country was at stake as a result of invasions, which dislodged Polonnaruwa as the capital. Vijayabahu, the king of the Dambadeniya dynasty, fought the invaders and established Dambadeniya. King Parakramabahu II was the king who inherited the throne after King Vijayabahu. He was considered a genius, who was a great poet and a prolific writer. Among the books he wrote are *Kausilumina*, which is considered a great piece of literature. Unifying the three kingdoms that existed within Sri Lanka at that point of time is regarded as greatest achievement. King Bosath Vijayabahu, as the eldest son of King Parakramabahu the second was crowned in 1270. He was well known for his modest behavior and for his religious activities. He was killed in the second year of his reign by a minister called Miththa.

After the assassination of Vijayabahu IV his brother became king after a series of conflicts with several dissident generals thus became Bhuvanekabahu I. He followed his father's footsteps as a writer and continued with the religious activities started by his brother Vijayabahu IV. He considered Dambadeniya as insecure so he made Yapahuwa a rock fortress his permanent residence. In 1298 a Tamil general called Arya Chakravarthi came to island from Pandya kingdom of south India with a massive army and plundered Yapahuwa and took the tooth relic to India. This incident ended the eleven year reign of Bhuvanekabahu I and also Yapahuwa Kingdom.

Map of Sri Lanka

Parakramabahu III who was son of Vijayabahu III and grandson of Parakramabahu II became king in Polonnaruwa. He tried to bring back the tooth relic to island via establishing diplomatic relationships with the Pandyan Kingdom. He succeeded and housed the tooth relic in the temple of tooth in Polonnaruwa. King died after reigning five years in 1303.

After the death of King Parakrama Bahu III, King Buvanekabahu II (1293–1302) son of Bhuvanekabahu I succeeded his cousin in 1303 and shifted capital to nearby Kurunagala and ruled for two years until his death in 1305. He was followed by Parakramabahu IV (1302–1326) and Buwaneka Bahu III (1326 – 1335) alias Wanni Buwaneka Bahu the son of Pandith Parakrama Bahu II ruled from Kurunegala was and is believed to be the last king to rule the country from Kurunegala. After the reign of Buwaneka Bahu III, the newly throned king Vijayabahu V ruled from Dambadeniya and Yapahuwa from 1335 to 1341 before once again the kingdom of Sri Lanka shifted to Gampola.

4. CULTURAL AND ARCHAEOLOGICAL CONTEXT

According to the archaeological remains in the area proto historic settlements, early historic and late historic evidences could be identified. Most important archaeological remains identified with in the area are as follows.

1. Nalanda Gedige
2. Menikdena Monastery Complex
3. Kiralessa Monastery Complex
4. Ibbankatuwa Megalithic Cemetery
5. Yatigalpotta Megalithic Cemetery
6. Hewanewala Megalithic Cemetery
7. Yapahuwa
8. Galsonkantha
9. Geradigala Inscription
10. Neelagama Inscription
11. Viharahinna Monstery

1. Nalanda Gedige

Nalanda Gedige is an ancient complete stone building near Matale district. This building was an ancient Hindu Temple constructed in between 8th to 10th century with Dravedian architecture 9Pllava Style) and then believe to have been used by Buddhists. Nalanda Gedige is designed like a Hindu temple with a mandapa, an entrance hall (originally roofed), a short passage to a bare cello, and an ambulatory round the holy center. There is no sign of Hindu gods today, however, and the temple is said to have been used by Buddhists. The richly decorated facade sections are predominantly in the South Indian style. However, the god Kubera appears on the south side of the tympanum over the sanctuary and this is a feature only to be found in Sri Lanka.

Archeological work of the premises began in1893 by the Public Works Department and in 1911 first archeological commissioner H. C. P. Bell unearthed several sections of the monument. In 1953, former archeological commissioner Senarath Paranavithana unearthed and restored the retaining walls and conserved the Stupa which was ruined. In 1970 due to the accerated Mahaveli Development Scheme the premises was to be submerged. As such the monument was dismantled and erected in an elevated ground near to its riginal location which was believed to be the centre of Sri Lanka.

2. Menikdena Monastery Complex

The history of Menikdena Monastery dates back to the time of King Kittisiri Megha (555-573 AD) but some archeologists believe this monastery dates back as far as 3rd to 4th century AD. From the beginning, it served as a home to recluse Arahants from this time and was known as Budugama. Records also indicate that Menikdena was used as a military base by King Vijayabahu I (1110 - 1111 AD) during his campaign against the

Cholas and that it also served the same purpose during the campaign of King Parakramabahu I against King Gajabahu II (1132 - 1153 AD).

Menikdena has the typical five structures found in such monastic complex commonly identified as Pabbatha Vihara. The entrance to the monastery is from the Menikdena Tank side. Six wide granite steps flanked by guardstones and a blank moonstone make up the entrance. On the right before the steps is a granite pillar inscription. On the left to the entrance is the Stupa which is built on a large high platform. The entrance is a set of granite steps with guardstones. At the top on the sides of the steps is a carved animal which is not very clear. Only the dome of the stupa remains and three of the four flower alters has been partially restored but one has been left as it was found. Only one buddha statue remains in a reasonably good state. Yupa gala of the stupa has been taken out and lies on the floor. Around the stupa are dilapidated stone carved with the Siri Pathula and a broken stone lamp.Opposite the stupa is a bodhigara where the Bo tree used to stand. Beyond these two are the image house and the Chapter house. The massive stone pillars of the chapter house still stand majestically. Menikdena has been declared as an Archaeological Reserve in 1957.

3. Kiralessa Monastery Complex

Due to the non availability of recorded data the history of the Monastery is not known yet. The monastery is also located in close proximity to Menikdena also has the typical five structures found in such monastic complex commonly identified as Pabbatha Vihara. As such it is believed that this monastery also could be dated to 7th Century AD. The small image house compared to similar type of monasteries situated in the South Western section while chapter house is situated in the South Western section of the Monastery.

4. Ibbankatuwa Megalithic Cemetery

The Ibbankatuva megalithic burial site located at the foot of the Talakiriyagama Mountain covers an extent of over 13 acres and is one of the best examples of cist burial sites discovered in Sri Lanka. Ibbankatuwa historical cemetery belongs to the Megalithic pre-historic era.Archaeologically the ground date back to around 750 BC to 400 BC. Several tombs can be seen covered with stone slabs and another interesting fact is those tombs had contained personal items such as clay pots, necklaces etc. Some items had contained Gem Stones which are seen in India giving some hints about the links with the India. Archeologists present several arguments on this site as the people lived in this area has had trade with a foreign country as beads, glass and terra-cotta were discovered

5. Yatigalpotta Megalithic Cemetery

The site of Yatigalpotta Megalithic Cemetery is situated at the western slope of the Beliya Mountain. Departmnet of archaeology for its excavations has identified about 135 Cist berrial remains in the site.

6. Hewanewala Megalithic Cemetery

Havanvela is situated in close proximity to Galewela of the Matale District in the intermediary transitional eco zone and the Megalithic Cemetery is situated in the premis belongs to Devarakkitharamaya. Preliminary investigations have revealed that Havanvela is a megalithic cist burial site.

7. Yapahuwa

Yapahuwa served as the capital of Sri Lanka in the latter part of the 13th century (1273–1284). Built on a huge, 90 meter high rock boulder in the style of the Sigiriya rock fortress, Yapahuwa was a palace and military stronghold against foreign invaders. The palace and fortress were built by King Buvanekabahu I (1272–1284) in the year 1273. Many traces of ancient battle defences can still be seen, while an ornamental stairway, is its biggest showpiece. On top of the rock are the remains of a stupa, a Bodhi tree enclosure, and a rock shelter/cave used by Buddhist monks, indicating that earlier this site was used as a Buddhist monastery, like many boulders and hills in the area. There are several caves at the base of the rock. In one of them there is a shrine with Buddha images. One cave has a Brahmi script inscription. At the southern base of the rock there is a fortification with two moats and ramparts. In this enclosure there are the remains of a number of buildings including a Buddhist shrine. There is also a Buddhist temple called Yapawwa Rajamaha Vihara built during the Kandyan period. The Tooth Relic was brought from Dambadeniya and kept in the Tooth Temple built for the purpose at the top of the third staircase. The relics were carried away from the temple here to South India by the Pandyas, and then recovered in 1288 by Parakkramabahu III (1287–1293), who temporarily placed them in safety at Polonnaruwa.

8. Galsonkantha

The Pinwewa Galsohonkanatta burial site consists of two burials namely Cist Burial with a coved stone and Barrel burial with a cover.

9. Geradigala Inscription

The Geradigala inscription belongs to the 8th Century established by Kasypa the 3rd (724-730) located at the Damunumulla Village of the Matale District. Thsi has been read and included in the Ancient Inscriptionsin Ceylon.

10. Neelagama Inscription

Neelagama inscription situated at the Neelagama Rock temple located near Bambaragaswewa. The inscription is belived to be established during 6th or 7th century AD.

11. Viharahinna Monastery

Althogh there areno historical records of the site it is beklived that the site was one of the places where King Dutugemunu rested on his way to war. Here his mother -- Queen Vihara Maha Devi -- joined him and hence the name Viharahinna in honor of his mother. Ancient brick foundation and some stone pillars. The few guard stones and moonstones that were visible showed no ornamentation. The balustrades on either side of the shallow steps leading to the image house were charming in their very simplicity. A broken granite image of the Lord Buddha, maybe around 11 feet in height, could be seen in the inner chamber of the image house. Aside from the conserved ruins of the image house there is an ancient inscription on a stone slab displayed by the new shrine room. Nearby, under a tree, are arranged some fragments of ancient brick and stone, including a broken figure of a crouching bull and some ancient bricks, said to belong to the Polonnaruwa period. A little way into the jungle, almost covered by the undergrowth, is an interesting slab of stone carved with the "siripathula".

5. DESCRIPTION OF THE ARCHAEOLOGICAL REMAINS AND REMAINS OF ARCHAEOLOGICAL NATURE WITH IN THE STUDY AREA

According to studies carried out within the project area 39 archeologically important sites have been identified. Descriptions of the sites are given below.

1. **<u>Ancient Iron Slag Deposit</u>**

   An ancient Iron Slag Deposit of approximately 50 x 50 meters in a cultivated area within a distance of about 268 meters from the right side of the Canal was identified as a natural mound. It is situated in the Central Province, Matale District, Dambualla Divisional Secretariat Division, Lenadora South GS Division at GPS Point 07^{0}N 45.702 and 80^{0}E 40.192.

2. **<u>Ancient Quarry</u>**

   An ancient Quarry of Crystalline lime stone and Dolomite within a distance of about 600 meters from the left side of the Canal from the Bowatenna Tunnel was identified as a natural mound which has been used by people with in the area. In this mound potsherd, slag and Iron ore was identified and is situated in the Serudandapola Village. It is situated in the Central Province, Matale District, Dambualla Divisional Secretariat Division, Lenadora South GS Division at GPS Point 07^{0}N 45.030 and 80^{0}E 40.333.

3. **<u>Mound Belongs Ancient Settlers</u>**
Mound belongs to Ancient Sellers was identified in a land belongs to Mangala which has Red Ware belongs to the early historical period. The deposit could be identified in an area of 75 x 50m with lime stone and Dolomite deposits within a distance of about 480 meters from the left side of the Canal. It is situated in the Central Province, Matale District, Dambualla Divisional Secretariat Division, Lenadora South GS Division at GPS Point 07^0N 45.142 and 80^0E 40.271.

4. **<u>Ruined Area</u>**
An area with ruined structure with un carved stone pillars, a part of a statue, bricks and tiles were identified in an area within a distance of about 665 meters from the left side of the Canal. It is situated in the Central Province, Matale District, Dambualla Divisional Secretariat Division, Lenadora South GS Division at GPS Point 07^0N 45.098 and 80^0E 40.139.

5. **<u>Mound Belongs Ancient Settlers near the Ambagahadalupotha Tank</u>**
Ancient mound in the land belongs to M.D. Ukkubanda was identified which has Red ware and plain redware together with Iron Slag in an are approximately 75 x 75 m within a distance of about 253 meters from the right side of the Canal. It is situated in the Central Province, Matale District, Dambualla Divisional Secretariat Division, Lenadora South GS Division at GPS Point 07^0N 45.761 and 80^0E 40.085.

6. **<u>Ancient Settlement near the Gallenawatta Tank</u>**
Ancient Settlement near the left embankment of the newly repaired Galenawatta Tank was identified which has potsherd and Iron Slag in a land belongs to L.G.Nandasena and Dharamadasa Yatawara within a distance of about 12 meters from the right side of the Canal. It is situated in the Central Province, MataleDistrict, Dambualla Divisional Secretariat Division, Ethabendiwewa GS Division at GPS Point 07^0N 46.534 and 80^0E 39.012.

7. **<u>Manikdena Ancient Tank</u>**
Manikdena Ancient Tank will be fed by the cannel. It is situated in the Central Province, Matale District, Dambualla Divisional Secretariat Division, Ethabendiwewa GS Division at GPS Point 07^0N 46.223 and 80^0E 38.405.

8. **<u>Ancient Settlement near the Manikdena Ancient Tank</u>**
Ancient Settlement near the embankment of the Manikdena Ancient Tank was identified which has potsherd and Iron Slag in an area of about 2 acres in a land belongs to M.G. Samantha Thilakaratne within a distance of 10 meters from the right side of the Canal. It is situated in the Central Province, Matale District, Dambualla Divisional Secretariat Division, Ethabendiwewa GS Division at GPS Point 07^0N 46.295 and 80^0E 38.371.

9. **<u>Ancient Settlement near the Udamehela Tank</u>**
Ancient Settlement at the end of the embankment of the Udamehela Tank was identified which has potsherd within a distance of about 39 meters from the left side of the Canal. It is situated in the Central Province, Matale District, Dambualla Divisional Secretariat Division, Ethabendiwewa GS Division at GPS Point 07^0N 45.934 and 80^0E 38.193.

10. **<u>Ancient Settlement No. 1 near the Kongolla Tank</u>**
Ancient Mound near the Kongolla Tank was identified which has potsherd and iron Slag in an area of about 150 x 150 m within a distance of about 18 meters from the right side of the Canal. It is situated in the Central Province, Matale District, Dambualla Divisional Secretariat Division, Ethabendiwewa GS Division at GPS Point 07^0N 45.088 and 80^0E 37.738.

11. **<u>Ancient Settlement No. 2 near the Kongolla Tank</u>**
Ancient Mound near the Kongolla Tank was identified which has potsherd, iron Slag, Chinese and British ceramic ware in an area of about 75 x 75 m belongs to the land of officer in charge of fields within a distance of about 40 meters from the right side of the Canal. It is situated in the Central Province, Matale District, Dambualla Divisional Secretariat Division, Ethabendiwewa GS Division at GPS Point 07^0N 46.761 and 80^0E 40.085.

12. **Ancient Potsherd Deposit**
Ancient Potsherd Deposit was identified within a distance of 106 meters from the left side of the Canal. It is situated in the Central Province, Matale District, Dambualla Divisional Secretariat Division, Kospotha GS Division at GPS Point 07^0N 44.971 and 80^0E 32.829.

13. **Ancient Settlement at the Kalgasyaya Village**
Ancient Mound for a size of about 100 x 80 meters with Red Ware potsherd and Iron Salg was identified n the land belongs to Kmal Thalakiriyagama within a distance of about 05 meters from the left side of the Canal. It is situated in the Central Province, Matale District, Dambualla Divisional Secretariat Division, Kospotha GS Division at GPS Point 07^0N 45.261 and 80^0E 32.863.

14. **Neelagama Ancient Temple**
Neelagama Ancient Temple with rock cut caves on the early ancient period is situated in a Rock Hillock within a distance of about 123 meters from the left side of the Canal. It is situated in the Central Province, Dambualla Divisional Secretariat Division, Matale District, Neelagama GS Division at GPS Point 07^0N 46.677 and 80^0E 32.158.

15. **Ancient Caves Near Neelagama Ancient Temple**
Rock cut caves on the early ancient period is situated in a Rock Hillock within a distance of about 03 meters from the left side of the Canal. It is situated in the Central Province, Dambualla Divisional Secretariat Division, Matale District, Neelagama GS Division at GPS Point 07^0N 46.629 and 80^0E 32.154.

16. **Ruined Area at Korakahagolla**
Ruined Area with bases of stone pillars with a spared of potsherd is situated in a land belongs to Daya Hemasiri which also includes a mound may be a stupa ransacked by treasure hunters was identified within a distance of about 35 meters from the left side of the Canal. It is situated in the North Western Province, Kurunegala District, Glewela Divisional Secretariat Division, Pibiduna Gama GS Division at GPS Point 07^0N 48.163 and 80^0E 30.050.

17. **Ruined Tank**
Ruined Tank with a 75 m embankment was identified within a distance of about 40 meters from the right side of the Canal. It is situated in the North Western Province, Kurunegala District, Polpithigama Divisional Secretariat Division, at GPS Point 07^0N 49.912 and 80^0E 29.637.

18. **Cairn Burial Site of Gorakapelessa**
Cairn Burial Site in an area of 100 x 100 m was identified within a distance of 100 meters from the left side of the Canal inside Pahalla Pllekele Forest Reserve. The area consists of two ancient tanks, a settlement and area consisting Iron Slugs. It is situated in the North Western Province, Kurunegala District, Polpithigama Divisional Secretariat Division, at GPS Point 49.841 and 80^0E 29.447.

19. **Ancient Iron Slag Deposit**
An ancient Iron Slag Deposit of approximately 75 x 75 meters in the teak planted area with red ware potsherd within a distance of about 100 meters from the left side of the Canal was identified as a natural mound. It is situated in the North Western Province, Kurunegala District, Polpithigama Divisional Secretariat Division at GPS Point 07^0N 49.841 and 80^0E 29.447.

20. **Ruined Mahakitula Tank**
Mahakithula Tank has been completely ruined and in which the ancient sluice could be identified. There are several stone slabs in the area where the sluise was. It is situated in the North Western Province, Kurunegala District, Polpithigama Divisional Secretariat Division, Kalugala GS Division at GPS Point 07^0N 49.908 and 80^0E 29.239.

21. **Ancient Settlement near the Mahakitula Tank**
A deposit of about 50 x 50 m with Black and Red ware towards the South East of the Mahakithula Tank was identified within a distance of about 90 meters from the left side of the Canal. This could be dated to

early historical period which is situated in the North Western Province, Kurunegala District, Polpithigama Divisional Secretariat Division, Kalugala GS Division at GPS Point 07^{0}N 49.843 and 80^{0}E 29.300.

22. Mahadambe Tank

Mahadambe Tank which has already been repaired is to be expanded under the project. It is situated in the North Western Province, Kurunegala District, Polpithigama Divisional Secretariat Division, Dambe GS Division at GPS Point 07^{0}N 49.403 and 80^{0}E 29.947.

23. Ancient Settlement

A deposit of about 100 x 80 m with Red ware potsherd and Iron Slags near the Mahadambe Tank was identified. This may be an early settlement which is situated in the North Western Province, Kurunegala District, Polpithigama Divisional Secretariat Division, Dambe GS Division at GPS Point 07^{0}N 52.267 and 80^{0}E 27.777.

24. Mahakirula Tank

Mahakirula Tank is to be expanded under the project. It is situated in the North Western Province, Kurunegala District, Polpithigama Divisional Secretariat Division, Herath Gama GS Division at GPS Point 07^{0}N 52.328 and 80^{0}E 26.946.

25. Ancient Settlement near the Mahakirula Tank

A deposit of about 40 x 50 m with pot shreds towards the left of the Mahakirula Tank was identified within a distance of about 268 meters from the left side of the Canal. This is situated in the North Western Province, Kurunegala District, Polpithigama Divisional Secretariat Division, Herath Gama GS Division at GPS Point 07^{0}N 52.297 and 80^{0}E 26.927.

26. Ancient Pot Shred Deposit

An ancient Pot Shred Deposit with Red Ware of approximately 35 x 35 meters near the left bank of the Kirala canal within a distance of about 33 meters from the right side of the Canal was identified as a natural mound. It is situated in the North Western Province, Kurunegala District, Polpithigama Divisional Secretariat Division, Herath Gama GS Division at GPS Point 07^{0}N 52.543 and 80^{0}E 26.558

27. Jayalthgamawewa Ancient Tank

Jayalathgamawewa Ancient Tank with a ruined approximately 150 m embankment is situated in the North Western Province, Kurunegala District, Polpithigama Divisional Secretariat Division, Tambuwatawana GS Division at GPS Point 07^{0}N 55.706 and 80^{0}E 23.407.

28. Nelumwewa Ancient Tank

Nelumwewa Ancient Tank with a ruined approximately 75 m embankment is situated in the North Western Province, Kurunegala District, Polpithigama Divisional Secretariat Division, Tambuwatawana GS Division at GPS Point 07^{0}N 55.874 and 80^{0}E 23.394.

29. Gorakagahawewa Ancient Tank

Gorakagahawewa Ancient Tank with a ruined approximately 75 m embankment is situated in the North Western Province, Kurunegala District, Polpithigama Divisional Secretariat Division, Tambuwatawana GS Division at GPS Point 07^{0}N 55.935 and 80^{0}E 23.367.

30. Polgahawewa Ancient Tank

Polgahawewa Ancient Tank with a ruined approximately 80 m embankment is situated in the North Western Province, Kurunegala District, Polpithigama Divisional Secretariat Division, Tambuwatawana GS Division at GPS Point 07^{0}N 55.994 and 80^{0}E 23.378.

31. Ancient Settlement near the Polgahawewa Ancient Tank

A settlement which has been vacated by the settler about 5 years ago was identified within a distance of about 114 meters from the right side of the Canal. This is situated in the North Western Province, Kurunegala District, Polpithigama Divisional Secretariat Division, Kduruwewa GS Division at GPS Point 07^{0}N 56.056 and 80^{0}E 23.363.

32. Karagaswewa Ancient Rock Temple

Karagaswewa Ancient Rock Temple with cave used for a image house may be belongs to the early historical period with a shatters pot shreds was identified within a distance of about 97 meters from the right side of the Canal. This is situated in the North Western Province, Kurunegala District, Polpithigama Divisional Secretariat Division, Karagaswewa GS Division at GPS Point 07^0N 56.217 and 80^0E 23.147.

33. Metigannawewa Ancient Tank

Metigannawewa Ancient Tank which is completely ruined was identified within a distance of about 558 meters from the left side of the Canal. This is is situated in the North Western Province, Kurunegala District, Polpithigama Divisional Secretariat Division, Watuwattegama GS Division at GPS Point 07^0N 54.315 and 80^0E 22.634.

34. A caved stone with a Cobra Figure

A carved stone with a cobra figure was identified in an area ruined by treasure hunters near the Metigannawewa Ancient Tank which was identified within a distance of about 635 meters from the left side of the Canal. This is situated in the North Western Province, Kurunegala District, Polpithigama Divisional Secretariat Division, Watuwattegama GS Division at GPS Point 07^0N 54.267 and 80^0E 22.605.

35. Kaduruwewa Ancient Tank

Kaduruwewa Ancient Tank which is the end of the NWP Canal is situated in the North Western Province, Kurunegala District, Polpithigama Divisional Secretariat Division, Kaduruwewa GS Division at GPS Point 07^0N 56.882 and 80^0E 22.394.

36. Ruined Area near Wawulewa Ancient Tank

A ruined area with roughly carved stone pillers ransacked by treasure hunters were identified near the Wawulewa Ancient Tank within a distance of about 209 meters from the left side of the starting point of the Canal leading to Ambakolawewa. This is situated in the North Western Province, Kurunegala District, Polpithigama Divisional Secretariat Division, Kumbukulawa GS Division at GPS Point 07^0N 49.674 and 80^0E 25.230.

37. Rock Monastery of Liyanagama

A carved cave in which a monk is inhabited was identified near the Ihalawatte Tank. This is situated in the North Western Province, Kurunegala District, Polpithigama Divisional Secretariat Division, Hathigamuwa GS Division at GPS Point 07^0N 49.546 and 80^0E 23.161.

38. An Area with Artifacts near Rock Monastery of Liyanagama

A land belongs to P. G. Thilakaratne which is situated inbetween Ihalawattewewa and Liyanagama Rock monastery was identified with an area of about 100 x 75 m full of Red Ware and Red Painted ware shreds. This is situated in the North Western Province, Kurunegala District, Polpithigama Divisional Secretariat Division, Hathigamuwa GS Division at GPS Point 07^0N 49.546 and 80^0E 23.159.

39. Rock Monastery of Kowilkanda

An area with carved cave and ancient stone pillars were identified with in the area of rock monastery of Kowilkanda This is situated in the North Western Province, Kurunegala District, Mahawa Divisional Secretariat Division, Moragaswewa GS Division at GPS Point 07^0N52.126 and 80^0E 20.074.

6. ANTICIPATED IMPACTS OF PROPOSED PROJECT ON THE IDENTIFIED ARCHAEOLOGICAL REMAINS AND REMAINS OF ARCHAEOLOGICAL NATURE

All archaeological remains and remains of archaeological nature which were identified with in the project area during the survey was plotted in the maps provided by the project authorities in order to identify weather they falls within the identified areas of proposed activities of the project. Anticipated impacts on these archaeological sites are described below.

L1. Ancient Iron Slag Deposit

An ancient Iron Slag Deposit of approximately 50 x 50 meters in a cultivated area within a distance of about 268 meters from the right side of the Canal was identified as a natural mound. GPS Points of the site is 07^0N 45.702 and 80^0E 40.192. Accordingly **no impact** will cause due to the construction of the canal.

L2. Ancient Quarry

An ancient Quarry of Crystalline lime stone and Dolomite within a distance of about 600 meters from the left side of the Canal from the Bowatenna Tunnel was identified as a natural mound which has been used by people with in the area. In this mound potsherd, slag and Iron ore was identified and is situated in the Serudandapola Village. GPS Points of the site 07^0N 45.030 and 80^0E 40.333. Accordingly **no impact** will cause due to the construction of the canal.

L3. Mound Belongs Ancient Settlers

Mound belongs to Ancient Sellers was identified in a land belongs to Mangala which has Red Ware belongs to the early historical period. The deposit could be identified in an area of 75 x 50m with lime stone and Dolomite deposits within a distance of about 480 meters from the left side of the Canal. GPS Points of the site is 07^0N 45.142 and 80^0E 40.271. Accordingly **no impact** will cause due to the construction of the canal.

L4. Ruined Area

An area with ruined structure with uncarved stone pillars, a part of a statue, bricks and tiles were identified in an area within a distance of about 665 meters from the left side of the Canal. GPS Points of the site is 07^0N 45.098 and 80^0E 40.139. Accordingly **no impact** will cause due to the construction of the canal.

L5. Mound Belongs Ancient Settlers near the Ambagahadalupotha Tank

Ancient mound in the land belongs to M.D. Ukkubanda was identified which has Red ware and plain redware together with Iron Slag in an are approximately 75 x 75 m within a distance of about 253 meters from the right side of the Canal. GPS Points of the site is 07^0N 45.761 and 80^0E 40.085. Accordingly **no impact** will cause due to the construction of the canal.

L6. Ancient Settlement near the Gallenawatta Tank

Ancient Settlement near the left embankment of the newly repaired Galenawatta Tank was identified which has potsherd and Iron Slag in a land belongs to L.G.Nandasena and Dharamadasa Yatawara within a distance of about 12 meters from the right side of the Canal. GPS Points of the site is 07^0N 46.534 and 80^0E 39.012. Accordingly **no impact** will cause due to the construction of the canal.

L7. Manikdena Ancient Tank

Manikdena Ancient Tank will be fed by the cannel. GPS Points of the site is 07^0N 46.223 and 80^0E 38.405. Since there are no archeological remains to be seen **no impact** will cause due to the feeding of water from the canal.

L8. Ancient Settlement near the Manikdena Ancient Tank

Ancient Settlement near the embankment of the Manikdena Ancient Tank was identified which has potsherd and Iron Slag in an area of about 2 acres in a land belongs to M.G. Samantha Thilakaratne within a distance of 10 meters from the reservoir. GPS Points of the site is 070N 46.295 and 80^0E 38.371. **No impact** will cause due to the construction of the canal.

L9. Ancient Settlement near the Udamehela Tank

Ancient Settlement at the end of the embankment of the Udamehela Tank was identified which has potsherd within a distance of about 39 meters from the left side of the Canal. GPS Points of the site is 07^0N 45.934 and 80^0E 38.193. Accordingly **no impact** will cause due to the construction of the canal.

L10. <u>Ancient Settlement No. 1 near the Kongolla Tank</u>

Ancient Mound near the Kongolla Tank was identified which has potsherd and iron Slag in an area of about 150 x 150 m within a distance of about 18 meters from the right side of the Canal. GPS Points of the site is 07^0N 45.088 and 80^0E 37.738. Accordingly **no impact** will cause due to the construction of the canal.

L11. <u>Ancient Settlement No. 2 near the Kongolla Tank</u>

Ancient Mound near the Kongolla Tank was identified which has potsherd, iron Slag, Chinese and British ceramic ware in an area of about 75 x 75 m belongs to the land of officer in charge of fields within a distance of about 40 meters from the right side of the Canal. GPS Points of the site is 07^0N 46.761 and 80^0E 40.085. Accordingly **no impact** will cause due to the construction of the canal.

L12. <u>Ancient Potsherd Deposit</u>

Ancient Potsherd Deposit was identified within a distance of 106 meters from the left side of the Canal. GPS Points of the site is 07^0N 44.971 and 80^0E 32.829. Accordingly **no impact** will cause due to the construction of the canal.

L13. <u>Ancient Settlement at the Kalgasyaya Village</u>

Ancient Mound for a size of about 100 x 80 meters with Red Ware potsherd and Iron Salg was identified n the land belongs to Kmal Thalakiriyagama within a distance of about 05 meters from the left side of the Canal. GPS Points of the site is 07^0N 45.261 and 80^0E 32.863. Accordingly **no impact** will cause due to the construction of the canal.

L14. <u>Neelagama Ancient Temple</u>

Neelagama Ancient Temple with rock cut caves on the early ancient period is situated in a Rock Hillock within a distance of about 123 meters from the left side of the Canal. GPS Points of the site is 07^0N 46.677 and 80^0E 32.158. Although **no direct impact** will cause due to the construction of the canal, indirect **impact may be caused** when using heavy machinery and rock blasting.

L15. <u>Ancient Caves Near Neelagama Ancient Temple</u>

Rock cut caves on the early ancient period is situated in a Rock Hillock within a distance of about 03 meters from the left side of the Canal. GPS Points of the site is 07^0N 46.629 and 80^0E 32.154. Since the caves are with inscription **direct impact** of the site could be identified due to the construction of the canal.

L16. <u>Ruined Area at Korakahagolla</u>

Ruined Area with bases of stone pillars with a spared of potsherd is situated in a land belongs to Daya Hemasiri which also includes a mound may be a stupa ransacked by treasure hunters was identified within a distance of about 35 meters from the left side of the Canal. GPS Points of the site is 07^0N 48.163 and 80^0E 30.050. Accordingly **no impact** will cause due to the construction of the canal.

L17. <u>Ruined Tank</u>

Ruined Tank with a 75 m embankment was identified within a distance of about 40 meters from the right side of the Canal. GPS Points of the site is 07^0N 49.912 and 80^0E 29.637. Since the site is due to be submerged with the construction of the Mahakithula Tank **direct impact** of the site could be identified due to project.

L18. <u>Cairn Burial Site of Gorakapelessa</u>

Cairn Burial Site in an area of 100 x 100 m was identified within a distance of 100 meters from the left side of the Canal inside Pahalla Pllekele Forest Reserve. The area consists of two ancient tanks, a settlement and area consisting Iron Slugs. GPS Points of the site is 07^0N 49.841 and 80^0E 29.447. Since the site is due to be submerged with the construction of the Mahakithula Tank **direct impact** of the site could be identified due to project.

L19. Ancient Iron Slag Deposit

An ancient Iron Slag Deposit of approximately 75 x 75 meters in the teak planted area with red ware potsherd within a distance of about 100 meters from the left side of the Canal was identified as a natural mound. GPS Points of the site is 07^0N 49.841 and 80^0E 29.447. Since the area is due to be submerged **direct impact** of the site could be identified due to project.

L20. Ruined Mahakitula Tank

Mahakithula Tank has been completely ruined and in which the ancient sluice could be identified. There are several stone slabs in the area where the sluice was. GPS Points of the site is 07^0N 49.908 and 80^0E 29.239. Since the tank is expected to be rebuild the stone slabs belongs to the sluice may be disturbed. As such there is a **direct impact** on the site.

L21. Ancient Settlement near the Mahakitula Tank

A deposit of about 50 x 50 m with Black and Red ware towards the South East of the Mahakithula Tank was identified within a distance of about 90 meters from the left side of the Canal. This could be dated to early historical period and GPS Points of the site is 07^0N 49.843 and 80^0E 29.300. Since the site is due to be submerged with the construction of the Mahakithula Tank **direct impact** of the site could be identified due to project.

L22. Mahadambe Tank

Mahadambe Tank which has already been repaired is to be expanded under the project. GPS Points of the site is 07^0N 49.403 and 80^0E 29.947. Since no evidences of archaeological remains could be identified **no impact** will cause due to the expansion.

L23. Ancient Settlement

A deposit of about 100 x 80 m with Red ware potsherd and Iron Slags near the Mahadambe Tank was identified. This may be an early settlement located in GPS Points of 07^0N 52.267 and 80^0E 27.777. Since the site is due to be submerged with the construction of the Mahakithula Tank **direct impact** of the site could be identified due to project.

L24. Mahakirula Tank

Mahakirula Tank is to be expanded under the project. GPS Points of the site is 07^0N 52.328 and 80^0E 26.946. Since no evidences of archaeological remains could be identified **no impact** will cause due to the expansion.

L25. Ancient Settlement near the Mahakirula Tank

A deposit of about 40 x 50 m with pot shreds towards the left of the Mahakirula Tank was identified within a distance of about 268 meters from the left side of the Canal. GPS Points of the siteis 07^0N 52.297 and 80^0E 26.927. N**o impact** will cause due to the construction of the canal.

L26. Ancient Pot Shred Deposit

An ancient Pot Shred Deposit with Red Ware of approximately 35 x 35 meters near the left bank of the Kirala canal within a distance of about 33 meters from the right side of the Canal was identified as a natural mound. GPS Points of the site is 07^0N 52.543 and 80^0E 26.558. N**o impact** will cause due to the construction of the canal.

L27. Jayalthgamawewa Ancient Tank

Jayalathgamawewa Ancient Tank with a ruined approximately 150 m embankment is situated at GPS Points of 07^0N 55.706 and 80^0E 23.407. Since no evidences of archaeological remains could be identified **no impact** will cause if this tank is decided to be feed from the project.

L28. Nelumwewa Ancient Tank

Nelumwewa Ancient Tank with a ruined approximately 75 m embankment is situated at GPS Points of 07^0N 55.874 and 80^0E 23.394. Since no evidences of archaeological remains could be identified **no impact** will cause if this tank is decided to be feed from the project.

L29. Gorakagahawewa Ancient Tank

Gorakagahawewa Ancient Tank with a ruined approximately 75 m embankment is at GPS Points of 07^0N 55.935 and 80^0E 23.367. Since no evidences of archaeological remains could be identified **no impact** will cause if this tank is decided to be feed from the project.

L30. <u>Polgahawewa Ancient Tank</u>

Polgahawewa Ancient Tank with a ruined approximately 80 m embankment is at GPS Points of 07^0N 55.994 and 80^0E 23.378. Since no evidences of archaeological remains could be identified **no impact** will cause if this tank is decided to be feed from the project.

L31. <u>Ancient Settlement near the Polgahawewa Ancient Tank</u>

A settlement which has been vacated by the settler about 5 years ago was identified within a distance of about 114 meters from the right side of the Canal. GPS Points of the site is 07^0N 56.056 and 80^0E 23.363. Accordingly **no impact** will cause due to the construction of the canal.

L32. <u>Karagaswewa Ancient Rock Temple</u>

Karagaswewa Ancient Rock Temple with cave used for a image house may be belongs to the early historical period with a shatters pot shreds was identified within a distance of about 97 meters from the right side of the Canal. GPS Points of the site is 07^0N 56.217 and 80^0E 23.147. Accordingly **no impact** will cause due to the construction of the canal.

L33. <u>Metigannawewa Ancient Tank</u>

Metigannawewa Ancient Tank which is completely ruined was identified within a distance of about 558 meters from the left side of the Canal. GPS Points of the site is 07^0N 54.315 and 80^0E 22.634. Accordingly **no impact** will cause due to the construction of the canal.

L34. <u>A caved stone with a Cobra Figure</u>

A carved stone with a cobra figure was identified in an area ruined by treasure hunters near the Metigannawewa Ancient Tank which was identified within a distance of about 635 meters from the left side of the Canal. GPS Points of the site is 07^0N 54.267 and 80^0E 22.605. Accordingly **no impact** will cause due to the construction of the canal.

L35. <u>Kaduruwewa Ancient Tank</u>

Kaduruwewa Ancient Tank which is the end of the NWP Canal is situated at the GPS Points of 07^0N 56.882 and 80^0E 22.394. Since no evidences of archaeological remains could be identified **no impact** will caused when this tank is feed from the project.

L36. <u>Ruined Area near Wawulewa Ancient Tank</u>

A ruined area with roughly carved stone pillers ransacked by treasure hunters were identified near the Wawulewa Ancient Tank within a distance of about 209 meters from the left side of the starting point of the Canal leading to Ambakolawewa. GPS Points of the site is 07^0N 49.674 and 80^0E 25.230. Accordingly **no impact** will cause due to the construction of the canal.

L37. <u>Rock Monastery of Liyanagama</u>

A carved cave in which a monk is inhabited was identified near the Ihalawatte Tank. GPS Points of the site is 07^0N 49.515 and 80^0E 23.124. Since the monastery is situated in the slope of the mountain **no impact** will cause due to the construction of the canal.

L38. <u>An Area with Artifacts near Rock Monastery of Liyanagama</u>

A land belongs to P. G. Thilakaratne which is situated in between Ihalawatte tank and Liyanagama Rock monastery was identified with an area of about 100 x 75 m full of Red Ware and Red Painted ware shreds. GPS Points of the site is 07^0N 49.546 and 80^0E 23.159. Although the canal is to be constructed through this site there will be a **direct impact** on the site.

L39. <u>Rock Monastery of Kowilkanda</u>

An area with carved cave and ancient stone pillars were identified with in the area of rock monastery of Kowilkanda GPS Points of the site is 07^0N52.126 and 80^0E 52.126. Accordingly **no impact** will cause due to the construction of the canal

7. PROPOSED MITIGATORY MEASURES THAT HAVE TO BE TAKEN TO MINIMISE THE ANTICIPATED IMPACTS OF PROPOSED PROJECT ON THE IDENTIFIED ARCHAEOLOGICAL REMAINS AND REMAINS OF ARCHAEOLOGICAL NATURE

The mitgaatory measures that have to take to minimize the anticipated impacts of the proposed project are given below.

L14. <u>Neelagama Ancient Temple</u>

Neelagama Ancient Temple with rock cut caves on the early ancient period is situated in a Rock Hillock within a distance of about 123 meters from the left side of the Canal. GPS Points of the site is 07^0N 46.677 and 80^0E 32.158. Although **no impact** will cause due to the construction of the canal, extremes precautions should taken during the construction of the canal especially when heavy machinery is used and during the rock blasting.

L15. <u>Ancient Caves Near Neelagama Ancient Temple</u>

Rock cut caves on the early ancient period is situated in a Rock Hillock within a distance of about 03 meters from the left side of the Canal. GPS Points of the site is 07^0N 46.629 and 80^0E 32.154. Since the caves are with inscription **direct impact** of the site could be identified due to the construction of the canal. **As such the canal path has to be sifted at least 150 meters from the site.**

L17. <u>Ruined Tank</u>

Ruined Tank with a 75 m embankment was identified within a distance of about 40 meters from the right side of the Canal. GPS Points of the site is 07^0N 49.912 and 80^0E 29.637. Since the site is due to be submerged with the construction of the Mahakithula Tank **direct impact** of the site could be identified due to project. **But since there are no archeological evidences are to be seen the site could be allowed to be submerged after informing the Department of Archaeology.**

L18. <u>Cairn Burial Site of Gorakapelessa</u>

Cairn Burial Site in an area of 100 x 100 m was identified within a distance of 100 meters from the left side of the Canal inside Pahalla Pllekele Forest Reserve. The area consists of two ancient tanks, a settlement and area consisting Iron Slugs. GPS Points of the site is 07^0N 49.841 and 80^0E 29.447. Since the site is due to be submerged with the construction of the Mahakithula Tank, **direct impact** of the site could be identified due to project. The site may be have been disturbed due to the teak cultivation. **But since the site is due to be submerged with the construction of the Mahakithula Tank, it is proposed to inform the Department of Archeology and obtain instructions to record the site by an archeological excavation and allow it to be submerges.**

L19. <u>Ancient Iron Slag Deposit</u>

An ancient Iron Slag Deposit of approximately 75 x 75 meters in the teak planted area with red ware potsherd within a distance of about 100 meters from the left side of the Canal was identified as a natural mound. GPS Points of the site is 07^0N 49.841 and 80^0E 29.447. **Since the area is due to be submerged it could be investigated together with the Cairn Burial Site indicated in L18.**

L20. <u>Ruined Mahakitula Tank</u>

Mahakithula Tank has been completely ruined and in which the ancient sluice could be identified. There are several stone slabs in the area where the sluice was. GPS Points of the site is 07^0N 49.908 and 80^0E 29.239. **Since the tank is expected to be rebuild the stone slabs belongs to the sluice of the tank should be removed from the submerging area and stacked as an exhibit near the new sluice.**

L21. Ancient Settlement near the Mahakitula Tank

A deposit of about 50 x 50 m with Black and Red ware towards the South East of the Mahakithula Tank was identified within a distance of about 90 meters from the left side of the Canal. This could be dated to early historical period and GPS Points of the site is 07^0N 49.843 and 80^0E 29.300. Since the site is due to be submerged with the construction of the Mahakithula Tank **direct impact** of the site could be identified due to project. **Since the area is due to be submerged it could be investigated together with the Cairn Burial Site indicated in L18.**

L23. Ancient Settlement

A deposit of about 100 x 80 m with Red ware potsherd and Iron Slags near the Mahadambe Tank was identified. This may be an early settlement located in GPS Points of 07^0N 52.267 and 80^0E 27.777. Since the site is due to be submerged with the expansion of the Mahadambe Tank **direct impact** of the site could be identified due to project. . **Since the area is due to be submerged it is proposed to investigate the site by the Department of Archeology and allow it to be submerges.**

L27. Jayalthgamawewa Ancient Tank

Jayalathgamawewa Ancient Tank with a ruined approximately 150 m embankment is situated at GPS Points of 07^0N 55.706 and 80^0E 23.407. Since no evidences of archaeological remains could be identified **no impact** will cause if this tank is decided to be feed from the project **but department of archeology should be informed if this tank is to be further developed.**

L28. Nelumwewa Ancient Tank

Nelumwewa Ancient Tank with a ruined approximately 75 m embankment is situated at GPS Points of 07^0N 55.874 and 80^0E 23.394. Since no evidences of archaeological remains could be identified **no impact** will cause if this tank is decided to be feed from the project **but department of archeology should be informed if this tank is to be further developed.**

L29. Gorakagahawewa Ancient Tank

Gorakagahawewa Ancient Tank with a ruined approximately 75 m embankment is at GPS Points of 07^0N 55.935 and 80^0E 23.367. Since no evidences of archaeological remains could be identified **no impact** will cause if this tank is decided to be feed from the project **but department of archeology should be informed if this tank is to be further developed.**

L30. Polgahawewa Ancient Tank

Polgahawewa Ancient Tank with a ruined approximately 80 m embankment is at GPS Points of 07^0N 55.994 and 80^0E 23.378. Since no evidences of archaeological remains could be identified **no impact** will cause if this tank is decided to be feed from the project **but department of archeology should be informed if this tank is to be further developed.**

L38. An Area with Artifacts near Rock Monastery of Liyanagama

A land belongs to P. G. Thilakaratne which is situated in between Ihalawatte tank and Liyanagama Rock monastery was identified with an area of about 100 x 75 m full of Red Ware and Red Painted ware shreds. GPS Points of the site is 07^0N 49.546 and 80^0E 23.159. **Although the canal is to be constructed through this site it may be destroyed with the approval of the Department of Archaeology sine the site is already destroyed due to the coconut cultivation as no significant archeological evidences could be preserved.**

Photographs

 

Neelagama Ancient Temple

 

Ancient Caves Near Neelagama Ancient Temple

 

Cairn Burial Site of Gorakapelessa & Ancient Iron Slag Deposit


Remains of the Ancient Sluice at Ruined Mahakitula Tank


An Area with Artifacts near Rock Monastery of Liyanagama

Annexure VI – V Flora and Fauna

Annex II

Table 1. Plant species recorded from plots in Mahakirula and Mahakitula proposed reservoir area in Kahalla-Pallekele Sanctuary.

Plant family, species name, local name, habit (HA) (C - Climber or Creeper, T – Tree; S – Shrub; H – Herbaceous), the taxonomic status TS (N– Indigenous; E – Endemic; I – Introduced and naturalized) and Conservation Status CS (EN- Endangered, VU- Vulnerable).

Family	*Species*	Local Name	HA	TS	CS	Mahakirula reservoir area	Mahakitula reservoir area
Anacardiaceae	*Lannea coromandelica*	Hik	T	N		1	1
Annonaceae	*Miliusa indica*	Kikili Messa	S	N		1	1
Annonaceae	*Polyalthia coffeoides*	Omara	T	N		1	1
Annonaceae	*Polyalthia korinti*	Ulkenda	S	N		1	1
Apocynaceae	*Carissa spinarum*	Heen Karamba	C	N		1	1
Apocynaceae	*Wrightia angustifolia*		T	E		1	
Bignoniaceae	*Stereospermum colais*	Dunumadala	T	N		1	
Boraginaceae	*Carmona retusa*	Heen Thambala	S	N		1	1
Capparaceae	*Capparis zeylanica*	Sudu Welangiriya	C	N		1	1
Celastraceae	*Pleurostylia opposita*	Panakka	T	N			1
Connaraceae	*Connarus monocarpus*	Radaliya	C	N		1	1
Ebenaceae	*Diospyros ebenum*	Kaluwara	T	N	EN	1	1
Ebenaceae	*Diospyros nummulariifolia*		T	E		1	
Ebenaceae	*Diospyros ovalifolia*	Kunumella	T	N		1	1
Erythroxylaceae	*Erythroxylum zeylanicum*		T	E		1	
Euphorbiaceae	*Cleistanthus pallidus*		T	E		1	
Euphorbiaceae	*Dimorphocalyx glabellus*	Weliwenna	T	N		1	1

Euphorbiaceae	*Mischodon zeylanicus*	Tammanna	T	N		1	
Family	***Species***	**Local Name**	**HA**	**TS**	**CS**	**Mahakirula reservoir area**	**Mahakitula reservoir area**
Euphorbiaceae	*Phyllanthus polyphyllus*	Kuratiya	T	N		1	
Euphorbiaceae	*Drypetes sepiaria*	Wira	T	N		1	1
Euphorbiaceae	*Mallotus rhamnifolius*		T	N		1	1
Fabaceae	*Acacia leucophloea*	Maha Andara	T	N			
Fabaceae	*Bauhinia racemosa*	Maila	T	N		1	
Fabaceae	*Cassia fistula*	Ehela	T	N		1	1
Fabaceae	*Cassia roxburghii*	Ratu Wa	T	N		1	
Fabaceae	*Derris parviflora*	Kala Wel	C	E		1	1
Hippocrateaceae	*Salacia reticulata*	Kotala Himbutu	C	N		1	1
Lauraceae	*Alseodaphne semecarpifolia*	Wewarana	T	N		1	1
Linaceae	*Hugonia mystax*	Bugetiya	S	N		1	1
Loganiaceae	*Strychnos nux-vomica*	Goda Kaduru	T	N			1
Melastomataceae	*Memecylon capitellatum*		T	E		1	
Melastomataceae	*Memecylon umbellatum*	Korakaha	S	N		1	1
Meliaceae	*Aglaia elaeagnoidea*		T	N		1	
Meliaceae	*Chukrasia tabularis*	Hulan Hik	T	N		1	
Meliaceae	*Walsura trifoliolata*	Kiri Koon	T	N		1	1
Moraceae	*Ficus racemosa*	Attikka	T	N		1	1
Moraceae	*Ficus sp.*		T	N		1	
Moraceae	*Streblus asper*	Nitulla	T	N		1	
Myrtaceae	*Eugenia bracteata*	Tembiliya	T	N		1	
Myrtaceae	*Syzygium cumini*	Madan	T	N		1	1

Family	*Species*	Local Name	HA	TS	CS	Mahakirula reservoir area	Mahakitula reservoir area
Ochnaceae	*Ochna lanceolata*	Mal Kera	T	N		1	1
Olacaceae	*Olax imbricata*		C	N		1	1
Oleaceae	*Jasminum angustifolium*		C	N		1	
Polypodiaceae	*Drynaria quercifolia*	Beduru	Ep	N		1	
Rhamnaceae	*Scutia myrtina*		S	N		1	1
Rhamnaceae	*Ventilago madraspatana*	Yakkada Wel	C	N		1	1
Rhamnaceae	*Ziziphus oenoplia*	Heen Eraminiya	C	N		1	
Rubiaceae	*Benkara malabarica*		S	N		1	1
Rubiaceae	*Discospermum sphaerocarpum*		T	N		1	
Rubiaceae	*Haldina cordifolia*	Kolon	T	N	VU	1	1
Rubiaceae	*Ixora coccinea*	Ratambala	S	N		1	1
Rubiaceae	*Ixora pavetta*	Maha Ratambala	T	N		1	1
Rubiaceae	*Psydrax dicoccos*	Panderu	T	N		1	
Rubiaceae	*Tarenna asiatica*	Tarana	S	N		1	1
Rutaceae	*Atalantia ceylanica*	Yakinaran	T	N		1	
Rutaceae	*Chloroxylon swietenia*	Buruta	T	N		1	1
Rutaceae	*Glycosmis mauritiana*		S	N		1	1
Rutaceae	*Pleiospermium alatum*	Tumpat Kurudu	T	N		1	1
Sapindaceae	*Dimocarpus longan*	Mora	T	N		1	1
Sapindaceae	*Lepisanthes senegalensis*	Gal Kuma	T	N		1	1
Sapindaceae	*Lepisanthes tetraphylla*	Dambu	T	N		1	1
Sapindaceae	*Sapindus emarginata*	Kaha Penela	T	N		1	1
Sapindaceae	*Schleichera oleosa*	Koon	T	N		1	1

Sapotaceae	*Madhuca longifolia*	Mi	T	N		1	1
Family	***Species***	**Local Name**	**HA**	**TS**	**CS**	**Mahakirula reservoir area**	**Mahakitula reservoir area**
Sapotaceae	*Manilkara hexandra*	Palu	T	N		1	1
Sapotaceae	*Mimusops elengi*	Munamal	T	N		1	
Sterculiaceae	*Pterospermum suberifolium*	Welan	T	N		1	1
Sterculiaceae	*Sterculia foetida*	Telambu	T	N		1	
Tiliaceae	*Berrya cordifolia*	Halmilla	T	N		1	1
Tiliaceae	*Diplodiscus verrucosus*	Dik Wenna	T	E		1	
Tiliaceae	*Grewia helicterifolia*	Bora Daminiya	T	N		1	1
Tiliaceae	*Grewia orientalis*		C	N		1	1
Verbenaceae	*Premna tomentosa*	Seru	T	N		1	1
Verbenaceae	*Tectona grandis*	Tekka	T	I		1	1
Verbenaceae	*Vitex altissima*	Milla	T	N		1	1
Vitaceae	*Cissus latifolia*	Wal Diya Labu		N			1
Vitaceae	*Cissus quadrangularis*	Heressa	C	N			1

Table 2. Plant species recorded from plots in scrublands in Kahalla- Pallekele sanctuary during the field survey.

Plant family, species name, local name, habit (HA) (C - Climber or Creeper, T – Tree; S – Shrub; H – Herbaceous), the taxonomic status TS (N– Indigenous; E – Endemic; I – Introduced and naturalized) and Conservation Status CS (VU- Vulnerable).

Family	*Species*	Local Name	HA	TS	CS
Apocynaceae	*Carissa spinarum*	Heen Karamba	C	N	
Apocynaceae	*Ichnocarpus frutescens*	Garadi Wel	C	N	
Asclepiadaceae	*Calotropis gigantea*	Wara	S	N	
Asparagaceae	*Asparagus racemosus*	Hathawariya	C	N	
Asteraceae	*Vernonia cinerea*	Monara Kudumbiya	H	N	
Asteraceae	*Vicoa indica*	Ran Hiriya	H	N	
Capparaceae	*Crateva adansonii*	Lunu Warana	T	N	
Celastraceae	*Maytenus emarginata*		S	N	
Euphorbiaceae	*Drypetes sepiaria*	Wira	T	N	
Euphorbiaceae	*Euphorbia antiquorum*	Daluk	T	N	
Euphorbiaceae	*Flueggea leucopyrus*	Katu Pila	S	N	
Euphorbiaceae	*Phyllanthus polyphyllus*	Kuratiya	T	N	
Fabaceae	*Acacia leucophloea*	Maha Andara	T	N	
Fabaceae	*Alysicarpus vaginalis*	Aswenna	H	N	
Fabaceae	*Bauhinia racemosa*	Maila	T	N	
Fabaceae	*Cassia fistula*	Ehela	T	N	
Fabaceae	*Cassia roxburghii*	Ratu Wa	T	N	
Fabaceae	*Derris parviflora*	Kala Wel	C	E	
Fabaceae	*Derris scandens*	Bo Kala wel	C	N	
Fabaceae	*Dichrostachys cinerea*	Andara	T	N	
Linaceae	*Hugonia mystax*	Bugetiya	S	N	
Malvaceae	*Sida acuta*	Gas Bavila	H	N	
Myrtaceae	*Syzygium cumini*	Madan	T	N	
Oleaceae	*Jasminum angustifolium*		C	N	
Periplocaceae	*Hemidesmus indicus*	Iramusu	C	N	
Poaceae	*Dactyloctenium aegyptium*	Putu Tana	H	N	
Poaceae	*Imperata cylindrica*	Iluk	H	N	
Rhamnaceae	*Scutia myrtina*		S	N	
Rhamnaceae	*Ziziphus oenoplia*	Heen Eraminiya	C	N	
Rubiaceae	*Canthium coromandelicum*	Kara	T	N	
Rubiaceae	*Catunaregam spinosa*	Kukurumanna	T	N	
Rubiaceae	*Mitragyna parvifolia*	Helamba	T	N	VU
Rutaceae	*Limonia acidissima*	Divul	T	N	
Sapindaceae	*Allophylus cobbe*	Kobbe	C	N	
Sapotaceae	*Manilkara hexandra*	Palu	T	N	
Sterculiaceae	*Pterospermum suberifolium*	Welan	T	N	

Tiliaceae	*Diplodiscus verrucosus*	Dik Wenna	T	E	
Tiliaceae	*Grewia orientalis*		C	N	

Table 3. Plant species recorded from rock outcrop associated vegetation during the field survey.

Plant family, species name, local name, habit (HA) (C - Climber or Creeper, T – Tree; S – Shrub; H – Herbaceous), the taxonomic status TS (N– Indigenous; E – Endemic; I – Introduced and naturalized) and Conservation Status CS (EN- Endangered, VU- Vulnerable).

Family	*Species*	Local Name	HA	TS	CS
Anacardiaceae	*Lannea coromandelica*	Hik	T	N	
Anacardiaceae	*Nothopegia beddomei*	Bala	T	N	
Anacardiaceae	*Spondias pinnata*	Wal Ambarella	T	N	
Annonaceae	*Mitrephora heyneana*		T	N	
Annonaceae	*Polyalthia korinti*	Ulkenda	S	N	
Apocynaceae	*Carissa spinarum*	Heen Karamba	C	N	
Apocynaceae	*Wrightia angustifolia*		T	E	
Araliaceae	*Schefflera stellata*	Ittha	T	N	
Asclepiadaceae	*Sarcostemma brunonianum*	Muwa Kiriya	C	N	
Asparagaceae	*Asparagus racemosus*	Hathawariya	C	N	
Asteraceae	*Eupatorium odoratum*	Podisinnamaran	S	I	
Asteraceae	*Vernonia zeylanica*	Pupulu	C	E	
Bignoniaceae	*Stereospermum colais*	Dunumadala	T	N	
Boraginaceae	*Carmona retusa*	Heen Thambala	S	N	
Burseraceae	*Commiphora caudata*	Siviya	T	N	
Capparaceae	*Capparis zeylanica*	Sudu Welangiriya	C	N	
Celastraceae	*Maytenus emarginata*		S	N	
Connaraceae	*Connarus monocarpus*	Radaliya	C	N	
Convolvulaceae	*Argyreia osyrensis*	Dumbada	C	N	
Convolvulaceae	*Merremia tridentata*	Heen Madu	C	N	
Dioscoreaceae	*Dioscorea tomentosa*	Uyala	C	N	
Dracaenaceae	*Sansevieria zeylanica*	Niyanda	H	N	
Ebenaceae	*Diospyros ebenum*	Kaluwara	T	N	EN
Ebenaceae	*Diospyros nummulariifolia*		T	E	
Ebenaceae	*Diospyros ovalifolia*	Kunumella	T	N	
Euphorbiaceae	*Cleistanthus pallidus*		T	E	
Euphorbiaceae	*Drypetes sepiaria*	Wira	T	N	
Euphorbiaceae	*Euphorbia antiquorum*	Daluk	T	N	
Euphorbiaceae	*Flueggea leucopyrus*	Katu Pila	S	N	
Euphorbiaceae	*Mallotus rhamnifolius*		T	N	
Euphorbiaceae	*Mischodon zeylanicus*	Tammanna	T	N	
Euphorbiaceae	*Phyllanthus polyphyllus*	Kuratiya	T	N	
Euphorbiaceae	*Sapium insigne*		T	N	
Fabaceae	*Abrus precatorius*	Olinda	C	N	
Fabaceae	*Acacia pennata*		C	N	

Fabaceae	*Bauhinia tomentosa*	Petan	T	N	
Fabaceae	*Cassia fistula*	Ehela	T	N	
Family	***Species***	**Local Name**	**HA**	**TS**	**CS**
Fabaceae	*Cassia roxburghii*	Ratu Wa	T	N	
Fabaceae	*Tephrosia purpurea*	Pila	H	N	
Hernandiaceae	*Gyrocarpus americanus*	Hima	T	N	
Hippocrateaceae	*Reissantia indica*		C	N	
Hippocrateaceae	*Salacia reticulata*	Kotala Himbutu	C	N	
Hypoxidaceae	*Curculigo orchioides*	Heen Bin Tal	H	N	
Lauraceae	*Alseodaphne semecarpifolia*	Wewarana	T	N	
Linaceae	*Hugonia mystax*	Bugetiya	S	N	
Loganiaceae	*Strychnos nux-vomica*	Goda Kaduru	T	N	
Malpighiaceae	*Hiptage benghalensis*	Puwak Gediya Wel	C	N	
Melastomataceae	*Memecylon capitellatum*		T	E	
Melastomataceae	*Memecylon petiolatum*		T	E	VU
Melastomataceae	*Memecylon umbellatum*	Korakaha	S	N	
Meliaceae	*Munronia pinnata*	Bin Kohomba	H	N	
Meliaceae	*Walsura trifoliolata*	Kiri Koon	T	N	
Menispermaceae	*Tinospora sinensis*	Bu Kinda	C	N	
Moraceae	*Ficus arnottiana*	Patana Bo	T	N	
Moraceae	*Ficus benghalensis*	Nuga	T	N	
Moraceae	*Ficus microcarpa*		T	N	
Moraceae	*Ficus mollis*	Wal Aralu	T	N	
Myrtaceae	*Eugenia bracteata*	Tembiliya	T	N	
Ochnaceae	*Ochna lanceolata*	Mal Kera	T	N	
Olacaceae	*Olax imbricata*		C	N	
Oleaceae	*Chionanthus zeylanica*	Geriata	T	N	
Oleaceae	*Jasminum angustifolium*		C	N	
Rhamnaceae	*Ventilago madraspatana*	Yakkada Wel	C	N	
Rhamnaceae	*Ziziphus oenoplia*	Heen Eraminiya	C	N	
Rubiaceae	*Benkara malabarica*		S	N	
Rubiaceae	*Canthium coromandelicum*	Kara	T	N	
Rubiaceae	*Catunaregam spinosa*	Kukurumanna	T	N	
Rubiaceae	*Discospermum sphaerocarpum*		T	N	
Rubiaceae	*Mussaenda frondosa*	Mussanda	S	N	
Rubiaceae	*Psydrax dicoccos*	Panderu	T	N	
Rubiaceae	*Tarenna asiatica*	Tarana	S	N	
Rutaceae	*Chloroxylon swietenia*	Buruta	T	N	
Rutaceae	*Glycosmis mauritiana*		S	N	
Rutaceae	*Murraya paniculata*	Etteriya	T	N	
Rutaceae	*Pleiospermium alatum*	Tumpat Kurudu	T	N	
Sapindaceae	*Dimocarpus longan*	Mora	T	N	
Sapindaceae	*Lepisanthes senegalensis*	Gal Kuma	T	N	
Sapotaceae	*Manilkara hexandra*	Palu	T	N	
Sterculiaceae	*Pterospermum suberifolium*	Welan	T	N	

Sterculiaceae	*Sterculia balanghas*	Nawa	T	N	
Sterculiaceae	*Sterculia foetida*	Telambu	T	N	
Family	***Species***	**Local Name**	**HA**	**TS**	**CS**
Tiliaceae	*Diplodiscus verrucosus*	Dik Wenna	T	E	
Tiliaceae	*Grewia helicterifolia*	Bora Daminiya	T	N	
Tiliaceae	*Grewia orientalis*		C	N	
Verbenaceae	*Lantana camara*	Gandapana	S	I	
Verbenaceae	*Premna alstoni*		S	E	
Verbenaceae	*Premna tomentosa*	Seru	T	N	
Verbenaceae	*Vitex altissima*	Milla	T	N	
Vitaceae	*Cissus latifolia*	Wal Diya Labu		N	
Vitaceae	*Cissus quadrangularis*	Heressa	C	N	
Vitaceae	*Cissus vitiginea*		C	N	

Table 4. Forest and Wildlife reserves in Kurunegala and Matale districts

(FR= Forest Reserve, PR- Proposed Forest Reserve, OSF- Other State Forest, S- Sanctuary) (Source: EIMS)

Name of Reserve	Category	Extent (ha)	District
Kahalla-Pallekele	S	21690	ANU KUR
Angurukandayaya	PR	139.2	KUR
Badagamuwa	FR	213.9	KUR
Banhedawaka	PR	159.0	KUR
Barigoda	FR	78.5	KUR
Degadaturawa	PR	161.9	KUR
Dewalakanda	FR	112.5	KUR
Digalla	FR	87.0	KUR
Dikkele Mukalana	FR	308.1	KUR
Doluwakanda	PR	400.6	KUR
Dunkanda	PR	301.1	KUR
Elawaka	PR	168.3	KUR
Galgiriyakanda	PR	1182.5	KUR
Getadivula	PR	581.5	KUR
Gonagama	PR	235.1	KUR
Gorakadola	FR	191.1	KUR
Habilikanda	PR	180.9	KUR
Henegedaralanda	PR	729.6	KUR
Kankaniyamulla	FR	1047.9	KUR
Kanugollayaya	PR	119.5	KUR
Kendahena	FR	69.2	KUR
Kimbulwan Oya	S	492.1	KUR
Kirindigolla	FR	171.0	KUR
Kumbalpola	PR	96.3	KUR
Likolawewa	FR	3462.2	KUR
Ma Eliya	FR	381.2	KUR
Manapaya	PR	314.0	KUR
Mawattagama	PR	1512.6	KUR
Meeambakanda	FR	124.6	KUR
Minuwangeta	PR	139.2	KUR
Mipitikanda	PR	235.9	KUR
Moturampatana	PR	235.9	KUR
Mudungoda	PR	774.2	KUR
Nagolla	FR	123.1	KUR
Nelligalkanda	FR	50.0	KUR
Neugalkanda	PR	376.0	KUR
Pallekele	FR	12721.4	KUR
Panwewa	FR	241.7	KUR
Paragaharuppe	FR	54.0	KUR
Polgolla	FR	51.5	KUR
Polkatukanda	FR	151.5	KUR
Sangappale	PR	4505.8	KUR
Sundapola	FR	121.6	KUR
Talagomuwa	FR	81.3	KUR

Welikumbura	FR	80.9	KUR
Weuda Mukalana	FR	152.1	KUR
Yakdessakanda	PR	1010.9	KUR
Butawella	OSF	1050.0	KUR
Talpattekanda	OSF	150.0	KUR
Tambutakanda	OSF	250.0	KUR
Bogodayagama	OSF	100.0	KUR
Dambulla Oya	PR	104.4	MTL
Elagomuwa	PR	870.1	MTL
Inamaluwa	PR	309.6	MTL
Inamaluwa	FR	1896.9	MTL
Pallegama-Himbiliyakada	PR	4547.2	MTL
Pelwehera	PR	240.0	MTL
Pelwehera	FR	1925.9	MTL
Potawa	PR	77.2	MTL
Wegodapola	PR	418.5	MTL
Masawa	OSF	150.0	MTL
Inamalawa	OSF	600.0	MTL
Galboda	OSF	600.0	MTL
Opalagala	OSF	350.0	MTL
Sacombe	OSF	250.0	MTL
Talabugahaela	OSF	300.0	MTL
Heratgedara	OSF	650.0	MTL
Makulussa	OSF	325.0	MTL
Gosgahapatana	OSF	750.0	MTL
Amsawagama	OSF	450.0	MTL
Beliyakanda	OSF	250.0	MTL
Etabendiwela	OSF	325.0	MTL
Tottawelgola	OSF	800.0	MTL
Gederagalpatana	OSF	1500.0	MTL
Menikdeniya	OSF	450.0	MTL
Puswellagolla	OSF	10000.0	MTL
Hiriwaduna	OSF	950.0	MTL
Dambagolagama	OSF	400.0	MTL

Terrestrial and Aquatic Fauna Recorded

<u>Abbreviations Used</u>: **TS** - Taxonomic Status; **E** - Endemic; **N** - Native; **M** -Migrant; **I** - Introduced; **NCS** - National Conservation Status; **EN** - Endangered; **VU** - Vulnerable; **NT** - Near Threatened; **LC** - Least Concerned; **TA** - Tank; **FO** - Forest; **SC** - Scrub, **1** - From Nalanda diversion to Maha Kitula wewa ; **2** - From Maha Kitula to Maha Kirula wewa; **3** - From Mahakirula to Ehetu Wewa

Family	Scientific Name	English Name	Sinhala Name	TS	NCS	Mahakiriula			Mahakithula		Canal Path		
						TA	FO	SC	FO	SC	1	2	3
						Dragonflies							
Coenagrionidae	*Ceriagrion coromandelianum*	Yellow Waxtail		N	LC	+							
Coenagrionidae	*Pseudagrion microcephalum*	Blue Sprite		N	LC	+							
Libellulidae	*Brachythmis contaminata*	Asian Groundling		N	LC	+					+		
Libellulidae	*Crocothemis servilia*	Oriental Scarlet		N	LC							+	
Libellulidae	*Diplacodes trivialis*	Blue Percher		N	LC	+						+	
Libellulidae	*Orthetrum sabina*	Green Skimmer		N	LC	+							
Libellulidae	*Pantala flavescens*	Wandering Glider		N	LC	+					+	+	+
Libellulidae	*Rhyothemis variegata*	Varigated Flutter		N	LC							+	
Libellulidae	*Trithemis aurora*	Crimson Dropwing		N	LC	+							
Platycnemididae	*Copera marginipes*	Yellow Featherleg		N	LC	+							
Protoneuridae	*Prodasineura sita*	Stripe-headed Threadtail		E	LC	+						+	

Family	Scientific Name	English Name	Sinhala Name	TS	NCS	Mahakiriula			Mahakithula		Canal Path		
						TA	FO	SC	FO	SC	1	2	3
Butterflies													
Lycaenidae	*Castalius rosimon*	Common Pierrot	Podu Mal-nilaya	N	LC		+	+		+		+	+
Lycaenidae	*Chilades lajus*	Lime Blue	Podu Panu-nilaya	N	LC		+		+				
Lycaenidae	*Freyeria trochilus*	Grass Jewel	Ran Thruna-nilaya	N	LC		+	+		+			
Lycaenidae	*Neopithicops zalmora*	Quaker	Maha thith Dumburu-nilaya	N	LC		+		+				
Lycaenidae	*Prosotas nora*	Common Lineblue	Podu Nil-iriya	N	LC				+				
Lycaenidae	*Zizina otis*	Lesser Grass Blue	Podu Thruna-nilaya	N	LC			+		+			
Nymphalidae	*Danaus chrysippus*	Plain tiger	Podu koti-thambiliya	N	LC	+	+	+	+	+	+	+	
Nymphalidae	*Danaus genutia*	Common tiger	Iri Koti-thambiliya	N	LC		+		+	+			+
Nymphalidae	*Euploea core*	Common crow	Podu kaka-kotithiyaya	N	LC		+	+	+		+		
Nymphalidae	*Junonia almana*	Peacock pansy	Monera alankarikya	N	LC			+		+			
Nymphalidae	*Junonia atlites*	Grey pansy	Aluwan alankarikya	N	LC			+		+		+	
Nymphalidae	*Junonia iphita*	Chocolate soldier	Podu alankarikya	N	LC		+		+				
Nymphalidae	*Junonia lemonias*	Lemon pansy	Dumburuwan alankarikya	N	LC		+		+	+			
Nymphalidae	*Melanitis leda*	Common evening brown	Podu dumburuwa	N	LC	+	+	+		+	+		
Nymphalidae	*Mycalesis perseus*	Common bushbrown	Podu panduru-dumburuwa	N	LC		+		+				+
Nymphalidae	*Neptis hylas*	Common sailor	Gomara selaruwa	N	LC		+	+	+		+	+	+

Family	Scientific Name	English Name	Sinhala Name	TS	NCS	Mahakiriula			Mahakithula		Canal Path		
						TA	FO	SC	FO	SC	1	2	3
Nymphalidae	*Parantica aglea*	Glassy tiger	Suduwan nil-kotithiya	N	LC		+		+				
Nymphalidae	*Phalantha phantha*	Leopard	Podu thith-thambiliya	N	LC			+		+	+		
Nymphalidae	*Tirumala limniace*	Blue tiger	Podu nil-kotithiya	N	LC		+		+				
Nymphalidae	*Ypthima ceylonica*	White four-ring	Podu heen-dumburuwa	N	LC	+	+		+	+			
Papilionidae	*Graphium agamemnon*	Tailed jay	Kola papilia	N	LC		+			+		+	
Papilionidae	*Pachliopta aristolochiae*	Common rose	Podu rosa papilia	N	LC		+			+	+		
Papilionidae	*Pachliopta hector*	Crimson rose	Maha rosa papilia	N	LC		+		+		+	+	
Papilionidae	*Papilio crino*	Banded peacock	Monara papilia	N	VU		+						
Papilionidae	*Papilio domoleus*	Lime butterfly	Kaha papilia	N	LC		+	+	+		+		
Papilionidae	*Papilio polymnestor*	Blue mormon	Maha nilaya	N	LC	+	+	+	+		+		
Papilionidae	*Papilio polytes*	Common mormon	Kalu papilia	N	LC	+		+	+	+			+
Pieridae	*Appias galena*	Lesser albatross	Kuda sudana	E	LC	+		+		+	+	+	+
Pieridae	*Catopsilia pomona*	Lemon emigrant	Kaha piyasariya	N	LC		+		+		+		+
Pieridae	*Catopsilia pyranthe*	Mottled emigrant	Thith-piya piyasariya	N	LC			+		+	+		+
Pieridae	*Delias eucharis*	Jezebel	Podu Maha-sudda	N	LC			+	+		+	+	+
Pieridae	*Eurema hecabe*	Common grass yellow	Maha kahakolaya	N	LC			+			+		+
Pieridae	*Hebomoia glaucippe*	Great orange tip	Yoda sudana	N	LC		+		+				

Family	Scientific Name	English Name	Sinhala Name	TS	NCS	Mahakiriula			Mahakithula		Canal Path		
						TA	FO	SC	FO	SC	1	2	3
Pieridae	*Leptosia nina*	Psyche	Kalu-thith sudda	N	LC	+	+	+	+	+	+	+	+
Pieridae	*Pareronia ceylanica*	Dark wanderer	Anduru nil piyasariya	N	LC		+	+		+			
Land Snails													
Ariophantidae	*Cryptozona bistrialis*			N	LC		+		+				
Camaenidae	*Beddomea frifasciatus*			E			+		+				
Cyclophoridae	*Theobaldius Spp.*			E			+		+		+		
Freshwater Fish													
Cyprinidae	*Rasbora carverii*	Carverii Rasbora	Caveri Randiya	N	LC	+						+	
Cichlidae	*Oreochromis niloticus*	Tilapia	Tilapia/ Koraliya	I		+						+	
Channidae	*Channa striata*	Murrel	Loola	N	LC	+						+	
Amphibians													
Bufonidae	*Duttaphrynus melanostictus*	Common house toad	Sulaba geai gemba	N	LC					+	+		
Dicroglossidae	*Euphlyctis cyanophlyctis*	Skipper frog	Utpatana madiya	N	LC	+						+	
Dicroglossidae	*Fejervarya cf. syhadrenensis*	Common paddy field frog	Sulaba vel madiya	N	LC	+						+	
Rhacophoridae	*Polypedates maculatus*	Spotted tree frog	Pulli gas madiya	N	LC						+		+
Reptiles													
Agamidae	*Calotes versicolor*	Common garden lizard	Gara katussa	N	LC		+		+		+	+	+

Family	Scientific Name	English Name	Sinhala Name	TS	NCS	Mahakiriula			Mahakithula		Canal Path		
						TA	FO	SC	FO	SC	1	2	3
Agamidae	*Otocryptis nigristigma*	Black spotted kangaroo lizard	Wiyali Pinum katussa	E	LC		+	+	+				
Colubridae	*Ahaetulla nasuta*	Green vine snake	Ahaetulla	N	LC			+	+				
Colubridae	*Dendrelaphis tristis*	Front Spot bronze back	Handa haldanda	N	LC				+				
Colubridae	*Coeloganthus helena*	Trinket snake	Katakaluwa	N	LC		+						
Colubridae	*Boiga forsteni*	Forsten’s cat snake	Naga mapila	N	LC				+				
Colubridae	*Ptyas mucosa*	Rat snake	Gerandiya.	N	LC			+		+	+	+	
Crocodylidae	*Crocodylus palustris*	Mugger crocodile	Hala kimbula	N	LC	+							
Elapidae	*Bungarus caeruleus*	The common krait	Thel karawala	N	LC			+					
Elapidae	*Naja naja*	Indian cobra	Naya	N	LC				+	+		+	
Gekkonidae	*Hemidactylus frenatus*	Common house-gecko	Sulaba gehuna	N	LC					+	+	+	+
Natricidae	*Amphiesma stolatum*	Buff striped keelback	Aharukuka	N	LC	+							
Natricidae	*Xenochrophis cf. piscator*	Checkered Keelback	Diya bariya	E	LC	+						+	
Pythonidae	*Python molurus*	Indian python	Pimbura	N	LC			+		+			
Scincidae	*Eutropis carinata*	Common skink	Sulaba hikanala	N	LC		+	+	+		+	+	
Trionychidae	*Lissemys ceylonensis*	Flapshell turtle	Kiri ibba	E	LC	+							
Varanidae	*Varanus salvator*	Water monitor	Kabaragoya	N	LC	+					+	+	

Family	Scientific Name	English Name	Sinhala Name	TS	NCS	Mahakiriula			Mahakithula		Canal Path		
						TA	FO	SC	FO	SC	1	2	3
Viperidae	*Daboia russelii*	Russell's viper	Tith polonga.	N	LC					+		+	
Viperidae	*Hypnale hypnale*	Merrem's hump-nose viper	Polon thelissa	N	LC		+		+	+			
Birds													
Accipitridae	*Haliaeetus leucogaster*	White-bellied Sea-eagle	Kusa-ali Sayurukussa	N	LC	+							
Accipitridae	*Haliastur indus*	Brahminy Kite	Bamunu Piyakussa	N	LC	+					+	+	
Accipitridae	*Spilornis cheela*	Crested Serpent Eagle	Silu Sarapakussa	N	LC	+		+	+		+		+
Aegithinidae	*Aegithina tiphia*	Common Iora	Podu Iorawa	N	LC		+	+		+	+	+	+
Alaudidae	*Mirafra affinis*	Rufous-winged Bushlark	Rathpiya Akul-thulikawa	N	LC		+			+		+	+
Alcedinidae	*Alcedo atthis*	Common Kingfisher	Mal Pilihuduwa	N	LC	+						+	
Alcedinidae	*Halcyon smyrnensis*	White-throated Kingfisher	Layasudu Madi-pilihuduwa	N	LC	+	+			+	+	+	+
Anatidae	*Dendrocygna javanica*	Lesser Whistling-duck	Heen Thamba-seruwa	N	LC	+						+	
Anhingidae	*Anhinga melanogaster*	Oriental Darter	Peradigu Ahikava	N	LC	+							
Apodidae	*Apus affinis*	House Swift	Punchi Thurithaya	N	LC		+			+	+		
Apodidae	*Cypsiurus balasiensis*	Asian Palm Swift	Asiaa Thal-thurithaya	N	LC		+	+		+			+
Ardeidae	*Ardea cinerea*	Grey Heron	Alu Koka	N	LC	+							

Family	Scientific Name	English Name	Sinhala Name	TS	NCS	Mahakiriula			Mahakithula		Canal Path		
						TA	FO	SC	FO	SC	1	2	3
Ardeidae	*Ardea purpurea*	Purple Heron	Karawal Koka	N	LC	+							
Ardeidae	*Ardeola grayii*	Indian Pond Heron	Kana-koka	N	LC	+						+	
Ardeidae	*Bubulcus ibis*	Cattle Egret	Gava-koka	N	LC	+							
Ardeidae	*Casmerodius albus*	Great Egret	Maha Sudu-koka	N	LC	+						+	
Ardeidae	*Egretta garzetta*	Little Egret	Punchi Ali-koka	N	LC	+						+	
Bucerotidae	*Anthracoceros coronatus*	Malabar Pied Hornbill	Poru-Kandaththa	N	LC		+		+	+			
Bucerotidae	*Ocyceros gingalensis*	Sri Lanka Grey Hornbill	Sri Lanka Alu Kandaththa	E	LC		+		+		+		
Charadriidae	*Vanellus indicus*	Red-wattled Lapwing	Rath-yatimal Kirella	N	LC	+						+	
Ciconiidae	*Ciconia episcopus*	Woolly-necked Stork	Padili Manawa	N	NT	+							
Columbidae	*Chalcophaps indica*	Emerald Dove	Neela-Kobeiyya	N	LC		+	+		+			
Columbidae	*Ducula aenea*	Green Imperial Pigeon	Neela Mahagoya	N	LC		+	+			+	+	
Columbidae	*Streptopelia chinensis*	Spotted Dove	Alu Kobeiyya	N	LC		+	+	+	+	+	+	+
Cuculidae	*Centropus sinensis*	Greater Coucal	Ati-kukula	N	LC		+	+	+	+	+	+	+
Cuculidae	*Eudynamys scolopacea*	Asian Koel	Kowula	N	LC		+		+	+	+	+	
Cuculidae	*Phaenicophaeus viridirostris*	Blue-faced Malkoha	Wathanil Malkoha	N	LC			+		+		+	+
Dicaeidae	*Dicaeum erythrorhynchos*	Pale-billed Flowerpecker	Lathudu Pililichcha	N	LC		+	+	+	+	+	+	+
Dicruidae	*Dicrurus caerulescens*	White-bellied Drongo	Kawuda	N	LC						+	+	+

Family	Scientific Name	English Name	Sinhala Name	TS	NCS	Mahakiriula			Mahakithula		Canal Path		
						TA	FO	SC	FO	SC	1	2	3
Estrididae	*Lonchura striata*	White-rumped Munia	Nithamba Sudu Weekurulla	N	LC					+	+	+	+
Hirundinidae	*Hirundo daurica*	Red-rumped Swallow	Nithamba rathu Wahilihiniya	N	LC		+		+		+		+
Meropidae	*Merops orientalis*	Green Bee-eater	Punchi Binguharaya	N	LC		+		+	+	+		+
Monarchidae	*Terpsiphone paradisi*	Asian Paradise- flycathcher	Asia Rahanmara	N	LC		+		+	+		+	
Motacillidae	*Anthus rufulus*	Paddyfield Pipit	Keth Varatichcha	N	LC	+					+		
Muscicapidae	*Copsychus malabaricus*	White-rumped Shama	Wana Polkichcha	N	LC		+		+	+			
Muscicapidae	*Copsychus saularis*	Oriental Magpie Robin	Polkichcha	N	LC						+	+	+
Muscicapidae	*Cyornis tickelliae*	Tickell's Blue Flycatcher	Tickel Nil-masimara	N	LC		+		+				
Muscicapidae	*Saxicoloides fulicata*	Indian Robin	Indu Kalukichcha	N	LC					+	+	+	+
Nectariniidae	*Nectarina lotenia*	Loten's Sunbird	Lotenge Sutikka	N	LC		+	+		+		+	
Nectariniidae	*Nectarina zeylonica*	Purple-rumped Sunbird	Nithamba Dam Sutikka	N	LC		+	+	+	+		+	+
Oriolidae	*Oriolus xanthornus*	Black-hooded Oriole	Kahakurulla	N	LC			+		+			
Phalacrocoracidae	*Phalacrocorax fuscicollis*	Indian Cormorant	Indu Diyakava	N	LC	+						+	+
Phasianidae	*Gallus lafayetii*	Sri Lanka Junglefowl	Sri Lanka Wali-kukula	E	LC		+	+	+	+		+	
Phasianidae	*Pavo cristatus*	Indian Peafowl	Monora	N	LC		+	+	+	+		+	+
Picidae	*Dinopium benghalense*	Black-rumped Flameback	Rath-karela	N	LC		+			+	+	+	+
Podicipedidae	*Tachybaptus ruficollis*	Little Grebe	Punchi Gembithuruwa	N	LC	+					+	+	+

Family	Scientific Name	English Name	Sinhala Name	TS	NCS	Mahakiriula			Mahakithula		Canal Path		
						TA	FO	SC	FO	SC	1	2	3
Psittacidae	*Psittacula krameri*	Rose-ringed Parakeet	Rana Girawa	N	LC			+		+	+	+	+
Pycnonotidae	*Pycnonotus cafer*	Red-vented Bulbul	Kondaya	N	LC		+	+	+	+	+	+	+
Pycnonotidae	*Pycnonotus luteolus*	White-browed Bulbul	Bamasudu Kondaya	N	LC		+	+	+	+	+	+	+
Pycnonotidae	*Pycnonotus melanicterus*	Black-crested Bulbul	Kalu Hisasi Kondaya	E	LC		+	+	+	+		+	
Rallidae	*Amaurornis phoenicurus*	White-breasted Waterhen	Laya-sudu Korawakka	N	LC	+					+	+	+
Ramphastidae	*Megalaima haemacephala*	Coppersmith Barbet	Rathlaye Kottoruwa	N	LC		+	+	+	+	+	+	+
Ramphastidae	*Megalaima rubricapilla*	Crimson-fronted Barbet	Rathmhunath Kottoruwa	E	LC		+	+		+		+	+
Ramphastidae	*Megalaima zeylanica*	Brown-headed Barbet	Polos Kottoruwa	N	LC					+	+	+	+
Strigidae	*Ketupa zeylonensis*	Brown Fish Owl	Bora Kewul-bakamoona	N	LC		+						
Sturnidae	*Acridotheres tristis*	Common Myna	Mayna	N	LC		+	+	+	+	+	+	+
Sylviidae	*Orthotomus sutorius*	Common Tailorbird	Battichcha	N	LC		+	+	+	+	+	+	+
Threskiornithidae	*Threskiornis melanocephalus*	Black-headed Ibis	Indu Sudu Dakaththa	N	LC	+					+	+	+
Timalidae	*Pellorneum fuscocapillum*	Sri Lanka Brown-capped Babbler	Sri Lanka Boraga-demalichcha	E	LC		+	+	+	+		+	
Timalidae	*Turdoides affinis*	Yellow-billed Babbler	Demalichcha	N	LC		+	+	+	+	+	+	+

Family	Scientific Name	English Name	Sinhala Name	TS	NCS	Mahakiriula			Mahakithula		Canal Path		
						TA	FO	SC	FO	SC	1	2	3
Mammals													
Cercopithecidae	*Macaca sinica*	Sri Lanka toque monkey	Sri Lanka Rilawa	E	LC		+			+		+	+
Cercopithecidae	*Semnopithecus vetulus*	Purple-faced leaf monkey	Sri Lanka Kalu-wandura	E	EN		+						+
Cercopithecidae	*Semnopithecus priam*	Grey langur	Eli-wdura	N	LC		+	+	+	+			
Canidae	*Canis aureus*	Jackal	Hiwala	N	LC			+			+		+
Cervidae	*Axis axis*	Spotted deer	Tith Muwa	N	LC		+	+	+	+		+	+
Cervidae	*Rusa unicolor*	Sambur	Gõna	N	NT		+		+				
Elephantidae	*Elephas maximus*	Elephant	Aliya	N	EN		+	+	+	+		+	
Felidae	*Panthera pardus*	Leopard	Kotiya/Diviya	N	EN		+		+				
Felidae	*Prionailurus viverrinus*	Fishing cat	Handun Diviya	N	EN	+						+	
Herpestidae	*Herpestes edwardsii*	Grey mongoose	Alu Mugatiya	N	LC		+	+	+	+		+	+
Hystricidae	*Hystrix indica*	Procupine	Ittewa	N	LC					+	+	+	+
Leporidae	*Lepus nigricollis*	Black-naped hare	Wal Hawa	N	LC		+	+	+	+	+	+	+
Lorisidae	*Loris lydekkerianus*	Grey slender loris	Alu Unahapuluwa	N	NT				+			+	
Manidae	*Manis crassicaudata*	Pangolin	Kaballewa	N	NT		+	+	+			+	
Muridae	*Tatera indica*	Antelope rat	Weli-miya	N	LC			+					
Mustelidae	*Mustelidae*	Otter	Diya-balla	N	VU	+						+	

Family	Scientific Name	English Name	Sinhala Name	TS	NCS	Mahakiriula			Mahakithula		Canal Path		
						TA	FO	SC	FO	SC	1	2	3
Pteropodidae	*Pteropus giganteus*	Flying fox	Ma-vavula	N	LC					+	+		+
Sciuridae	*Funambulus palmarum*	Palm squirrel	Leena	N	LC			+			+	+	+
Sciuridae	*Ratufa macroura*	Giant squirrel	Dandu-leena	N	LC		+	+	+	+	+	+	+
Suidae	*Sus scrofa*	Wild boar	Wal Ura	N	LC		+	+	+	+	+	+	+
Tragulidae	*Moschiola meminna*	Sri Lanka mouse-deer	Sri Lanka Meminna	E	LC			+	+			+	
Ursidae	*Melursus ursinus*	Sloth bear	Walaha	N	EN		+						
Vespertillionidae	*Pipistrellus tenuis*	Pigmy pipistrel	Heen Koseta-vavula	N	LC		+		+	+		+	+
Viverridae	*Paradoxurus hermaphoditus*	Palm civet	Uguduwa	N	LC			+		+	+	+	+
Viverridae	*Viverricula indica*	Ring-tailed civet	Urulewa	N	LC		+	+	+		+		+

Photographs of the project area

Plate 1 A description on Restoration of MahaKiriula wewa

Plate 2 The dam of existing Mahakirula wewa

Plate 3 Scrublands close to the wewa

Plate 4 Scrublands and teak

Plate 5 Elephant damaged teak plantation

Plate 6 Elephant damaged teak plantation


Plate 7 Scrubland and teak, litter layer consists of dried teak leaves


Plate 8 Open areas in teak pplantation


Plate 9 Natural dry-mixed evergreen forest


Plate 10 Relatively undisturbed forest patch in Kahalla-Pallekele sanctuary


Plate 11 Isolated big tree in undisturbed forest


Plate 12 Understory trees and shrubs in the forest

Plate 13 Riverine forest along streams

Plate 14 Riverine forest along streams during August dry season

Plate 15 Mischodon zeylanicus (Tammanna) tree in riverinee forest near Mahakirula wewa

Plate 16 MahaKirula wewa

Plate 17 Standing dead tree in Mahakirula wewa

Plate 18 The existing dam of Mahakirula, this will be raised to increase the capacity of the wewa


Plate 19 Rock outcrop associated vegetation in Galkiriyagama kanda


Plate 20 The path of the canal at the foothill of Galkiriyagama kanda


Plate 21 The canal path along abandoned area


Plate 22 The existing habitats along the canal path


Plate 23 Scrublands


Plate 24 Abandoned paddy fields

Plate 25 scrubland and forest

Plate 26 Degraded forest area

Sri Lanka Forest Department Circular No. 28/ 1998

Number of Man Days for Planting, Maintenance of Forest Plantations and Nursery Practices
Nursery Practices (For All Areas)
Preparation of mother beds (except for teak – small seed beds):
For initial processes like clearance of land, preparation of seed beds etc.

	Man days
For a bed of 01m x 03 m	01
Sowing of seeds in a bed and shading of beds	01
Maintenance of a such bed for 01 month	03
For clearance of the land, if the mother beds are preparing in a newly selected land / per ha	60

Filling of polythene pots:
Collecting and supplying of surface soils, sand and preparation of soil mixtures and stacking of filled pots in beds etc.

For 1000 pots of 23cm x10cm (9”x4”)	06
For 1000 pots of 23cm x15cm (9”x6”)	08
For 100 pots of 45cm x30cm (18”x12”)	04

Transplanting:

1.3.1	Transplanting of 1000 plants and shading them	1.5
1.3.2	Shading of 04 beds of 01mx06m in which the pots are kept	01
1.3.3	For all the maintenance purposes such as watering, applying insecticides and weeding for 20,000 plants	01
1.3.4	Selecting of plants, grading, root pruning and re stacking of 5,000 plants	01
1.3.5	Maintenance of the drains of the beds, making a fence with sticks surrounding the beds to avoid the falling off the pots – 10 beds	01

Teak Nurseries:
First it is essential to do mechanical tilling and ploughing of the land. After that following processes can be carried out.

1.4.1	Preparation of a bed of 01mx10m	1.5
1.4.2	Pre treatment of 100kg of seeds and sowing of treated seeds in beds	10
1.4.3	All the maintenance processes such as weeding, watering, removing of insects, removing of excess leaves, cleaning of the drains etc. for 20 beds per month (only for first four months)	30
1.4.4	For 30 beds for next four months after above four months Stated in 1.4.3	30

		Man days
1.4.5	For making 500 stumps	01
1.4.6	Transplanting of teak stumps in polythene pots - 2000 pots	01

Loading of Stumps:

1.5.1	Loading of 2000 potted plants	01
1.5.2	Unloading of 2000 potted plants	01

Forest Planting

Boundary demarcation for surveying of the areas (demarcated boundary should be 01m wide). Following numbers of man days are required for setting the numbered pegs and surveying.

2.1 For 01km of shrub lands 07
2.2 For 01km of grass lands and open areas 04
2.3 For high lands/secondary forests in wet zone 09
2.4 Preparation of the lands in mountainous/hilly areas:
2.4.1 Clearing of strips along 01m wide contour lines in 2.5 m x2.5m intervals and low slashing of the remaining area – per hectare 30

Arranging and marking of the strips in 2.5mx2.5m intervals – per hectare 1.5
Digging holes of 30x30x30 cm in 2.5mx2.5m intervals and planting of potted plants – per hectare 37.5
2.4.4 For distribution of plants – per hectare 04
2.5 Preparation of land in wet and dry zones:
2.5.1 Low slashing, burning, re-burning of un-burnt things – per hectare 27
Arranging and marking of strips in 2.5mx2.5m intervals – per hectare 03

Digging of holes of 30 x30 x30 cm in 2.5m x2.5m intervals And planting of potted plants – per hectare 37.5
2.5.4 For distribution of plants – per hectare 03
2.6 Enrichment planting in secondary forests in the dry zone:
2.6.1 Clearance of 1.5m wide strips in 10m intervals, collecting of cuttings in to boundaries, arranging of strips and marking, Clearing a patch with diameter of 01m and digging of holes of 30 x 30 x 30 cm in 3.0m x 3.0m distance – per hectare 20
Distribution of plants and planting of potted plants – per hectare 05
2.7 Enrichment planting in secondary forests in the wet zone:
2.7.1 Clearance of 1.5m wide strips in 10m intervals, collecting of cuttings in to boundaries, arranging of strips and marking, clearing a patch with diameter of 01m and digging of holes of 30 x 30 x 30 cm in 3.0mx3.0m distance – per hectare 23

Man days

2.7.2 Distribution of plants and planting of potted plants
– per hectare 06

2.8 Converting of Pinus plantations in to broad-leaf plantations:

2.8.1 Clearance of 1.5m wide strips in 05 m intervals, collecting of cuttings in to boundaries, arranging of strips and marking, clearing a patch with diameter of 01m and digging of holes of 30x30x30 cm in 3.0mx3.0m distance – per hectare 15

2.8.2 Distribution of plants and planting of potted plants
– per hectare 08

Maintenance of Forest Plantations

3.1 Low slashing in 01m wide strips of forest plantations which are in 2.5mx2.5m intervals in mountainous/hilly areas – per hectare 20

3.2 For above process in forest plantations of dry zone – per hectare 27

Correct number of man days should be used when there are both wet and dry zones present in some districts. E.g. Dry zone units should be used in the case of Mahiyangana area in Badulla District.

3.3 For above process in forest plantations of wet zone – per hectare 28

3.4 Clearing of 01m diameter areas around the trees in mountainous/hilly areas land low slashing in forest plantations which are in 2.5mx2.5m intervals – per hectare 26

3.5 For above process (3.4) in forest plantations of dry zone
– per hectare 24

3.6 Fertilizing in forest plantations which are in 2.5mx2.5m intervals
– per hectare 05

3.8 Maintenance of enrichment forest plantations:

3.8.1 Clearing and cutting of vines in plantation strips in 10m x 03m interval and patch weeding of 01diameter patches around the plants in areas of dry zone – per hectare 07

3.8.2 Clearing and cutting of vines in plantation strips in 10m x 03m interval and patch weeding of 01 m diameter patches around plants in areas of wet zone – per hectare 08

Clearing and cutting of vines in strips when broad-leaf tree species are planted in Pinus plantations in 05mx03m intervals and patch weeding of 01diameter patches – per hectare 10

Clearing of Fire Belts

4.1 Clearing of fire belt of 10m wide and 01 km long 65

4.2 Clearing of internal fire belt of 05m wide and 01 km long 33

Annexure VII Cumulative Impact Assessment

CUMULATIVE IMPACT ASSESSMENT

Cumulative Impacts of the Mahaweli Water Security Investment Program

Introduction

Based on the findings of a Strategic Environment Assessment[15] undertaken by the government for the Mahaweli development program, the cumulative impacts of two key areas: biodiversity and hydrology were assessed for the investment program's projects and the under-construction Kaluganga and Moragahakanda Reservoirs, which are associated facilities. Mahaweli systems directly impacted by MWSIP include system E (Minipe), System IH (Nachchaduwa), system MH (Huruluwewa) System I (Mahakanadarawa).

A) Cumulative impact of the proposed North Central Province Canal Stage I on Sri Lanka's biodiversity

Even though Sri Lanka is a small island, its Biodiversity is significantly important both in a regional and global scale. Sri Lanka has the highest species density (number of species present per 10,000 sq. km) for flowering plants, amphibians, reptiles, and mammals in the Asian region (NARESA, 1991). Furthermore, the wet zone of Sri Lanka is declared as one of the 25 "global biodiversity hotspots" of the world (Mittermeier, 2005; Myers *et al.,* 2000). Designation of the wet zone of Sri Lanka as one of the global biodiversity hotspots stems from the fact that many of the species found in Sri Lanka is restricted to the island or endemic to Sri Lanka. Second reason being that many of the species are threatened, especially the species that are endemic to Sri Lanka (see table 1).

Table 1. Species diversity and Conservation status of few selected taxonomic groups found within Sri Lanka (MOE, 2012)

Taxonomic Group	Species	Endemic	Exotic	CR	EN	VU	NT
Freshwater Crabs	51	50 (98%)	0	34 (34)	12 (11)		5 (5)
Land Snails	231	205 (89%)	22	80 (70)	76 (72)	23 (20)	12 (10)
Amphibians	111	95 (85%)	0	34 (34)	28 (27)	10 (9)	3 (3)

[15] Ministry of Agriculture Development and Agrarian Services, *Dam Safety and Water Resources Planning Project: Strategic Environmental Assessment - Mahaweli Systems*, December 2012

Reptiles	191	124 (65%)	1	38 (36)	50 (39)	18 (11)	15 (7)
Freshwater Fish	91	50 (55%)	24	19 (16)	19 (17)	5 (4)	5 (3)
Spiders	501	257 (51%)	0	41 (14)	21 (10)		8 (2)
Dragonflies	118	47 (40%)	0	26 (22)	18 (14)	17 (4)	17 (1)
Flowering plants	3154	894 (%)	1035	218 (102)	552 (272)	615 (220)	350 (83)
Mammals	95	21 (22%)	12	13 (6)	25 (8)	15 (4)	7
Ferns	336	49 (15%)	0	42 (10)	88 (11)	70 (12)	40 (9)
Birds	240	33 (14%)	4	18	18 (7)	31 (11)	35 (3)
Butterflies	245	26 (11%)	1	21 (5)	38 (10)	40 (7)	21

Abbreviations Used: CR - Critically Endangered, **EN** - Endangered, **VU** - Vulnerable, **NT** - Near Threatened.

Sri Lanka also has a rich history that dates back to 500 BC. As Sri Lanka's civilization is based on agriculture there has been extensive remodelling of natural habitats during this long history, first in the dry zone during the height of the hydraulic civilization, then in the wet zone during the colonial period and after regaining independence in 1948, again the focus have shifted to the dry zone. During the last century alone, Sri Lanka's natural forest cover has declined by about 50% (see figure 1). The resulting loss and fragmentation of habitat have been the major drivers that has resulted in many of the species to become extinct or driven toward the brink of extinction.

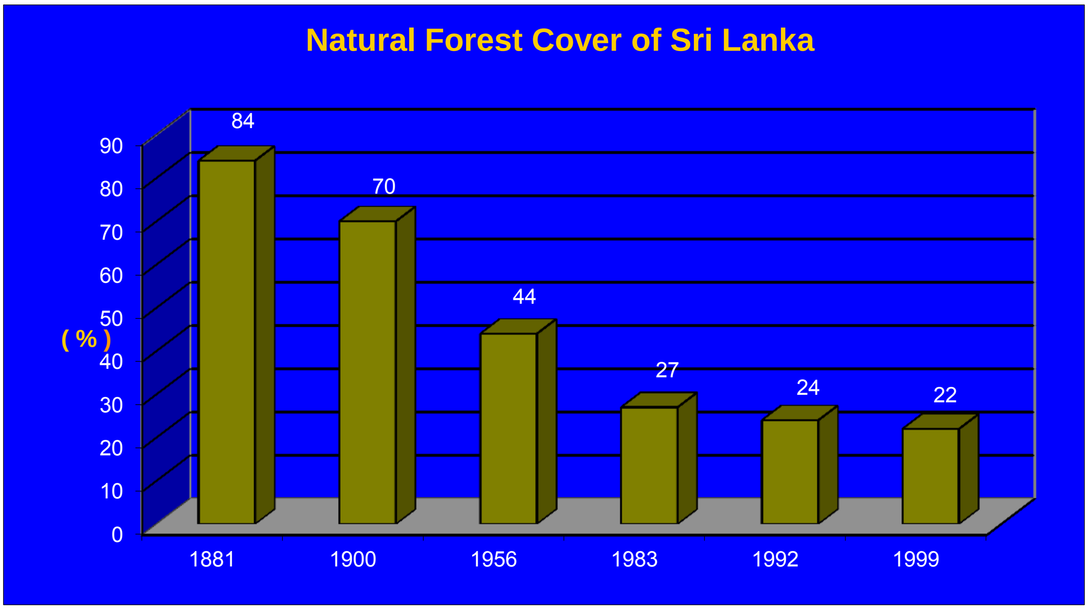

Figure 1. Change in the natural forest cover of Sri Lanka (Source: Forest Sector Master Plan).

The Mahaweli Ganga Development Programme that was drawn up during the period 1964 -1968 in order to utilize a regulated flow 5200 MCM annually from Mahaweli Ganga and adjacent river basins (Maduru Oya, Malwathu Oya, Kala Oya, Yan oya, Kivul Oya *etc*.,) for water resources development in four major sectors, irrigation, water supply, industrial use and hydroelectric power generation, has been the major driver that has contributed to wide scale land use changes in the Intermediate and dry zone of Sri Lanka during the last few decades. The whole of the Mahaweli Ganga development programme could not be completed as planned due to the armed conflict that prevailed mainly in the Northern and Eastern province of Sri Lanka for over three decades. However, with dawn of peace in 2009, the Ministry of Irrigation and Water Resources Management once again has recognized that implementation of remaining parts of this project is a priority taking into considering the current problems faced by the people in the dry zone. Further, development of water resources in the dry zone has been identified as one of the key climate change adaptation measure.

The proposed ADB funded Water Resources Development Investment Program (MWSIP) is part of the ongoing water resource development work that has been undertaken by the Ministry of Irrigation and Water Resources Management. The project will involve three sub projects

1. **Upper-Elahera Canal Project** – this includes Moragahakanda, Kaluganga, Kaluganga-Moragahakanda link canal and Upper-Elahera canal up to Hurulu wewa.
2. **North-western Canal Project** – This includes a canal from Lenadora to Kaduruwewa and establishment of two storage tanks, Maha Kithula and Maha Kirula
3. Raising the Minipe Anicut and rehabilitation of the Minipe LB canal

Each of the three sub projects of the proposed MWSIP will have an impact on one or more protected areas that has been established under the Fauna and flora Protection Ordinance or Forest Ordinance managed by the Department of Wildlife Conservation (DWC) or Forest Department (FD) as shown in Table 2.

Table 2. The protected areas that will be impacted by the MWSIP

Name of the Protected Area	Category	Extent (ha)		Year of Declaration
		Total	Affected	
North Western Canal Project				
Kahalla- Pallekele	S	21,690	342 (1.6%)	1989
Upper Elahera Canal Project				

Elahera-Giritale	S	14,035	190 (1.4%)	2000
Minneriya- Giritale	NR block III	4,745	0	1995
Minneriya	NP	8,889	15 (0.2)	1997
Hurulu	FR	25,000	0	1942
Upper Elahera Canal Project				
Victoria-Randenigala-Rantambe	S	42,089	25 (0.1%)	1987

Note: The proposed project activities of Kalu Ganga, Moragaha Kanda and Kaluganga-Morgahakanda Tunnel will not take place inside any declared protected areas.

Data Sources: MIWRM, 2014a; MIWRM, 2014b; MIWRM, 2014c; NRM, 2008; TEAMS, 1998

Description of protected areas according to the IUCN categorization (Dudley, 2008)

1. **National Park (NP)**: A Category II protected area managed by DWC.

2. **Nature Reserves (NR):** A Category IV protected area managed by DWC.

3. **Sanctuaries (S)**: A Category VI protected area managed by DWC.

4. **Forest Reserve (FR):** A Category IV protected area managed by FD.

The environment assessment reports of each of these sub projects have presented an analysis of the impact of the sub project on biodiversity and protected areas. The direct impact area of the MWSIP includes several protected areas. Further, Mahaweli river basin is the largest river basin in Sri Lanka with unique biogeographical attributes (there are several threatened endemic species that are restricted to Mahaweli River Basin). Therefore, the cumulative impact of the three proposed subprojects and their associated facilities on protected areas and critical species in the project affected areas was assessed. This report presents the findings of the cumulative impacts of the proposed MWSIP on the biodiversity in project impact area.

Habitat Diversity

Several natural habitat types were recorded in the project affected areas of MWSIP. These include tropical moist semi-evergreen forests, dry mixed evergreen forests, riverine forests and scrublands. A brief description of these habitat types are given below. Extents of these habitats that will be affected by each sub project is given in Table 3.

Tropical Moist semi-Evergreen Forest

These are closed canopy forest that generally consists of three layers, the canopy (20-25 m), sub canopy (5-10 m) and ground vegetation. The dominant plant species present in these forests include *Berrya cordifolia* (Hal Milla), *Pterospermum suberifolium* (Welan), *Vitex altissima* (Milla), *Lepisanthes tetraphylla* (Dambu), *Stereospermum colais* (Dunu madala), *Haldina cordifolia* (Kolon), *Mitragyna parvifolia* (Helamba), *Ventilago madraspatana* (Yakada Wel), *Holoptelea integrifolia* (Goda Kirilla), *Cipadessa baccifera* (Hal Bebiya), *Trema orientalis* (Gadumba), *Schleichera oleosa* (Koon), *Morinda coreia* (Ahu), *Azadirachta indica* (Kohomba), *Ficus* sp. (Nuga), *Ficus microcarpa*, *Ficus hispida* (Kota Dimbula), *Hibiscus vitifolius* (Maha Epala), *Careya arborea* (Kahata), *Peltophorum pterocarpum*, *Bauhinia racemosa* (Maila), *Flueggea leucopyrus* (Heen Katu Pila), *Croton aromaticus* (Wel Keppetiya), *Bridelia retusa* (Ketakala), *Merremia umbellata* (Kiri Madu) and *Alstonia scholaris* (Ruk Attana)

Dry-mixed Evergreen Forest

These are typical dry zone climax forest formations where the canopy reaches between 20-30 m beneath the canopy layer, the sub canopy (15 m), a shrub layer (5 m) and a herbaceous plant layer (1 m) can be seen. The canopy consists of tree species such as *Manilkara* (Palu), *Drypetes* (Wira), *Chloroxylon* (Burutha), *Alseodaphne* (Wewarana), *Berrya* (Halmilla), *Diospyros* (Kaluwara), *Schleichera oleosa* (Kon), *Pterospermum canescens* (Welan), and *Vitex altissima* (Milla). The sub canopy of the forest is dominated by *Drypetes* (Wira) and other medium sized trees such as *Diospyros ovalifolia, D. ferrea, Feronia acidissima, Xylopia nigricans, Nothopegia beddomei, Pleiospermium alatum, Cassia fistula*, *Bauhinia racemosa* can also be seen in this layer. The shrub lyer comprise of species such as *Ochna lanceolata, Tarenna asiatica, Memecylon angustifolium, M. capitellatum, M. umbellatum, Mallotus resinosus, Croton laccifer,* and *Dimorphocalyx glabellus.*

Riverine Forest

These are narrow strips of tall forests found along the banks of streams and rivers. This habitat is dominated by water loving trees such as *Terminalia arjuna* (Kumbuk), *Madhuca longifolia* (Mi), *Pongamia pinnata* (Magul Karanda), *Ficus racemosa* (Attikka), and *Nauclea orientalis* (Bakmi). Other species such as *Polyalthia longifolia* (Owila)*, Diospyros malabaricum* (Timbiri)*, Mangifera zeylanica* (Etamba)*, Nothopegia beddome* (Bala)*, Garcinia spicata* (Ela gokatu)*, Diospyros ferrea, Diospyros montana, Diospyros ovalifolia* (Kunumella)*, Homonoia riparia, Cynometra zeylanica, Hydnocarpus venenata* (Makulu)*, Barringtonia acutangula,* and *Vitex leucoxylon,* are found in these forests. *Dimorphocalyx glabellus* (Weliwenna) is the common understorey species found in the riverine forests.

Scrublands

Scrub vegetation forms in places where chena (shifting cultivation) have been abandoned. Soon after a chena plot is left to fallow, various herbaceous pioneer species begin to appear followed by woody species in a series of succession leading to the appearance of a secondary forest. It is found in areas where the climax forest is degraded. The degraded areas takes a long time to be converted back to closed-canopy forests through natural succession. The early seral stages of this natural succession are regarded as scrublands. These scrublands are comprise of a mixture of tree, herbaceous and shrub species such as *Azadirachta indica, Bauhinia racemosa, Carissa spinarum, Catunaregam spinosa, Dichrostachys cinerea, Flueggea leucopyrus, Gmelina asiatica, Grewia orientalis, Hugonia mystax, Ichnocarpus frutescens, Lantana camara, Limonia acidissima, Memecylon umbellatum, Phyllanthus polyphyllus, Scutia myrtina, Syzygium cumini, Toddalia asiatica* and *Ziziphus oenoplia*.

Table 3. The main natural habitats that will be affected by the MWSIP

Type of Ecosystem	**Extent (ha)**		**Name of the Sub Project**
	Total	**Affected**	
Moist semi-evergreen forests	24,191,640	3,540	Moragahakanda*
		518	Kalu Ganga*
Dry mixed evergreen forests	108,108,440	149	UE Canal
		300	NWP canal
		1,804	Moragahakanda*
		4,990	Kaluganga*
Riverine forests	2,229,040	25	Minipe Raising
		5	Kaluganga Link tunnel
		61	Kaluganga*
Scrublands	45,957,560	56	UE Canal
		50	NWP canal
		108	Moragahakanda*

Abbreviations Used: **UE** - Upper Elahera, **NWP** - North-western Province

Data Sources: MIWRM, 2014a; MIWRM, 2014b; MIWRM, 2014c; NRM, 2008; TEAMS, 1998*Moragahakanda and Kaluganga reservoirs are currently under construction and will not be funded by MWSIP but are considered as associated facilities

Total amount of natural habitats that will be affected by the MWSIP and associated facilities is approximately 11,606 ha. Out of the total extent of natural habitat lost, the MWSIP projects will only contribute to about 5% (585 ha) while the remaining 95% of the habitat loss will result due to Moragahakanda and Kaluganga projects that include two large reservoirs and large scale resettlements. Compared to the total extent of the available habitat in Sri Lanka, the area affected by the MWSIP and associated facilities is estimated to be approximately 0.006%.

Species Diversity

The species diversity was found to be highest in the Moragahakanda and Kaluganga projects compared to other sub projects. This could be attributed to the fact that the area impacted by these two projects is much greater than the other sub projects. A summary of the fauna and flora recorded in the project impacted area of each sub project is given in table 4.

Table 4. A summary of the fauna and flora recorded in each the project affected areas of each sub project of MWSIP and associated facilities.

Project Name	Total	Endemic	Exotic	Migrant	CR	EN	VU	NT
KGP - Flora	401	29	43	0	0 (1)	7 (0)	16 (6)	14 (0)
KGP - Fauna	327	51	1	16	5 (0)	5 (11)	17 (1)	19 (3)
MKP - Flora	456	29	71	0	0 (0)	7 (2)	13 (7)	11 (0)
MKP - Fauna	272	45	2	12	6 (1)	6 (11)	10 (1)	22 (8)
KMT - Flora	130	13	10	0	0 (0)	3 (0)	7 (4)	10 (0)
KMT - Fauna	136	9	0	7	0 (0)	1 (1)	2 (0)	2 (1)
UEC - Flora	174	10	10	0	0 (0)	2 (0)	2 (1)	1 (0)
UEC - Fauna	240	17	1	16	0 (0)	3 (4)	3 (4)	7 (4)
NWP - Flora	133	9	3	0	0 (0)	0 (1)	0 (0)	0 (0)
NWP - Fauna	181	15	1	9	0 (0)	5 (4)	2 (2)	6 (8)
MAR - Flora	240	17	62	0	0 (1)	3 (0)	14 (5)	16 (0)
MAR - Fauna	147	14	1	1	0 (0)	1 (4)	6 (0)	7 (5)

Abbreviations used: KGP – Kalu Ganga Project, **MKP** – Moragaha Kanda Project, **KMT** – Kaluganga-Moragahakanda Tunnel, **UEC** – Upper Elahera Canal, **NWP** –North-western Province

Canal, **MAR** – Minipe Anicut Raising, **CR** – Critically Endangered, **EN** - Endangered, **VU** - Vulnerable, **NT** - Near Threatened.

Data Sources: EML, 2011; IUCN, 2007; MIWRM, 2014a; MIWRM, 2014b; MIWRM, 2014c; NRM, 2008; TEAMS, 1998

Threatened and Endemic Species

Altogether 46 endemic plants species were recorded in the project impact areas of all the sub projects (see annex I). These included 10 species listed as Endangered, 22 species listed as Vulnerable, 22 species listed as Near Threatened and 26 species listed as Least Concern in the National List of Threatened Species (MOE, 2012). Further, out of the 46 endemic species recorded 1 species is listed as Critically Endangered, 3 species as Endangered, 7 species as Vulnerable in the Global List of Threatened Species (IUCN, 2014). It should also be noted that all but 1 species has been evaluated using an old version of the Global Criteria (version 2.3 in 1996) and the status given in the global list is outdated for Sri Lankan flora. Further 35 out of the 46 endemic species have not been evaluated in the Global list. Therefore, the listing provided in the national list is a more reliable depiction of the present conservation status of Sri Lankan flora. In addition to these threatened endemic fauna 17 species of native plants (5 - Endangered and 12 - Vulnerable) listed as Nationally threatened and 17 species as Nationally Near Threatened has been recorded from the project affected areas of MWSIP. Likewise 2 native species of plants listed as Globally Vulnerable has also been recorded from project affected areas of MWSIP.

Among the fauna recorded in the project impacted areas of each of the three sub projects of MWSIP, 66 are endemic to Sri Lanka (see annex I). These 66 endemic species included 7 species listed as Critically Endangered, 9 species listed as Endangered, 26 species listed as Vulnerable, 32 species listed as Near Threatened and 32 species listed as Least Concern in the National List of Threatened Species (MOE, 2012). Further, out of the 66 endemic species, 1 species is listed as Critically Endangered, 12 species as Endangered, 11 species as Vulnerable, 4 species as Near Threatened and 38 species as Least Concern in the Global List of Threatened Species (IUCN, 2014). As in the case of flora, the status indicated in the Global List are outdated for Sri Lankan fauna, especially for the endemic species where the listing provided in the national list is a more reliable depiction of their present conservation status. Further 39 out of the 66 endemic species have not been evaluated in the Global list. In addition to these threatened endemic fauna 12 species of native plants (4 - Endangered and 8 - Vulnerable) listed as Nationally threatened and 23 species as Nationally Near Threatened has been recorded from the project affected areas of MWSIP. Likewise 6 native species of plants listed as Globally threatened (3 - Endangered and 3 - Vulnerable) and 9 species as Globally Near Threatened has also been recorded from project affected areas of MWSIP.

Restricted Range Species

Mahaweli River, the largest river basin in Sri Lanka with a watershed area of 10,448 km^2 represents ca. 16% of the land area of the Island. The upper catchment of the Mahaweli river supports one of the most high biodiverse areas in Sri Lanka, the Knuckles Conservation Forest. Further, Mahaweli River and some of the sub catchments (Raththota oya, Kalu ganga, Theligamu oya and Kambarawa oya) of the Amban ganga, one of the main tributaries of Mahaweli river, is inhabited by number of fish that are endemic to Sri Lanka and restricted to these sub catchments. Altogether 11 endemic species are restricted to the Mahaweli river. In addition, there appears to be number of yet undescribed species of fish inhabiting Mahaweli river. A list of species that are restricted to Mahaweli river are shown in table 5 along with comments on the impact of the proposed MWSIP on these species.

Table 5. List of species that is restricted to the Mahaweli river basin

Family	Scientific Name	Common Name	TS	NCS	GCS	Remarks
Cyprinidae	*Devario aequipinnatus*	Knuckles Danio	E	CR	LC	KG and MK
Cyprinidae	*Labeo fisheri*	Common Labeo	E	CR	EN	MK
Cyprinidae	*Laubuca insularis*	Knuckles labuca	E	CR	NE	KG and MK
Cyprinidae	*Puntius martenstyni*	Martenstyni's barb	E	CR	EN	KG and MK
Cyprinidae	*Puntius srilankensis*	Blotched filamented barb	E	CR	NE	KG and MK
Dicroglossidae	*Nannophrys marmorata*	Sri Lanka rock frog	E	EN	VU	Not affected
Agamidae	*Ceratophora tennentii*	Leafnose lizard	E	CR	EN	Not affected
Agamidae	*Cophotis dumbara*	Knuckles pygmy lizard	E	CR	CR	Not affected
Agamidae	*Calotes pethiyagodai*	Pethiyagoda’s crestless lizard	E	NE	NE	Not affected
Scincidae	*Chalcidoseps thwaitesii*	Fourtoe snakeskink	E	CR	NE	Not affected
Gekkonidae	*Cyrtodactylus soba*	Knuckles forest gecko	E	CR	NE	Not affected

Abbreviations used:TS - Taxonomic Status, **E** - Endemic, **NCS** - National Conservation Status, **GCS** - Global Conservation Status, **CR** - Critically Endangered, **EN** - Endangered, **VU** - Vulnerable, **NE** - Not

Evaluated, KG – Kaluganga reservoir (associated facility to MWSIP), MK-Moragahakanda reservoir (associated facility to MWSIP)

Data Sources: Amarasinghe *et al*., 2014; ARROS, 2005; IUCN, 2014; MOE, 2012; Pethiyagoda, 1991; Pethiyagoda *et al*., 2008; Samarawickrama *et al*., 2006.

Out of the 11 restricted range species that occur in the Mahaweli river basin five species of freshwater fish has been recorded in the areas to be inundated under the Moragahakanda and Kaluganga reservoirs. None of these species have been recorded in the project impacted area of the three subprojects coming under the MWSIP. The Mahaweli Authority of Sri Lanka with the assistance of IUCN Sri Lanka has already completed a translocation programme where the fish species identified to be impacted by the proposed Moragahakanda and Kalu ganga development projects have been relocated to suitable locations in the upper catchment of the Mahaweli River.

Mitigation Measures: Mitigation measures for the ongoing constructions of Kaluganga and Moragahakanda reservoir are currently being implemented (includes reforestation in degraded areas, introduction of community forestry programs in buffer zones and canal reservations, forestry programs in upper watershed areas, control of invasive species in existing protected areas, habitat enrichment in the protected area network in the immediate vicinity, and declaration of two new protected areas and establishment of elephant corridors to ensure free movement of wildlife and translocation of critical species from project affected areas into safe and suitable sites). The following discusses the overall measures in place to address the key issues for the for the three sub projects that comes under the proposed MWSIP. These include loss of habitat, disruption of movement patterns and death or injury to animals from falling into the canal (applies only to NWP and UEC sub projects), escalation of human-elephant conflict and reduction of downstream flow (applies only to Minipe raising project).

Loss of Habitat: A habitat enrichment programme will be undertaken with the aim of reforesting/ enriching approximately 1000 ha under the three sub projects (500 ha under Upper Elahara Canal, 350 ha under North-western Province Canal and 145 ha under the Minipe LB canal rehabilitation project) to achieve an overall biodiversity offset ratio of 2. The main aim will be to restore degraded areas or undertake reforestation of plantation forests within protected areas (250 ha in Minneriya-Giritale and 350 ha in Kahalla-Pallekelle Sanctuary). This will lead to increased habitat complexity and thereby enhance the carrying capacity of these protected areas which will compensate for the habitat loss. In addition to these efforts restoration of tank catchments will be undertaken with the aim of reducing the sedimentation of tanks as well as enhance their carrying capacity. Third aim of the reforestation programme is to link existing protected areas to prevent fragmentation of habitats. Such an opportunity is only presented in the Minipe LB canal where it has been proposed to undertake reforestation of the canal reservation to create a riverine forest that can link three important protected areas, namely Victoria-Randenigala-Rantembe Sanctuary, Knuckles Conservation forest and Wasgomuwa National Park.

Disruption of movement patterns and death or injury due to animals from falling into the canal: Since the upper Elahera canal and north–western province canal project involves establishment of long stretches of open lined canals it will result in disruption of movements of animals, especially less mobile species. Further, animals falling into the canal resulting in death or injury have been identified as a one of the main impacts of some of the long lined canals that are already being operated by the MIWRM. Therefore, the canal design has incorporated structures in the open sections of the canal at 500 m intervals to ensure safe passage of animals across the canal as well as to facilitate those animals that fall into the canal to exit the canal safely.

Escalation of Human-Elephant conflict: Under each of the three sub projects of MWSIP money is set aside to provide short term solutions for human-elephant conflict that will arise due to the project. However, it should be noted that human-elephant conflict is wide spread socio-political problem that requires a long term solution. Therefore, MIWRM has already commissioned a study through IUCN Sri Lanka to develop and institute a long term human-elephant conflict management strategy within the entire area that will undergo a change in the cropping pattern under the proposed MWSIP to ensure that human-elephant conflict will not prevent accruing the overall benefits envisaged through the proposed water resource development under the MWSIP.

Reduction in downstream flow: This impact will take place only in one of the three sub projects of MWSIP (the Minipe raising) as the proposed project will result in diversion of more water in to Minipe LB and RB canals. As a result a stretch of about 6.5 km between the Minipe anicut and the confluence between Mahaweli river and Badulu oya will be subjected to low flows. Further, this will result in the reduction of the wetted perimeter of the river. These two impacts will result in a reduction of population densities of aquatic fauna and flora inhabiting this stretch of the river. Therefore an e-flow shall be released to meet the ecological demands of the river. According to the water balance study, taking into account the water flow in this affected section of the river for the past 50 years, the e-flow along with spillages from Minipe anicut will ensure that at least 28% of the Mean Annual Flow of the river will be released into the river. Further, a short (0.5 m) weir will be constructed across the Mahaweli river downstream of the Minipe Anicut so that the e-flow released will be dispersed across the river bed to ensure that the wetted perimeter of the river shall not decrease drastically from its present day level. This will ensure that the aquatic species present in the river will not decline in their distribution and deep pools within the river that can support large fish species such as the Marsheer, are continuously refreshed and therefore the quantity and quality of water in such pools will not decline even with the increase in the diversion of water from the main river after completion of the Minipe raising.

Conclusions: The proposed sub projects of the MWSIP will not have any impacts on the endemic and Critically Endangered or Endangered faunal species that are restricted to the Mahaweli River Basin. *Semnopithecus vetulus* (Purple-faced leaf monkey) is the only endemic Endangered species that was recorded in the project impacted area of MWSIP projects. This species was recorded in the command area of the North-western Province Canal sub project and the proposed development activities will not have an impact on this species as it will not result in any habitat loss of the species. In addition to this four non endemic Endangered species, *Elephas maximus* (Asian Elephant), *Prionailurus viverrinus* (Fishing cat), *Panthera pardus* (Leopard) and *Melursus ursinus* (Sloth bear). Other than the Asian Elephants rest of the endangered species occur primarily in protected areas and the proposed development activities will not result in a significant habitat reduction of any of these species.

References

Amarasinghe, A. A. T., Karunarathna, D. M. S. S., Hallermann, J., Fujinuma, J., Grillitsch, H. and Campbell, P.D. (2014). A new species of the genus *Calotes* (Squamata: Agamidae) from high elevations of the Knuckles Massif of Sri Lanka. *Zootaxa* 3785 (1)59-78.

Dudley, N. (Editor) (2008). *Guidelines for Applying Protected Area Management Categories.* Gland, Switzerland: IUCN. x+86pp.

EML (2011). Detailed Biodiversity Study on Abundance & Behavioural Patterns/ Wildlife in the Project Area - Kaluganga Reservoir & Agricultural Extension Project

IUCN (2007). Biodiversity Assessment of the Moragahakanda Agriculture Development Project.

IUCN (2014). Global list of threatened species. www.iucnredlist.org

Mittermeier, R.A., Gil, P.R., Hoffman, M., Pilgrim, J., Brooks, T., Mittermeier, C.G., Lamoreux, J., & da Fonseca, G.A.B. (2005). Hotspots revisited: Earths biologically richest and most threatened ecoregions. Conservation International, Washington D.C. 392 pp.

MIWRM (2014a). Initial Environment Examination Report of the proposed raising of Minipe anicut project in Kandy District.

MIWRM (2014b). Environment Impact Assessment Report of the modifications to configurations of Moragahakanda-kaluganga projects proposed Upper Elehara canal (UEC), canal from Mannakkattiya tank to Mahakanadarawa tank and Kaluganga-moragahakanda link canal project.

MIWRM (2014c). Environment Impact Assessment Report of the diversion of Mahaweli water to upper Mi oya and Hakwatuna oya basins in Kurunegala district.

MOE (2012). The National Red List 2012 of Sri Lanka; Conservation Status of the Fauna and Flora. Ministry of Environment, Colombo, Sri Lanka.

Myers, N., Mittermeier, R.A., Mittermeier, C.G., da Fonseca, G.A.B. & Kent, J. (2000). Biodiversity hot spots for Conservation Priorities. *Nature*. 403: 853-858

NARESA (1991). Natural resources of Sri Lanka: conditions and trends. Natural Resources, Energy and Science Authority, Colombo pp. 280.

NRM (2008). Environmental Impact Assessment report of the Kalu Ganga Reservoir and Agricultural Extension project.

TEAMS (1998). Environment Impact Assessment Report of the Moragahakanda agricultural development project.

Annex I. The endemic and threatened species (Nationally and Globally) of plants and animals recorded in the project affected areas of each sub project of MWSIP and associated facilities.

Species Name	Common Name	TS	NCS	GCS	MO	KG	LK	UE	NW	MI
Butterflies										
Appias galena	Lesser albatross	E	LC	NE	+	+	+	+	+	+
Charaxes solon	Black rajah	N	NT	NE	+	+				
Graphium nomius	Spot swordtail	N	VU	NE	+	+				
Hasora taminatus	White banded Awl	N	NT	NE	+	+	+	+		
Ideopsis similes	Blue glassy tiger	N	VU	NE		+				
Pantoporia hordonia	Common lasker	N	NT	NE						+
Papilio crino	Banded peacock	N	VU	LC	+	+	+		+	+
Tirumala septentrionis	Dark blue tiger	N	NT	NE	+	+				
Troides darsius	Ceylon birdwing	E	LC	NE	+	+				+
Dragonflies										
Anax immaculifrons	Fiery Emperor	N	VU	LC						+
Euphaea splendens	Shining Gossamerwing	E	NT	NE	+	+				
Elattoneura centralis	Dark-glittering Threadtail	E	VU	NE						+
Ictinogomphus rapax	Rapacious Flangetail	E	LC	LC						+
Libellago adami	Adam's Gem	E	VU	NE		+				+
Libellago greeni	Green's Gem	E	EN	NE		+				
Orthetrum pruinosum	Pink Skimmer	N	NT	LC		+		+		+
Trithemis festiva	Indigo Dropwing	N	VU	LC		+		+		+
Vestalis apicalis	Black-tipped flashwing	E	VU	LC		+				
Freshwater Fish										
Belontia signata	Combtail	E	NT	LC	+					+
Channa orientalis	Smooth-breasted snakehead	E	VU	NE		+				
Devario cf . aequipinnatus	Knuckles Danio	E	CR	LC	+	+				
Esomus thermoicos	Flying barb	E	LC	LC		+		+		
Garra ceylonensis	Stone sucker	E	VU	EN	+	+		+		+

Species Name	Common Name	TS	NCS	GCS	MO	KG	LK	UE	NW	MI
Laubuca insularis	Knuckles labuca	E	CR	NE	+	+				
Laubuca lankensis	Lanka labuca	E	VU	NE		+				
Labeo fisheri	Common Labeo	E	CR	EN	+					
Puntius kelumi	Kelums Long snouted barb	E	EN	NE		+				
Puntius martenstyni	Martenstyni's barb	E	CR	EN	+	+				
Puntius singhala	Filamented Barb	E	LC	LC	+	+		+	+	
Puntius srilankensis	Blotched filamented barb	E	CR	NE	+	+				
Tor khudree	Mahseer	N	NT	EN	+	+				+
Frogs										
Adenomus kelaartii	Kelaart's dwarf toad	E	VU	EN		+				
Fejervarya kirtisinghei	Montain paddy field frog	E	VU	EN	+	+				
Hylarana gracilis	Wood frog	E	LC	LC	+					
Hylarana temporalis	Bronzed frog	E	NT	NT		+				
Ichthyophis glutinosus	Ceylon caecilian	E	VU	LC	+					
Lankanectes corrugatus	Corrugated water frog	E	VU	LC		+				
Nannophyrus marmorata	Marbled rock frog	E	CR	CR	+					
Philautus cavirostris	Tubercle tree frog	E	EN	EN	+	+				
Pseudophilautus fergusonianus	Ferguson's shrub frog	E	VU	LC	+					
Pseudophilautus popularis	Common shrub frog	E	NT	EN	+					
Pseudophilautus regius	Polonnaruwa shrub frog	E	VU	DD	+					
Polypedates cruciger	Common hour-glass tree frog	E	LC	LC	+	+		+		
Reptiles										
Aspidura brachyorrhos	Boie’s roughside	E	VU	NE		+				
Boiga forsteni	Forsten’s cat snake	N	NT	LC	+	+		+		
Calliophis haematoetron	Bloody vented coral snake	E	CR	NE		+				
Calotes ceylonensis	Painted lip lizard	E	NT	NE	+	+				
Calotes liolepis	Whistling lizard	E	NT	NE	+	+				
Chrysopelea taprobanica	Striped flying snake	E	LC	NE						
Cnemaspis podihuna	Dwarf day gecko	E	VU	NE	+	+				
Crocodylus palustris	Marsh Crocodile	N	NT	VU				+		

Species Name	**Common Name**	**TS**	**NCS**	**GCS**	**MO**	**KG**	**LK**	**UE**	**NW**	**MI**
Dendrelaphis bifrenalis	Boulenger's bronze back	E	NT	LC	+	+		+		
Dasia halianus	Haly's treeskink	N	NT	NE						
Cyrtodactylus triedra	Spotted bowfinger gecko	E	VU	NE						
Geckoella yakhuna	Blotch bowfinger gecko	E	VU	NE		+				
Geochelone elegans	Indian star tortoise	N	NT	LC	+				+	
Hemidactylus depressus	Kandyan gecko	E	LC	NE	+	+				
Lankascincus fallax	Common lankaskink	E	LC	NE	+	+				
Lissemys ceylonensis	Flapshell turtle	E	LC	NE					+	
Lyriocephalus scutatus	Hump-snouted lizard	E	VU	NT	+					
Nessia bipes	Smith's snakeskink	E	EN	NE	+					
Otocryptis nigristigma	Black spotted kangaroo lizard	E	LC	NE	+	+		+	+	
Otocryptis wiegmanni	Sri Lankan kangaroo lizard	E	NT	NE	+	+				
Trimeresurus trigonocephalus	Green pit viper	E	LC	NE	+	+				
Xenochrophis asperrimus	The checkered keelback	E	LC	NE		+				
Xenochrophis cf. piscator	Checkered Keelback	E	LC	NE		+			+	
				Birds						
Anhinga melanogaster	Darter	N	LC	NT	+			+	+	
Anthracoceros coronatus	Malabar Pied Hornbill	N	NT	NT	+				+	+
Cacomantis sonneratii	Banded Bay Cuckoo	N	NT	LC				+		
Ceryx erithaca	Oriental Dwarf Kingfisher	N	NT	NE		+		+		
Charadrius alexandrinus	Kentish Plover	N/M	VU	LC				+		
Charadrius dubius	Little Ringed Plover	N/M	VU	LC				+		
Ciconia episcopus	Woolly-necked Stork	N	NT	LC	+			+		+
Dendrocopos mahrattensis	Yellow-crowned Woodpecker	N	NT	LC		+				
Elanus caeruleus	Black-shouldered Kite	N	NT	LC		+				
Galloperdix bicalcarata	Sri Lanka Spurfowl	E	NT	LC	+	+				
Gallus lafayetii	Sri Lanka Junglefowl	E	LC	LC	+	+	+	+	+	+
Hirundapus giganteus	Brown-backed Needletail	N	NT	LC		+				
Hirundo hyperythra	Red-rumped Swallow	N	NT	NE	+	+	+	+		+
Ichthyophaga ichthyaetus	Grey-headed Fish-eagle	N	NT	NE	+			+	+	

Species Name	Common Name	TS	NCS	GCS	MO	KG	LK	UE	NW	MI
Loriculus beryllinus	Sri Lanka Hanging Parakeet	E	LC	LC	+	+	+			+
Megalaima flavifrons	Sri Lanka Yellow-fronted Barbet	E	LC	LC	+	+				
Megalaima rubricapillus	Sri Lanka Crimson-fronted Barbet	E	LC	LC	+	+	+	+	+	
Ocyceros gingalensis	Sri Lanka Grey Hornbill	E	LC	LC	+	+	+	+	+	+
Pelecanus philippensis	Spot-billed Pelican	N	LC	NT						+
Pellorneum fuscocapillus	Sri Lanka Brown-capped Babbler	E	LC	LC	+	+	+	+	+	+
Phaenicophaeus pyrrhocephalus	Sri Lanka Red-faced Malkoha	E	VU	VU		+				
Pomatorhinus melanurus	Sri Lanka Scimitar Babbler	E	LC	LC	+	+				
Pycnonotus melanicterus	Black-crested Bulbul	E	LC	LC	+	+		+	+	
Threskiornis melanocephalus	Black-headed Ibis	N	LC	NT					+	+
Tephrodornis pondicerianus	Common Woodshrike	E	LC	LC	+	+	+	+	+	+
Treron pompadora	Pompadour Green-pigeon	E	LC	LC	+	+	+	+	+	
Mammals										
Cervus unicolor	Sambur	N	NT	VU	+			+	+	
Elephas maximus	Elephant	N	EN	EN	+	+	+	+	+	+
Loris lydekkerianus	Grey slender loris	N	NT	LC	+	+			+	
Lutra lutra	Otter	N	VU	NT	+	+	+	+	+	
Macaca sinica	Sri Lanka toque monkey	E	LC	EN	+	+		+	+	+
Moschiola meminna	Sri Lanka mouse-deer	E	LC	LC	+	+	+	+	+	
Manis crassicaudata	Pangolin	N	NT	NT	+				+	
Melursus ursinus	Sloth bear	N	EN	VU					+	
Muntiacus muntjak	Barking deer	N	NT	NE	+			+		
Panthera pardus	Leopard	N	EN	NT	+			+	+	
Prionailurus viverrinus	Fishing cat	N	EN	EN	+	+		+	+	
Ratufa macroura	Giant squirrel	N	LC	NT	+	+	+		+	+
Semnopithecus priam	Grey langur	N	LC	NT	+			+	+	+
Semnopithecus vetulus	Purple-faced leaf monkey	E	EN	EN	+	+			+	
Flowering Plants										
Alangium salviifolium	Ruk Anguna	N	NT	NE			+			+
Alseodaphne semecarpifolia	Wewarana	N	VU	NE	+	+				+

Species Name	Common Name	TS	NCS	GCS	MO	KG	LK	UE	NW	MI
Anodendron paniculatum	As Wel	N	VU	NE						+
Anthocephalus chinensis		N	NT	NE		+				
Argyreia populifolia	Giritilla	E	LC	NE	+	+				
Artocarpus nobilis	Bedi Del	E	LC	VU	+					+
Calamus rotang	Heen-wewel	N	NT	NE	+	+				
Calamus thwaitesii	Ma-Wewel	N	VU	NE		+	+			
Calophyllum tomentosum	Tel Keena	E	VU	VU	+	+	+			
Carallia brachiata	Dawata	N	NT	NE	+	+	+			+
Cassine balae	Neraloo	E	LC	NE	+					
Chloroxylon swietenia	Satin Wood (E), Burutha (S)	N	VU	VU	+	+	+			+
Cissus heyneana	Wal-muddarappalam	E	LC	NE	+			+		
Cleistanthus pallidus		E	LC	NE				+		+
Coix gigantea	Heen Kirindi	N	NT	LC						+
Combretum albidum	Kaduru Ketiya Wel	N	NT	NE						+
Cryptocoryne beckettii	Athiudayan	E	VU	NE	+	+	+			+
Cryptocoryne parva		E	EN	NE	+	+	+			+
Cynometra zeylanica		E	NT	NE		+				+
Derris parviflora	Kala Wel	E	LC	NE	+	+	+	+	+	+
Dioscorea trimenii	Dahaiya-ala	E	EN	NE	+		+			
Diospyros ebenoides	Kalu-habaraliya	E	EN	EN	+					
Diospyros ebenum	Ebony (E) Kaluwara (S)	N	EN	DD	+	+		+	+	+
Diospyros nummulariifolia		E	LC	EN					+	
Diospyros oocarpa	Kalu-kudumberiya	N	NT	NE	+	+	+			
Diplodiscus verrucosus	Dikwenna	E	LC	NE		+		+	+	
Diyaminauclea zeylanica	Diya-mi	E	EN	NE		+				
Drypetes gardneri	Gal Wira	E	NT	NE	+	+	+			+
Dysoxylum ficiforme		N	NT	VU		+				+
Epipogium roseum		N	EN	NE	+					
Erythrina fusca	Yak-erambadu	N	NT	NE						+
Erythroxylum zeylanicum		E	LC	NE		+	+		+	

Species Name	Common Name	TS	NCS	GCS	MO	KG	LK	UE	NW	MI
Garcinia quaesita	Goraka	E	LC	VU		+				
Garcinia spicata	Ela Gokatu	N	NT	NE	+	+	+			+
Garcinia terpnophylla		E	EN	NE		+				
Glenniea unijuga	Wal mora	E	LC	VU	+	+		+		
Helicteres isora	Screw tree (E), Lihiniya (S)	N	NT	NE	+	+	+			+
Holoptelea integrifolia	Indian Elm (E) Goda kirilla (S)	N	NT	NE	+		+			+
Homonoia riparia	Willow-levaed Water Croton	N	NT	LC		+	+			+
Horsfieldia iryaghedhi	Ruk Gedhi	E	VU	CR		+				+
Hydnocarpus venenata	Makulu	E	LC	NE	+	+	+	+	+	+
Ixora jucunda	Wal-rathmal	E	LC	VU	+					
Knoxia hirsuta		E	VU	NE	+					
Lagenandra praetermissa	Kethala	E	LC	NE		+				+
Madhuca longifolia	Mousey Mi (E), Mi (S)	N	NT	NE	+	+	+			+
Mallotus eriocarpus	Val-keppetiya	E	LC	NE	+					
Mangifera zeylanica	Etamba	E	LC	VU	+	+	+			+
Manilkara hexandra	Palu	N	VU	NE	+	+		+		
Margaritaria indicus	Karavu	N	VU	NE	+	+	+	+		+
Memecylon angustifolium	Blue Mist (E), Kora kaha (S)	N	EN	NE		+				
Memecylon capitellatum	Wal-kaha	E	LC	NE	+	+		+	+	
Micromelum minutum	Wal-karapincha	E	LC	NE		+				
Munronia pinnata	Bin-kohomba	N	EN	NE	+	+		+		
Ochna jabotapita	Bo-kera	E	LC	NE	+					
Painteria nitida	Diya-Mmara	E	VU	NE		+				
Pandanus ceylanicus	Weta Keyiya	E	VU	NE	+	+	+			+
Phyllanthus myrtifolius		E	VU	NE	+	+				+
Pisonia aculeate	Vavul Lairitiya	N	NT	NE						+
Premna alstoni		E	LC	NE					+	
Psilanthus wightianus		N	VU	NE	+	+				
Pterygota thwaitesii	Gal Nawa	E	VU	NE		+				
Rhinacanthus flavovirens		E	VU	NE						+

Species Name	Common Name	TS	NCS	GCS	MO	KG	LK	UE	NW	MI
Salacia reticulata	Kotala Himbutu	N	EN	NE	+	+	+			+
Sansevieria zeylanica	Blow-string hemp (E), Niyanda	N	NT	NE		+				+
Sapium indicum	Kiri Makulu	N	VU	NE						+
Schefflera heterobotrya	Itha	E	NT	NE	+					
Scolopia pusilla	Katu Kenda	E	LC	NE	+	+	+			
Semecarpus nigro-viridis	Badulla	E	LC	VU	+	+	+			+
Strychnos benthamii		E	NT	NE				+		
Strychnos nux-vomica	Nux-vomica (E), Godakaduru	N	VU	NE	+	+				+
Strychnos potatorum	Ingini	N	VU	NE						+
Strychnos trichocalyx	Thelatiya	E	VU	NE	+					
Syzygium spathulatum		E	LC	EN	+					
Syzygium zeylanicum		N	VU	NE		+	+			+
Uvaria sphenocarpa		E	LC	NE	+	+	+			+
Vanda tessellata		N	VU	LC	+	+				+
Vernonia zeylanica	Pupula	E	LC	NE	+	+		+	+	+
Vitex altissima	Milla	N	NT	NE	+	+	+			+
Wrightia angustifolia		E	LC	NE	+	+		+	+	
Xylopia nigricans	Heen-kenda	E	NT	NE		+				

Abbreviations used: TS - Taxonomic Status, **E** - Endemic, **N** - Native, **NCS** - National Conservation Status, **GCS** - Global Conservation Status, **CR** - Critically Endangered, **EN** - Endangered, **VU** - Vulnerable, **NT** - Near Threatened, **NE** - Not Evaluated, **LC** - Least Concern, **MO** - Moragaha Kanda, **KG** - Kalu Ganga, **LK** - Moragakanda-Kaluganaga Tunnel, **UE** - Upper Elahera Canal, **NW** - North-western Province Canal, **MI** - Minipe Raising.

Data Sources: EML, 2011; IUCN, 2007, MIWRM, 2014a, MIWRM, 2014b, MIWRM, 2014c, NRM, 2008, TEAMS, 1998

B) Cumulative Impacts: Hydrology and Water Sharing

a. Current situation

Mahaweli water resources system as at present consists of the Upper Kotmale and Kotmale hydropower projects with 150 MW and 201 MW installed capacity and 4.5 MCM and 172 MCM of storage capacity on the upper reach. The Polgolla diversion barrage in Kandy across the Mahaweli River diverts 875 MCM for irrigation purposes in existing irrigation systems on Amban Ganga (Systems G, D1 and D2) and Kala Oya (System H), Malwathu Oya (IH) and Yan Oya (MH) for an extent of 86,760 ha at 186% Cropping Intensity, with hydropower generation at Ukuwela and Bowatenna 40MW each. The Victoria, Randenigala and Rantembe reservoirs are located downstream of the Polgolla barrage, with installed capacities of 210 MW, 126 MW and 50 MW, have 721 MCM, 861 MCM and 15 MCM storage capacities respectively. The low weir (anicut) at Minipe downstream of Rantembe reservoir diverts water to the LB canal feeding system E, the RB canal feeding system C and B and system A on the downstream totalling 55,580 ha irrigable land at 187% CI. Please refer Figure 2 for locations of the Mahaweli systems (both proposed and implemented) under Mahaweli Development Project Master Plan.

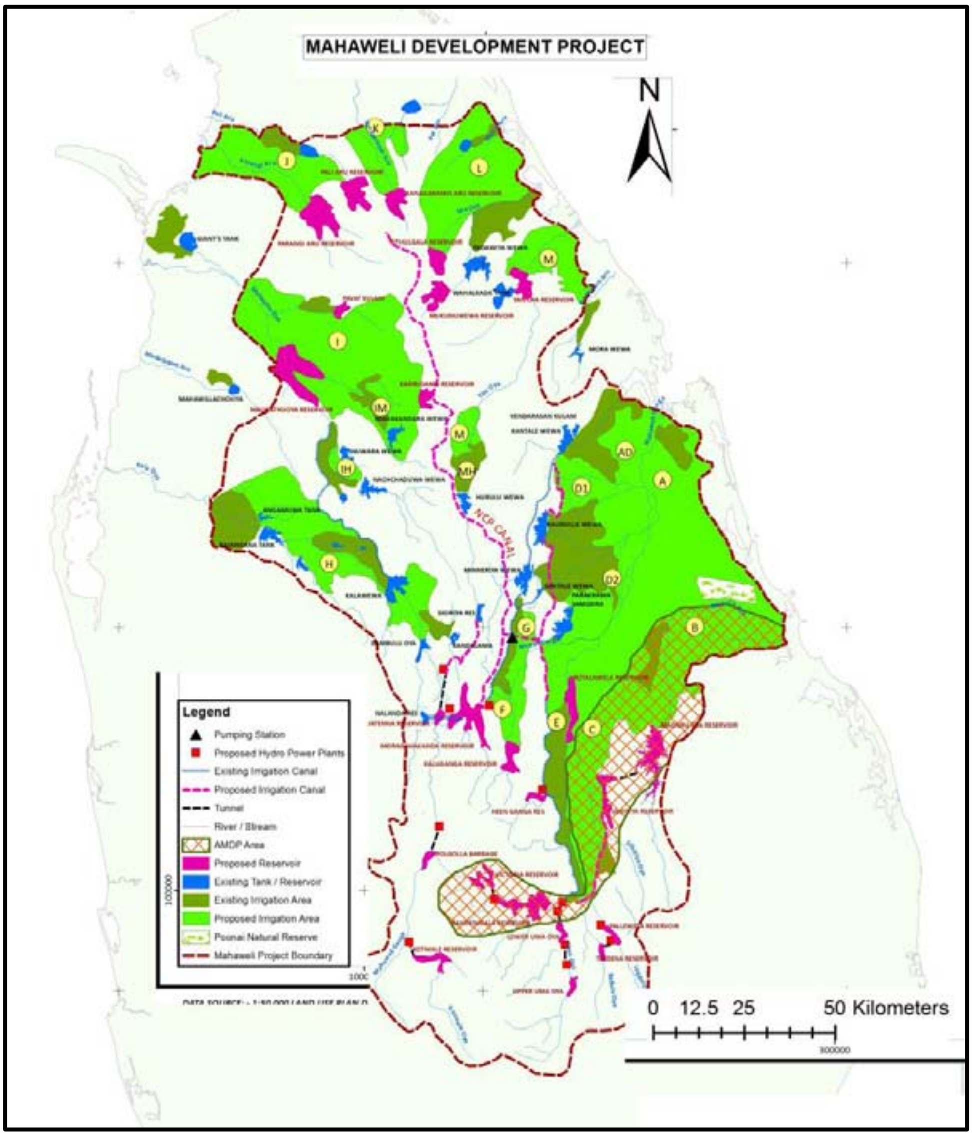

Figure 2. Locations of the Mahaweli systems (both proposed and implemented) under Mahaweli Development Project Master Plan.

b. Proposed project and associated projects

The proposed Moragahakanda and Kalu Ganga projects envisage regulating and storing of unutilized water resource of Amban Ganga and Kalu Ganga river basins, and thereby providing much needed irrigation water for cultivation with an increase of 200% cropping intensity (CI) in Mahaweli systems (Systems G, D1, D2 and F), 180% cultivation in Kala Oya, Malwathu Oya (System IH), Yan Oya (system MH) and additional area in Malwathu Oya (system I) benefitting 94,560 ha with an overall increase in the Cropping Intensity (CI) from 186% to 193%. In addition drinking water needs of Matale, Anuradhapura, Polonnaruwa and Trincomalee districts will be met up to year 2032. These two reservoir projects would improve socio-economic standards of the existing areas with some degree of strengthening of associated eco-systems through the improved water availability.

After identifying the importance of Moragahakanda and Kalu Ganga projects to the Mahaweli Water Resources System, the final stage of the MDP launched as the NCP Canal Project will utilize these two reservoirs to transfer unutilized water resources of main Mahaweli River and its tributaries of Uma Oya, Hasalaka and Heen Ganga from the water rich central wet zone of Sri Lanka to the water scarce North Central (NCP) and Northern Province (NP) for agriculture and domestic water needs. .

The proposed project (Mahaweli Water Security Investment Programme-MWSIP) includes three major conveyances namely, Kaluganga-Moragahakanda Transfer Canal (KMTC) of capacity 35 cumec from Kalu Ganga reservoir to Moragahakanda reservoir, and Upper Elehera Canal (UEC) of capacity 40 cumec from Moragahakanda to NCP canal downstream of Huruluwewa supply point and North Western Province Canal (NWPC). These diversions are made possible by other proposed diversions beyond the this project scope, such as Randenigala-Kalu Ganga transfer of water, and diversions of water at Kalinga Nuwara (which will be considered in phase 2).

The Randenigala reservoir will be the first diversion point of the Project. This project proposes to make use of 180 MCM of Uma Oya water diverted to Randenigala in the total diversion of 555 MCM to the proposed Randenigala-Kaluganga Transfer Canal (RKTC) and which is only 24% of total flow available at diversion point. It is also proposed to augment RKTC from flows after power generation at Hasalaka and Heen Ganga reservoirs, to increase the total diversion to Kalu Ganga to 660 MCM annually. The proposed pumping station will extract 10% of the flow at Kalinga Nuwara (located downstream of Minipe on the Mahaweli river). This extraction will utilize the excess flow at Angamedilla and will transfer 245 MCM to Elehera-Minneriya Yoda Ela.

The Minipe Anicut located downstream of Rantambe reservoir diverts water released from Rantambe after power generation, to Minipe Left Bank and Minipe Right Bank Canals for irrigation purposes. Minipe LB canal currently faces water distribution difficulties due to fluctuating flows from Rantambe reservoir and deteriorated condition of the LB Canal. Diversion of excess water in

Mahaweli Ganga upstream of Minipe anicut, extraction of Hasalaka and Heen Ganga flows to the above diversion and adoption of Mahaweli hydropower stations for peaking operation in the future would require a part of the currently spilling water at the Minipe Anicut to be stored, to reduce flow fluctuation at Minipe LB and RB canals. Therefore, it is proposed to raise the Anicut by 3.5 meters to create a water storage that will stabilize flow fluctuation and to rehabilitate the LB Canal (Minipe Left Bank Canal Rehabilitation -MLBCR) for more efficient water distribution. On the other hand, proposed Hasalaka and Heen Ganga reservoirs are designed in such a way to release their power flows directly to the Minipe LB in case of shortage of water towards end of canal during peak periods.

The four subprojects (MLBCRP, KMTC, UEC and NWPC) selected under MWSIP are of paramount importance as prerequisite projects in the NCPCP. The KMTC and UEC are important as the main conveyance routes, NWPC as the most benefited project outside original MDP and MLBCR identified as to be most affected irrigation project in main Mahaweli due to future peak power operations at Rantembe.

C. Impacts on the downstream users

This project proposes to make use of 180 MCM of Uma Oya water diverted to Randenigala (by Lower Uma Oya Development Project) in the total diversion of 555 MCM to the proposed Randenigala-Kaluganga Transfer Canal (RKTC). Water diverted at Randenigala is only 24% of total flow available at that diversion point.

It has been observed that more than 900 MCM (2005-2010) of water spills over at Minipe anicut annually. The long-term average spillage is estimated to be more than 1,000 MCM per annum (1970-2010). Water flowing downstream of Randenigala and Rantambe reservoirs after power generation form a part of this spillage. Most of these water flow to the sea unutilized except for water supply needs of the extraction point at Manampitiya, needs of System A for irrigation and water for recharging the water table in the downstream mahaweli flood plain together with river maintenance flow required for maintaining the valuable eco-system downstream.

The above mentioned water supply requirements are known through calculations and only the flows in excess of this requirement will be diverted at Randenigala, upstream of Minipe. Accordingly, annual spills over the Minipe Anicut will be reduced to 278 MC after the project (MCB, 2012b). Reference to the recommendations of the IEE report of Minipe Anicut Raising, a minimum of 8 cumecs will be released from the silt ejectors incorporated to the Minipe anicut, as well. This is further discussed under the section on environmental flows.

This study also proposes to augment RKTC from the proposed Hasalaka reservoir and Heen Ganga reservoir power flows to increase the total diversion to Kalu Ganga to 660 MCM annually. Currently, waters of Hasalaka Oya and Heen Ganga are intercepted by Minipe LB Canal, but most of the flows are confined to rainy periods, during which Minipe LB Canal command area also receives a substantial amount of rainfall. With the project, a part of the power flows from Hasalaka reservoir and Heen Ganga reservoir will be diverted to Minipe LB canal during any emergency and during peak-demand periods, thus making water availability more equitable.

The operation of Kalu Ganga reservoir will be such that there would be sufficient releases from the reservoir to Parakrama Samudra Scheme (PSS) to maintain its water level above 50% storage level and to maintain its CI at 200% level. The KMTC crosses Lel Oya, a tributary of the Kalu Ganga through an aqueduct, while UEC crosses three level-crossing namely, Kongetiya, Bogahawewa and Madeththewa having sufficient spillway lengths to discharge 67 cumec, 9.1 cumec and 43.2 cumec respectively for the design flood of 50 year frequency. Historically the flows of Kongetiya, Bogahawewa and Madeththewa which discharge in to Elehera-Minneriya Yoda Ela (EMYE) fill up Minneriya and Giritale reservoirs during the floods.

Therefore, after the implementation of the project, these three level-crossings will discharge entire floods flows in to the EMYE up to a maximum of EMYE conveyance capacity of 56.6 cumec. In the water balance study (WBS) these three ponds would operate as level-crossings without any abstractions in to canal. This infers that there is no negative effect on the system prevailing at present in terms of water availability to the ecosystems as well as irrigation needs under the streams going across the level crossings, due to the proposed diversion.

The UEC will divert about 128 MCM of water to Huruluwewa and this will be utilized in the Yan Oya Basin. Apart from Huruluwewa command area, the small tank systems under Ilukwewa, Ellepothana and proposed Brahmanayagama anicut systems will be benefited by this diversion. In addition, return flows produced by these directly-benefited irrigation systems will enhance water availability within the river basin. As the regolith aquifer in these parts of the country is heavily dependent on surface water, additional water retained in small tanks will enhance groundwater resources, as well.

The proposed pumping station at Kalinga Nuwara will abstract 10% of the Mahaweli flow at that location (located downstream of Minipe). This amount of water will be extracted out of the excess flow at Angamedilla, which spills during the rainy season each year. As such the existing rights for Amban Ganga water users would not be affected by the NCPCP but would be secured and strengthened by the Project. River maintenance flow allowed in the designs at Kalinga Nuwara is a minimum of 4.25 cumecs (MCB, 2012c). Angamedilla flows will be reduced from 398 MCM to 306 MCM/annum, due to these diversions (MCB, 2012b), and this would not affect the river maintenance flows.

Diversions of Mahaweli water to Anuradhapura city tanks (IH) via Nachaduduwa Feeder canal from the Kalawewa RB canal and to Huruluwewa (MH) via Kandalama-Huruluwewa Feeder Canal (KHFC) from Bowatenna-Dambulu Oya canal were two temporary measures taken at the time of Mahaweli Development Project during mid-seventies. As such these two systems; IH and MH have the lowest CI within existing irrigation systems. Rerouting of these two diversions via UEC would fulfil the requirements of the original Master Plan while providing a better opportunity to feed these two cascades of reservoirs directly from the UEC. The existing feeder canal would continue to supply excess water in Kala Oya basin as in the past.

Under the NWP Canal project it is proposed to transfer Mahaweli waters from downstream of the Bowatenne reservoir to the water scarce river basins of NWP. This transfer is to be made possible by re-routing the supply to Anuradhapura city tanks and Huruluwewa reservoir, from Bowatenna diversion to UEC. This would not only add operational flexibility to the Bowatenne-Kala Oya system but also facilitate in augmenting 12,000 ha of agricultural land and drinking water requirements of the NWP consisting of water scarce upper reach of Mi Oya basin and Hakwatuna Oya reservoir scheme of the Deduru Oya basin, leading to enrichment of the three basins in water resources.

The availability of water and its reliability of supply has been analysed in the Feasibility Study 2012 by the MCB consultants (MCB, 2012a). It has shown that diversion of 555 MCM annually above Minipe anicut (at Randenigala) together with 140 MCM at Hasalaka and Heen Ganga crossings en-route to Kalu Ganga, and 250 MCM annually downstream of Minipe (at Kalinga Nuwara) through pumping would benefit 73,000 ha of existing irrigable area and domestic supply of 70 MCM in the project area under average hydrologic situation. Allocations are always done at proposed diversion points after allowing for river maintenance flow which would include downstream consumptive use with provisions for the future demands and the environmental needs.

A project of this nature is potentially sensitive to climate change (CC) impacts, especially the rise in irrigation water demands due to global warming and diversion volumes due to changes to the rainfall patterns. The consultants have taken adaptation measures to overcome the CC impacts via taking the main diversion route through Victoria, Randenigala, Kalu Ganga and Moragahakanda reservoirs having more than 2000 MCM storage for regulation and storage, introduction of more than one diversion routes (alternative routes) for all major irrigation systems except for system H, designing the transfer canal system and diversion structures for paddy in both maha and yala seasons pattern at 180% CI for over and above average hydrologic situation, by facilitating to adopt paddy-cash crops cropping pattern during Yala under dry hydrologic situation for the same CI, and emphasizing the need for effective water management programs. Lastly, the provisions are there to extend pumping at Kalinga Nuwara to the Maha season under drought situation to maintain safe water levels in main storage reservoirs.

d. Environmental Flows

In the NCP Canal Project designs, the concept of environmental flow has been incorporated as "river maintenance flow". It is defined as "the minimum discharge required to maintain sufficient depth of water, flow velocity, water quality, aquatic ecosystem and scenery, requirements of all the livestock in and around the river, sea water extrusion, prevention of estuary clogging, ground water table and riparian rights of people, etc." (MCB, 2012C). The river maintenance flow consists of minimum environmental flow, existing irrigation and water supply demands downstream along with sufficient flow requirements necessary in the river to supply the said demands. If there is a hydropower reservoir upstream, the power release under firm energy generation should normally cover the river maintenance flow.

To define river maintenance flow criteria, the methods used by different researchers and water resources engineers to calculate environmental flows were studied. Tenant's method described in Subramanya (2013) recommends a 10% of mean annual flow to be released in the low flow periods of a river, and this was adopted as one of the criteria. In addition, minimum monthly flows were also studied to ensure historical minimum values are exceeded after the project. An additional criterion was adopted by using 20% of the average minimum monthly flows. This criterion was adopted because in smaller streams, the minimum monthly flow in a dry season month can be negligible, but the low stream flow in such a month is compensated by flows in other dry season months.

Considering hydrological factors specific to the diversion points of NCP Canal Project, the MCB Consultants developed a methodology to calculate river maintenance flow for this project. In this methodology, the uncertainties and inadequacy of data in such places as Kalinga Nuwara, where there is no long term river gauging data available, have been considered. The adopted process of calculation of river maintenance flow from 40 years of computed inflow time series is described step-wise, as follows:

1. Minimum monthly flows at the diversion point were tabulated and the lowest value was identified
2. From the above mentioned tabulation average monthly values were calculated, minimum of the monthly values was selected, 20% of minimum monthly average flow of the time series was calculated
3. Mean annual flow was calculated and 10% of the mean annual flow was calculated
4. Highest value of the (a), (b) and (c) (above) was selected as the river maintenance flow.

The minimum environmental flows/river maintenance flows (in cumecs) adopted in the designs at the major diversion points are as follows:

Location	**River**	**Minimum monthly value cumecs (Step 1)**	**Month**	**20% of minimum monthly average cumecs (Step 2)**	**Month and year of occurrence**	**10% of Mean annual flow (Step 3)**	**Maximum of Steps 1-3 (Step 4)**	**Allowable minimum river maintenance flow cumecs**
Lower Uma Oya	**Uma Oya**	1.39	March 1988	0.47	August	0.54		0.75
Kalinga Nuwara	**Mahaweli**	0.79	Oct. 1976	2.09	June	3.16		4.25
Hasalaka*	**Hasalaka Oya**	0.00	June 1994	0.01	Aug	0.24		0.5
Heen Ganga**	**Heen Ganga**	0.00	June, August	0.02	August	0.29		0.3

*0.5 cumecs would be released as environmental and irrigation requirements

** 2.4 and 0.4 cumecs to be released to Minipe LB during June and July respectively each year from RKTC

Source: MCB, 2012C

It can be seen that the river maintenance flow allowed at Kalinga Nuwara is more than the value obtained from minimum monthly flow criteria. A larger flow is allowed considering:

a. Irrigation requirements in the downstream including Mahaweli System A
b. Drinking water requirements in the downstream, which have to be satisfied its fullest (100%)

In the case of the Minipe Anicut, the current situation is governed by power generation at Rantambe and irrigation releases to Minipe LB and RB canals. As such, power flow from one turbine of Rantambe is spilled over at Minipe during power demand peaking periods. The objective of heightening of Minipe anicut is to regulate and store major part of this spillage and to issue to LB and RB irrigation systems. Since the natural habitats in the stretch between Minipe anicut and the

Badulu Oya confluence (which is 6.5 km downstream) is going to be affected by the flow pattern after the project is implemented, environmentalists working on the IEE study requested to release a minimum of 8 cumecs during the peaking period. Hence, the environmental flow that will be released from the Minipe Anicut will be 8 m^3/sec and 16 m^3/sec during the peaking period and during the cultivation and non-cultivation season (30th January to 15th April and 25th August to 15th November) respectively.

Further, this e-flow will be released for a period of 5 hours per day in two segments (2 hours from 1900 to 2100 and 3 hours from 0600 to 0900) to simulate the current flow regime of the river. The flow downstream of the Minipe Anicut is a regulated flow resulting mainly due to release of water after power generation from the Rantambe Power House. By adopting this procedure, it was found that e-flow along with spillages from Minipe anicut will ensure that at least 28% of the Mean Annual Flow of the river will be released into the river to meet the ecological demands downstream of the Minipe Anicut. This amount is in accordance with the method proposed by Tenanant, quoted in the draft Initial Environmental Examination Report of the Minipe Anicut Raising and LB Canal Rehabilitation Project (MCB, 2014).

In addition to the major diversions, the UEC and NWPC intercept several small streams. The Water Balance study was prepared without expecting any inflow from these streams. In most cases, these streams are by-passed by drainage under-crossings, drainage over-crossings and aqueducts on the conveyance canal. Wherever level-crossings occur, the spillways of such level crossings have been designed to pass the stream flow without abstraction by the conveyance canals.

a. Return flows and groundwater

Both the NCP Canal and NWP Canal will augment the water supply to small tank cascade systems located in the NCP and the NWP. The small tank cascade systems are defined as Madduma Bandara (1985), is a “connected series of tanks organized within the meso-catchments of theDdry Zone landscape, storing, conveying and utilizing water from an ephemeral rivulet” (Maddumabandara, 1985, quoted by Panabokke *et al*, 2002). From the ancient times, these tanks have utilized the return flows from upstream tanks to store and supply to the crops in the command area.

The NCP and NWP canals will directly augment a set of small tank irrigation systems in the Malwathu Oya, Paranki Aru, Pali Aru, Kanakarayan Aru, Ma Oya and Yan Oya (UEC and NCP Canals) and Mi Oya, Hakwatuna Oya/Deduru Oya (NWP Canal). The water availability in these river basins will be enhanced due to direct diversions as well as return flow resulting after crop water use in the directly benefited schemes. However, it is unlikely that there will be any excessive return flow during yala season because the water balance studies carried out by the MCB shows that water supply by the NCPC and NWPC will be sufficient only for 80% of the command area in that season.

The regolith aquifer in these parts of the country is heavily dependent on surface water (Panabokke et al, 2002), and additional water retained in small tanks and the return flows will enhance groundwater resources as well, especially in the dry season. In the Maha season when there is a lot of rain, groundwater is recharged by both rainfall and surface water in the tanks. As such, groundwater levels are generally high during Maha season, and NCP/NWP Canal diversions are unlikely to make a significant change during the rainy period. However, NCP/NWP canal diversions can increase the groundwater levels in the Yala season. The beneficial aspect of this ground water source is that, some tail-end farmers on the field canals who suffer from water shortages tap this water source through agro-wells during the Yala season. In addition, groundwater is used for domestic purposes. Studies carried out in similar diversion projects such as Weli Oya Project have shown that groundwater levels are enhanced after diversions, but they fall down in the command areas after irrigations(Imbulana et al, 2009). Command areas of small tank cascades benefitted by NCP and NWP canals can be expected to perform in the same manner. Tank water levels are also likely to fall during the end of yala season. Therefore, high groundwater levels cannot be expected throughout the year. Problems such as water-logging, and salinization have not been reported from similar diversion and small tank augmentation projects such as Weli Oya and Mau Ara. However, it is recommended that the quality of return flow is periodically monitored, considering the increased cropping intensity and promotion of crop diversification, after the project implementation.

References

- MCB, 2012a. Prefeasibility Study of the NCP Canal Project. MCB
- MCB, 2012b. Water Balance Study of the NCP Canal Project.
- MCB, 2012c. Interim Report: Consultancy Services for Feasibility Study on Proposed Randenigala – Kalu Ganga Transfer Canal Complex Enroute Hasalaka and Heen Ganga together with Lower Uma Oya Complexes with a Comprehensive Hydrological/Water Balance Study. MCB
- Panabokke, C. R.; R. Sakthivadivel; A. D. Weerasinghe. 2002. Evolution, present status and issues concerning small tank systems in Sri Lanka. Colombo, Sri Lanka: International Water Management Institute.
- SMEC, 2012. Dam Safety & Water Resources Planning Project. Component 3 - Multi-Sector Water Resources Planning. Strategic Environmental Assessment, Mahaweli Systems. Ministry of Agriculture Development and Agrarian Services
- Imbulana, K.A.U.S., Ratnayake, U.R., Herath, G.B.B., Koncagul, E. and Neupane, B.R. (eds.), (2009) Case Study in Walawe Basin Sri Lanka, A contribution to the United Nations World Water Assessment Programme, UN-WWAP, Paris; UNESCO; Ministry of Agricultural Development and Agrarian Services, Sri Lanka