Sri Lanka Tsunami Reconstruction Program (SLTRP)

USAID Contract # 386-C-00-05-00166-00

Environmental Assessment: Water Supply Facilities for Pottuvil, Arugam Bay and Panama

June 2007

SLTRPR-00056

CH2MHILL

In association with Chemonics, DEVTECH, FNI, Engineering Consultants Ltd., EML Consultants, Lanka Hydraulic Institute, MICD and Uni-Consultancy Service

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LIST OF ABBREVIATIONS

AL	Advanced Level
ARPPR	Accidental Release Prevention Program Rule
CBO	Community Based Organization
CEA	Central Environmental Authority
DS	Divisional Secretary
DWLC	Department of Wildlife Conservation
EA	Environmental Assessment
ERP	Emergency Response Plan
GCE	General Certificate of Education
GN	Grama Niladhari
GoSL	Government of Sri Lanka
IFRC	International Federation of the Red Cross
m^3/day	Cubic Meters per Day
mg/L	Milligrams per liter
NGO	Non-governmental Organization
NWSDB	National Water Supply and Drainage Board
O&M	Operation and Maintenance
OL	Ordinary Level
PCM	Participatory Coastal Management
PPM	Parts Per Million
PS	Pradeshiya Sabha
SLTRP	Sri Lanka Tsunami Response Programme
USEPA	United States Environmental Protection Agency

EXECUTIVE SUMMARY

PROJECT BACKGROUND

This environmental assessment (EA) for the Arugam Bay Water Supply Project was performed to meet U.S. Environmental Regulation 22 CFR 216. This report likewise considers general environmental requirements for Sri Lankan projects stipulated by the Central Environmental Authority (CEA). Its primary objective is to evaluate potential environmental impacts rendered by the construction of the components – extraction wells, treatment plant and distribution system – of the proposed water supply schemes for Pottuvil Town, Arugam Bay/Ulla and Panama Village to be developed under the United States Agency for International Development (USAID's) Sri Lanka Tsunami Reconstruction Program (SLTRP). Construction is expected to begin at the end of June 2007 and be completed by April 2008. CH2MHILL, the institutional contractor implementing SLTRP, will undertake the construction through a selected contractor using USAID funds. The National Water Supply and Drainage Board (NWSDB) will assume full responsibility for operation and maintenance of the facilities after construction

PROJECT JUSTIFICATION

Prior to the December 2004 tsunami, residents of these communities obtained their water from privately owned, shallow, hand-dug wells. There were no public piped water supplies serving any of these communities. The tsunami wave contaminated many of the wells in Arugam Bay area with saline water, chemical and biological contaminants.. Many residents were left without a nearby source of potable water. Following the tsunami some non-governmental organizations (NGOs) and local authority offices assisted these communities by distributing water. Presently, residents have resumed obtaining water from dug wells, which is of low quality and of inconsistent quantity. The current severe water shortage in the stated areas will be alleviated by implementation of this project. Specifically, Panama, Pottuvil town and Ulla will receive treated potable water once the water treatment and distribution systems are operational.

GENERAL PLANNING ARRANGEMENT

There will be two separate water supply schemes for the Pottuvil/Ulla and Panama areas, due largely to the distance between the two localities. The water supply scheme for Pottuvil/Ulla consists of a tube well field on the banks of Heda Oya, a conveyor pipeline running from the tube well field to the separately located treatment plant at "Coconut Site,"1 and distribution pipelines emanating from the treatment plant. Distribution pipelines will not be provided by the SLTRP project for Pottuvil; it is anticipated that the system will be constructed by the NWSDB with funds provided by the IFRC.

The water supply scheme for Panama village consists of a tube well field, a treatment plant located close to the tube well field, and the distribution pipelines emanating from the treatment plant. The site is located at a by-lane called Samurdhi Mawatha off Cemetery Road. In Panama, both the treatment plant and the distribution systems will be built by SLTRP.

[1] An informal name used internally by the SLTRP team.

ALTERNATIVES AND FINAL SELECTIION

From alternative water source options, groundwater extraction was selected as the most feasible option for both water supply schemes Pottuvil/Ulla and Panama. A manganese dioxide treatment method was selected as a primary treatment option because of low cost, low use of chemicals, low labor requirement, and low energy cost for inter filter backwashing.

CONCLUSIONS

Negative impacts are minor and mitigable; they are mostly construction impacts, which are temporary. Contingency impacts (emergencies) are infrequent and mitigable. Positive impacts clearly outweigh the negative temporary impacts, which are minor. The project activities are compliant with laws and policies. Respective preliminary approvals have been granted by relevant line agencies. The project is socially acceptable; no significant social issues or protests were observed during the EA study stage. Execution of the project is recommended with the proposed mitigatory measures and monitoring requirements detailed in this report.

1. INTRODUCTION

1.1 GENERAL

This chapter gives a brief introduction to the Environmental Assessment (EA) of the proposed water supply schemes for Pottuvil/Ulla and Panama, with an overview of its background, the Sri Lanka location, funding sources, requirements, and regulations.

This EA for Arugam Bay Water Supply Project (See Figure 1 for Project Location) has been performed to meet U.S. Environmental Regulation 22 CFR 216. This report likewise considers general environmental requirements for Sri Lankan projects stipulated by the Central Environmental Authority (CEA). Its primary objective is to evaluate potential environmental impacts rendered by the construction of the components – extraction wells, treatment plant and distribution system – of the proposed water supply schemes for Pottuvil Town, Arugam Bay/Ulla and Panama Village to be developed under the United States Agency for International Development (USAID's) Sri Lanka Tsunami Reconstruction Program (SLTRP).

Preliminary briefs on project background, alternatives considered, locations of project components, technology of water extraction treatment, and distribution were obtained from highly detailed reports listed below.

(a) SLTRP – Arugam Bay Water Supply Preliminary Assessment Report – Phase I – May 2006.

(b) SLTRP – Arugam Bay Water Supply Preliminary Assessment Report – Phase 2 – October 2006

(c) SLTRP – Preliminary Economic Analysis – Proposed Water Supply Scheme at Pottuvil and Panama – May 2006.

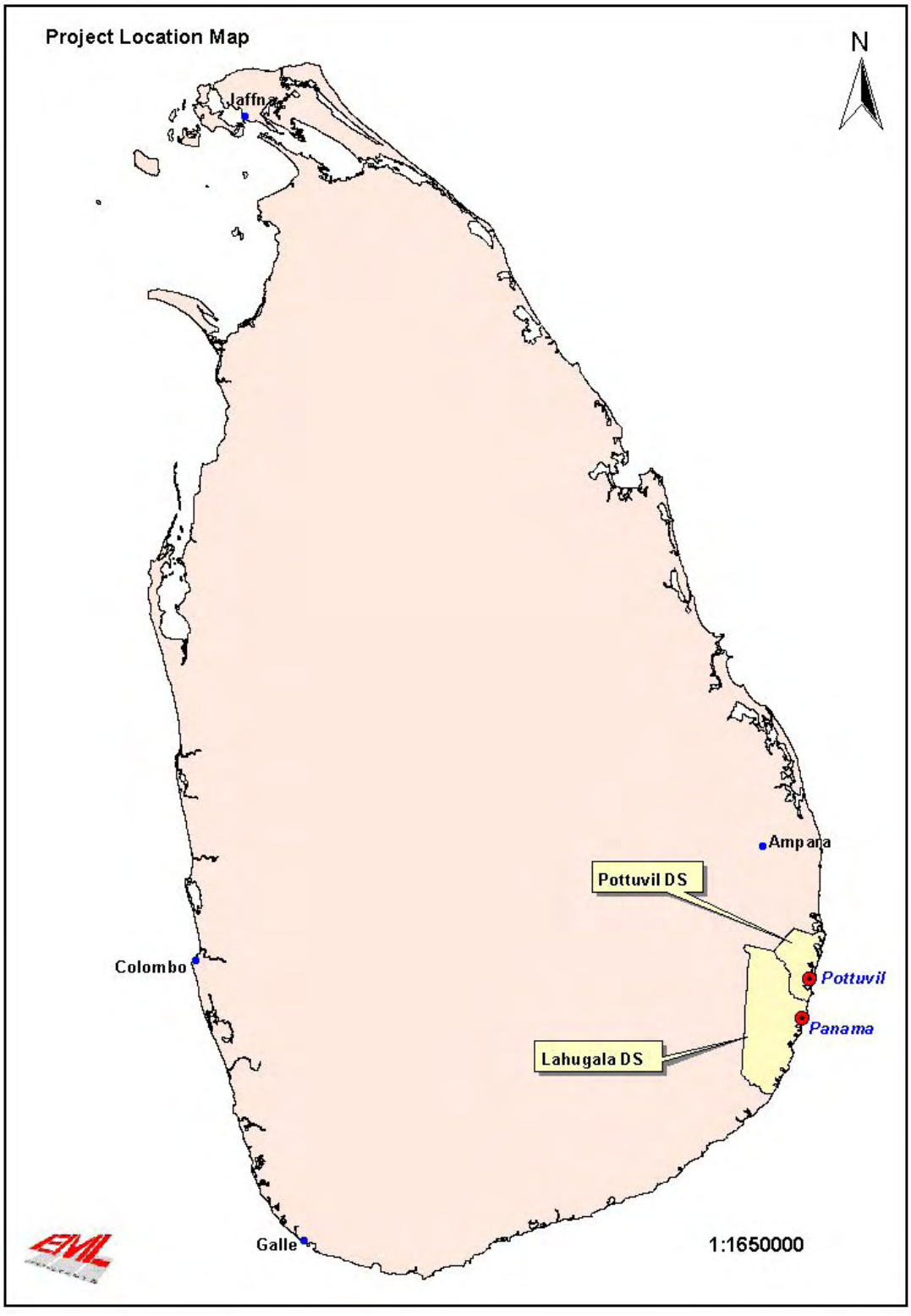
(d) SLTRP – Rota Tank Water Balance-Hydrological Study – May 2006

1.2 PROJECT BACKGROUND

The Arugam Bay water supply project is a subproject of SLTRP, and will construct drinking water systems for communities in the area of Arugam Bay on the southeast coast. The water supply project will focus on the water source and treatment systems. Refer to Figure 1 below for the project location.

Construction is expected to begin at the end of June 2007 and be completed by April 2008. CH2MHILL, the institutional contractor implementing SLTRP, will undertake the construction through a selected contractor using USAID funds. The National Water Supply and Drainage Board (NWSDB) will assume full responsibility for operation and maintenance of the facilities after construction.

Figure 1 - Project Location Map



The initial concept was to develop a single supply source and treatment system to serve communities near Arugam Bay, including Pottuvil, Arugam Bay, Ulla, and Panama. The contract scope implied that the source for this supply was to be the Rota Tank, a surface water impoundment located about five kilometers northwest of Pottuvil. However, during early evaluations, it was determined that jurisdictional limitations on the Rota Tank may prevent its use as a potable water supply. Therefore, the focus of the subproject shifted to explore alternative sources, including groundwater. Ultimately, groundwater was identified as the most appropriate source, and it was determined that two separate sources would be developed – one for Pottuvil/Ulla and one for Panama – to reduce future transmission pipeline costs.

A critical element of the project is the determination of the water demand requirements for the communities. The computed water supply demands for the 2025 time horizon are 5,000 cubic meters per day (m^3/d) for the Pottuvil-Arugam Bay-Ulla area and 600 m^3/d for the Panama area.

1.3 PROJECT JUSTIFICATION

Prior to the December 2004 tsunami, residents of these communities obtained their water from privately owned, shallow, hand-dug wells. A typical well was four meters deep, with the static water about one meter below ground surface. Some residents, particularly those living near the ocean, had wells that produced water with high levels of salinity. In such cases, they used the saline water from their well for washing and cleaning, and obtained their drinking water through an arrangement with someone owning a well that produced fresh (non-saline) water. There were no public piped water supplies serving any of these communities. The tsunami wave invasion contaminated many of the wells in Arugam Bay area.

The immediate impact of the tsunami was to contaminate many of the shallow wells with saline water located near the coast with chemical and biological contaminants. The tsunami waves picked up petroleum products from vehicles and filling stations, human and animal wastes, cleaning chemicals, battery acids, and other products, and deposited these into and around the wells. Many residents were left without a nearby source of potable water.

During site visits in November 2006, it was revealed that water is distributed using bowsers by Pottuvil Pradeshiya Saba (PS) to the residents. At the time of tsunami some non-governmental organizations (NGOs) have assisted the PS, but at the time of the visit this activity was being undertaken directly by the PS. As of now, people have resumed obtaining water from dug well owners, as sometimes there is sporadic discontinuation of water distribution.

Although there are dug wells in the Panama area, most water from these sources is not potable. It is discolored, stains clothing, and is unsuitable for bathing. This is particularly the case with shallow wells; there are limited deeper wells where the water quality is acceptable, and people share water from these wells.

The current severe water shortage in the stated areas will be alleviated by implementation of this project. Specifically, Panama, Pottuvil town and Ulla will receive well-treated potable water once the water treatment and distribution systems are operational.

1.4 FUNDING SOURCES

USAID is funding the treatment facilities in Pottuvil/Arugam Bay and Panama, as well as the construction of distribution systems in Panama. The transmission and distribution pipelines in Pottuvil/Arugam Bay are to be undertaken by NWSDB, most likely with the support of the International Federation of Red Cross (IFRC) funds.

1.5 PROJECT PROPONENT

The project proponent is NWSDB, which handles similar water supply projects throughout Sri Lanka.

1.6 APPLICABLE LAWS AND REGULATIONS

The primary driver of this report is compliance with the environmental assessment requirement as stated within the U.S. Regulation 22 CFR 216. This report must also satisfy Sri Lankan Environmental Requirements including the CEA Act, NWSDB Act, and the concomitant regulations under which treatment standards are determined and the EA is carried out.

2. PROJECT DESCRIPTION

This chapter describes the details of the water supply scheme, components (such as intake treatment plant and ancillaries and their respective locations in Pottuvil/Ulla and Panama areas), water treatment methods, sludge disposal method, and details of the proposed emergency response system. Photographs are included to illustrate the site environment.

2.1 GENERAL PLANNING ARRANGEMENT AND LOCATION

The general planning arrangement for the proposed water supply scheme is as follows.

(a) Water supply will be provided to Pottuvil Town, Arugam Bay area (Ulla), and Panama Village.

(b) There will be two separate water supply schemes for the Pottuvil/Ulla and Panama areas, due largely to the distance between the two localities.

(c) The water supply scheme for Pottuvil/Ulla consists of a tube well field on the banks of Heda Oya, a conveyor pipeline running from the tube well field to the separately located treatment plant at "*Coconut Site*,"[2] and distribution pipelines emanating from the treatment plant. Distribution pipelines will not be provided by the SLTRP project for Pottuvil; it is anticipated that the system will be constructed by the NWSDB with funds provided by the IFRC.

(d) The water supply scheme for Panama village consists of a tube well field, a treatment plant located close to the tube well field, and the distribution pipelines emanating from the treatment plant. The site is located at a by-lane called Samurdhi Mawatha off Cemetery Road. In Panama, both the treatment plant and the distribution systems will be built by SLTRP.

The locations of the above schemes components are presented in Figure 2 and 3 below. A schematic diagram of the tube well field on Heda Oya banks is given under Section 2.2.1 below.

[2] An informal name used internally by the SLTRP team.

Figure 2 - Location Map of Water Supply Scheme Components (Pottuvil/Ulla)

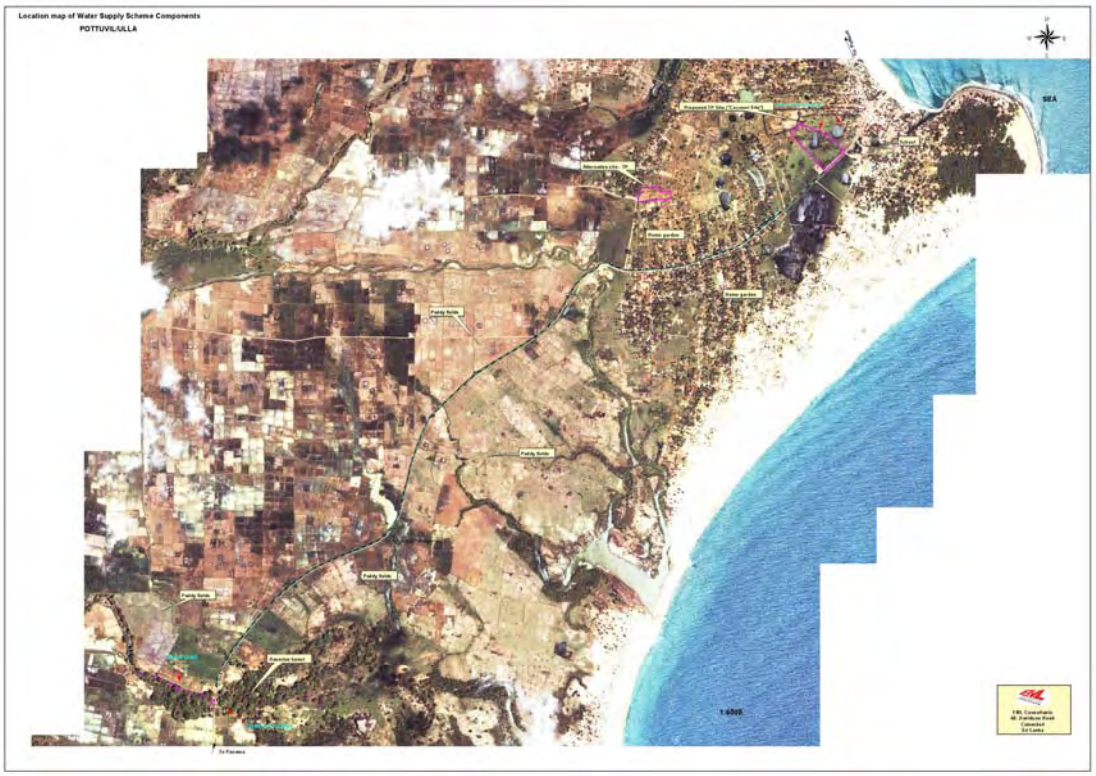
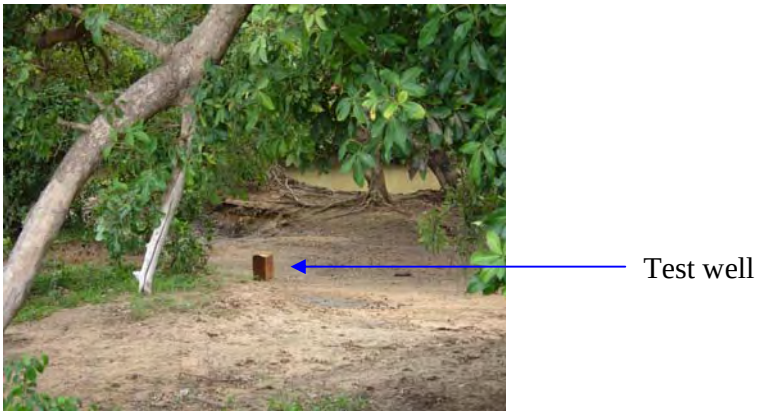


Figure 3 - Location Map of Water Supply Scheme Components (Panama)

Pictures of Pottuvil/Ulla Site

1. A test well close to Naval Aru Bridge

2. Other Test wells



3. Present view of Heda Oya (1st November 2006)

4. Bund Road

Riverine forest adjacent to bund road (tube wells will be constructed at the riverside border of the riverine forest)

5. Selected location for a Tube Well near Heda Oya

Proposed tube well location

6. Another location for a Tube Well

Heda Oya riverine forest

Another location for a tube well

Bund road

7. Proposed Site for the Treatment Plant (TP) - Pottuvil/Ulla site called "*Coconut Site"*

8. TP Site cont…

Abandoned fishpond

Pictures of Panama Site

1. Panama proposed water supply scheme site (well field and treatment plant)

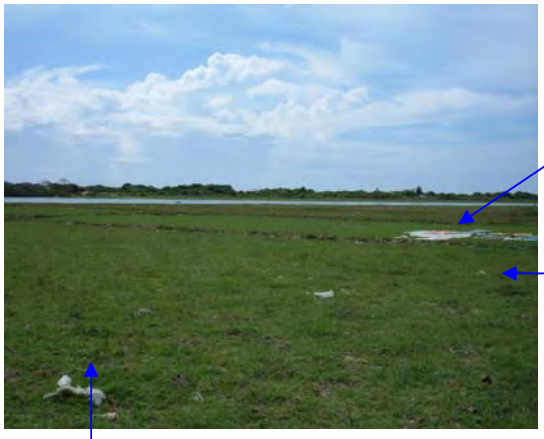
2. Test Well (Panama site)

Test Wells

3. Surrounding

Part of the proposed site

4. Surrounding (Ullawela Ground)



Tank

Ullawela ground

Proposed site (Panama)

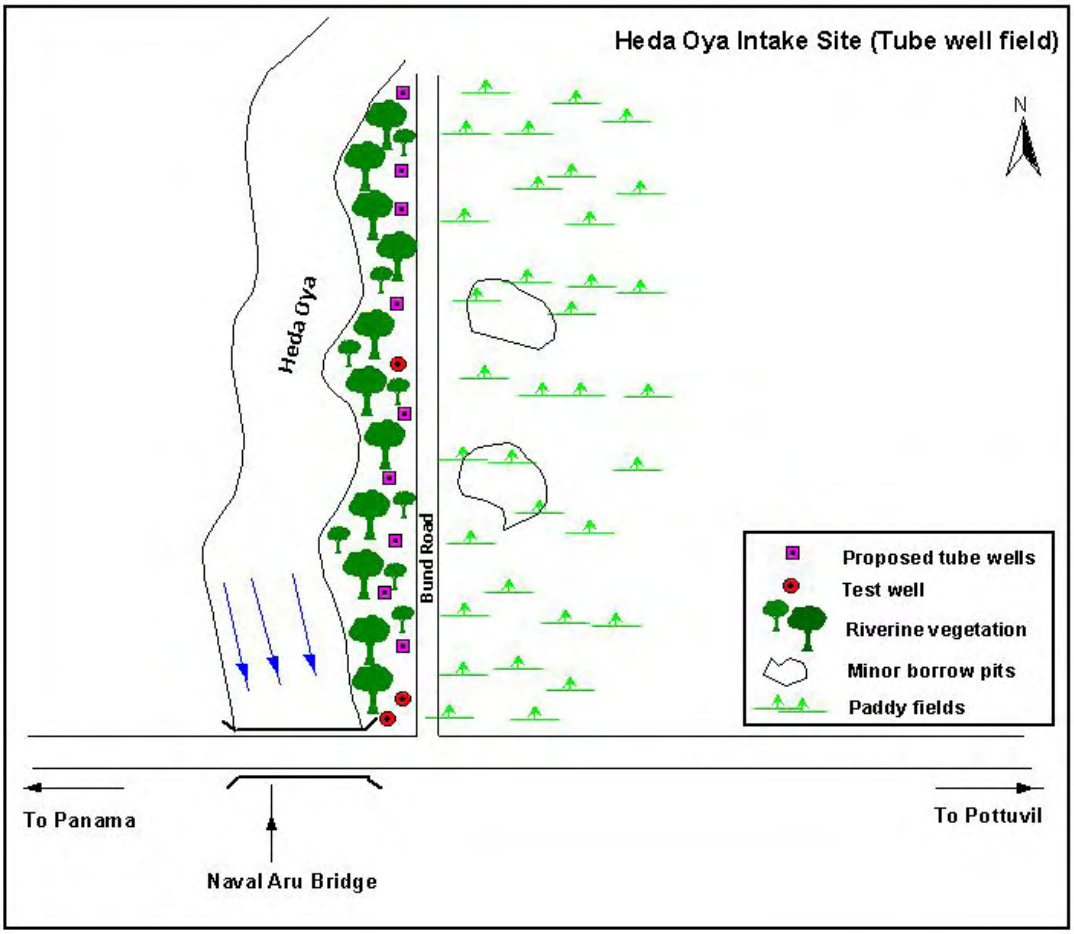
2.2 SCHEME COMPONENTS (INTAKES, PIPELINES AND TREATMENT PLANT)

2.2.1 Components of Pottuvil/Ulla Water Supply Scheme

Water Intake (Tube well fields)

The water intake system for this water supply sub scheme is a tube well field located on the banks of Heda Oya near the Naval Aru Bridge across Heda Oya on the Pottuvil-Panama Road. There are three existing tube wells in this location. An additional eight to ten tube wells are planned for construction on the left bank of Heda Oya. The drawing below shows the general layout of tube wells.

Figure 4 - Pottuvil/Ulla Water Supply Scheme – Tube well field (schematic diagram)



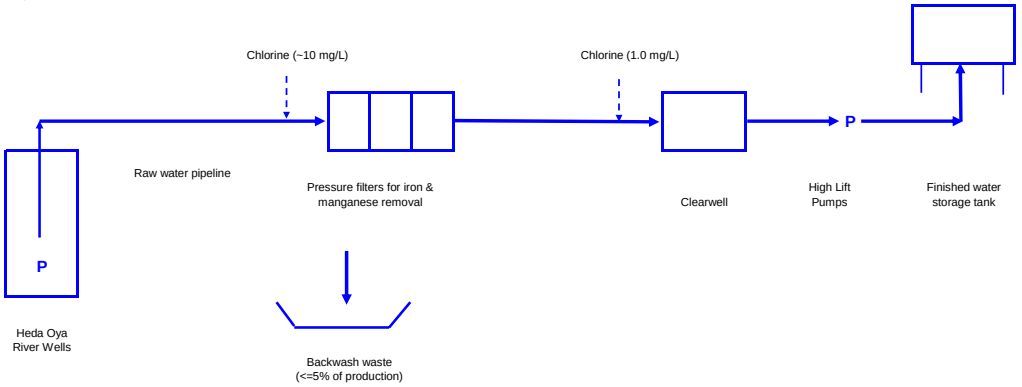
Conveyor Pipeline from the Intake to the Treatment Plant

The raw water transmission pipeline will be approximately four to six kilometers in length and is expected to lay the pipe along Pottuvil/Panama Road. If the pipe mains have to be laid through private property land, acquisition followed by compensation to land owners should be finalized. The pipeline will be constructed of ductile iron pipe. The exact layout of the pipe along Pottuvil-Panama main road has not yet been finalized. Refer to Figure 5 for the preliminary layout of the pipeline.

Figure 5- Pottuvil Water Supply – Conveyor Pipeline from the Intake to the Treatment Plant

Description:	Wells with submersible pumps		DI buried pipeline	Pressure filters	Concrete pump well, gravity fed from filters	High lift pumps	Elevated steel tank
Relative HGL elevation (M):*	-15	20	9	6	3	27	27

*The HGL elevations are preliminary. They will need confirmation as elevations, pumping rates, pipe length, and other head requirements are established. They are based on an assumed datum--substitute real elevations when known.



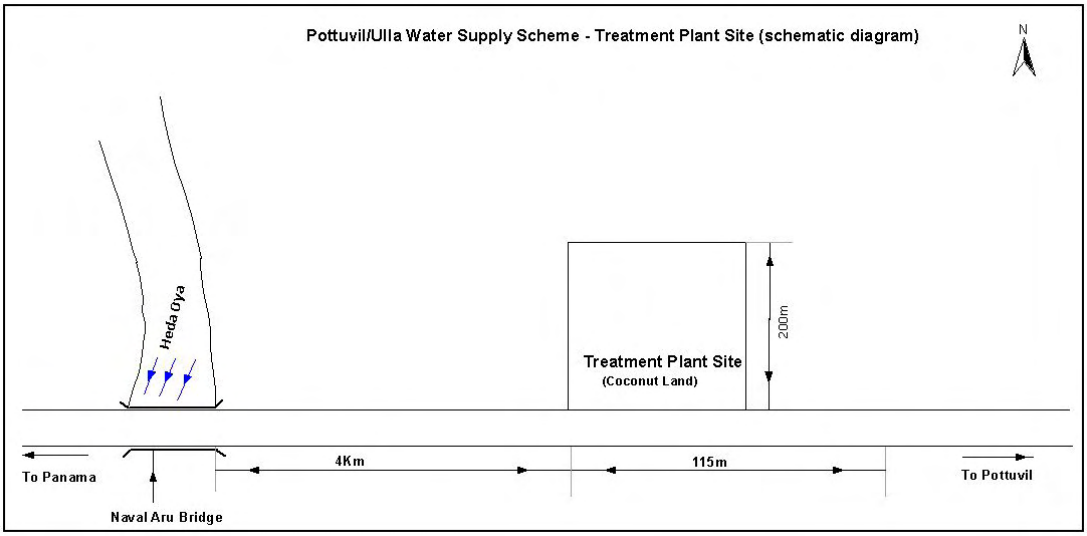
HGL in feet

Relative HGL elevation (ft):	-49	66	30	20	10	89	89

Treatment Plant

The treatment facility will be located remotely from the wells because they are in an area that is flooded during monsoon periods. This will place the treatment facilities nearer to the populated area, facilitating operation and maintenance and optimizing security requirements.

Figure 6 - Pottuvil/Ulla Water Supply Scheme (schematic diagram)



Distribution Pipe Network from the Treatment Plant.

The distribution pipe network will distribute water from the treatment plant site to the Pottuvil/Ulla area, and will be laid out along the main and by-roads to provide water to the inhabitants. The construction work of the distribution lines will be undertaken by another organization, such as the IFRC.

Other System Components

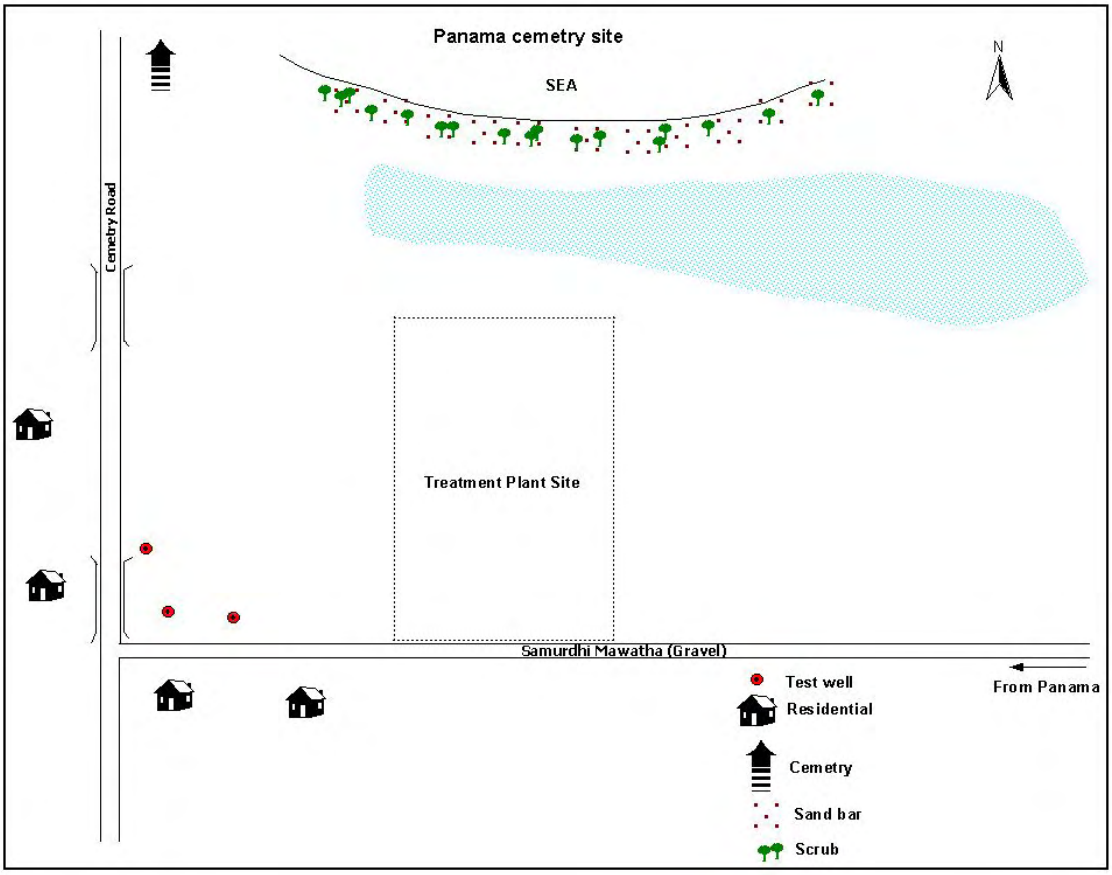
Other system components include a clean water sump, high lift pumps (including extra pumps to pump water to planned elevated storage tank north of the Arugam Bay bridge in Pottuvil), and an elevated finished water storage tank located on or near the treatment plant site. Highlift pumps will convey water from the clear water sump to the elevated storage tank. The elevated tank is necessary at this stage to ensure proper water access to treated water immediately upon completion of the water treatment plant. The elevated tank will provide pressure for filling water trucks or for pressurizing a distribution system.

Components of Panama Water Supply Scheme

Water Intake

The water intake for the Panama water supply scheme is a tube well field located at the start of a by-road called Samurdhi Mawatha off Cemetery Road in Panama. Three boreholes are already in existence and it is expected to construct additional boreholes to fulfill the water requirements.

Figure 7- Panama Water Supply Scheme – Tube well field (schematic diagram)



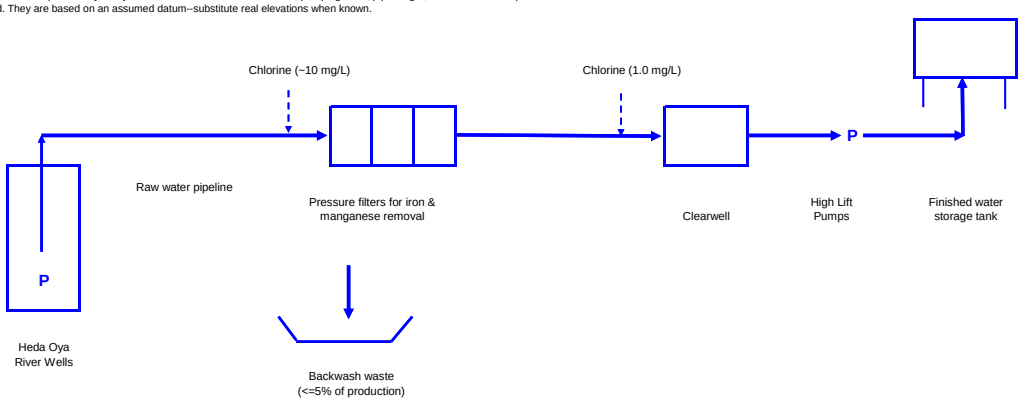
Treatment Plant and Well Field (Panama Scheme)

Figure 8. Panama Water Supply Scheme (schematic diagram)

Panama Water Supply Scheme

Description:	Wells with submersible pumps		DI buried pipeline	Pressure filters		Concrete pump well, gravity fed from filters	High lift pumps	Elevated steel tank
Relative HGL elevation (M):*	-15	11		9	6	3	27	27

*The HGL elevations are preliminary. They will need confirmation as elevations, pumping rates, pipe length, and other head requirements are established. They are based on an assumed datum--substitute real elevations when known.



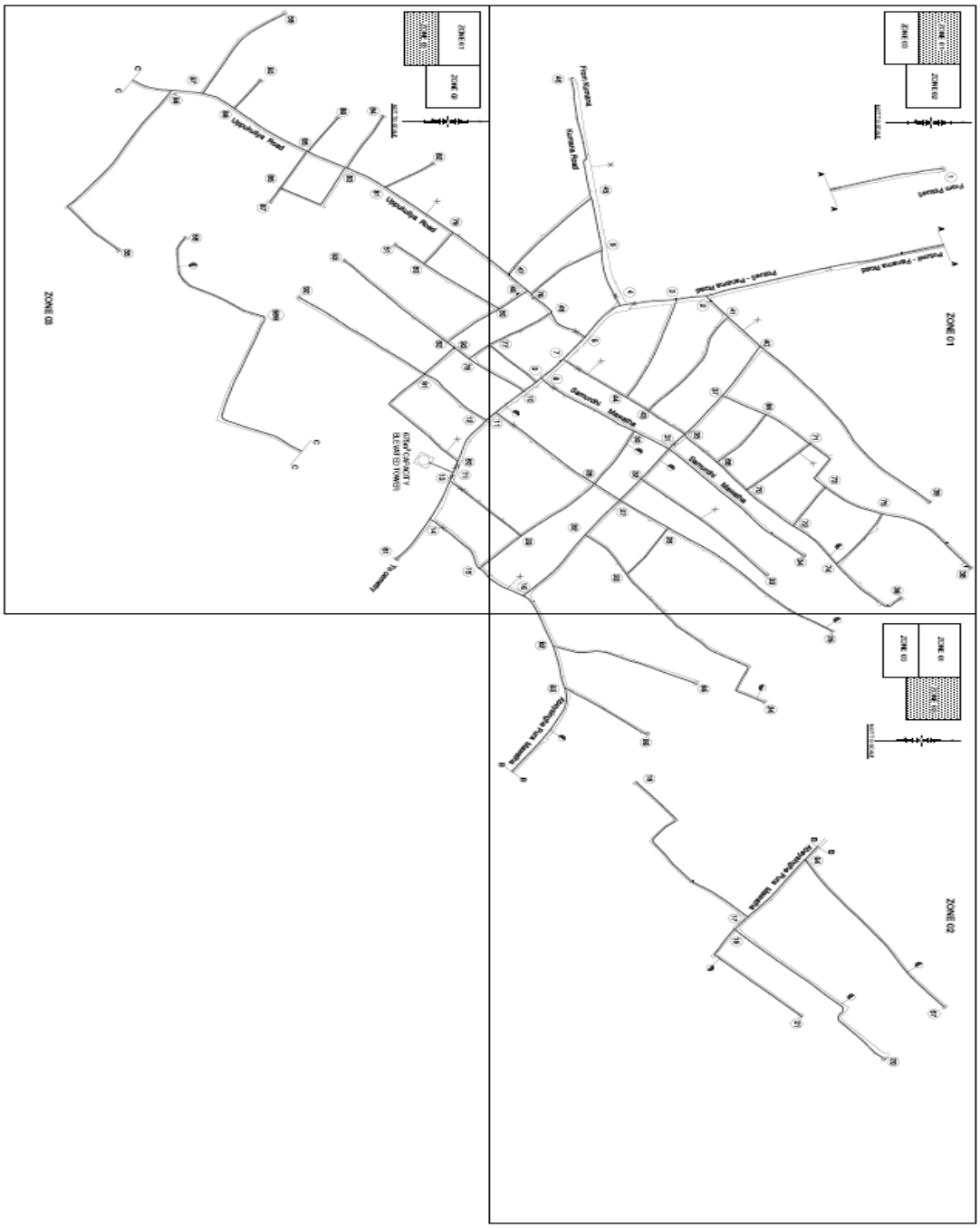
HGL in feet

Relative HGL elevation (ft):	-49	36		30	20	10	89	89

Distribution Pipe Network from the Treatment Plant

The distribution network will cover the entire Panama village and another recently built Kurulupokuna Tsunami Housing Scheme. The Panama distribution system will cover Kumana Road, Samurdhi Mawatha, Abesinhapura Mawatha, Abesinhapura Tsunami Resettlement, Uppukuliya Road, and roads emanating from the above roads. Ductile iron pipes (120mm maximum diameter) will be used for the distribution network. See Figure 8.1.

Figure 8.1 Distribution Pipe Network from the Treatment Plant.



5. Kurulupokuna Housing Scheme (part of the distribution area)

2.3 METHOD OF TREATMENT/FILTERING

2.3.1 Treatment Process

General

The treatment process consists of two primary steps: 1) iron and manganese reduction from groundwater; and 2) filtration of extracted water. These steps are described below.

Iron and Manganese Reduction from Groundwater

The recommended treatment system for iron and manganese reduction is to use pressure filters equipped with a manganese dioxide media and chlorine as the oxidant. Iron and manganese removal by manganese dioxide is a robust and cost-effective process. It reduces the level of operation and maintenance that is required, in addition to providing a lower capital and operation and maintenance (O&M) cost. Use of 900 kg chlorine gas cylinders is standard practice for facilities like these in Sri Lanka; these chlorine cylinders are used in most, if not all, existing water treatment facilities in the country.

Chlorine will be fed upstream from the filters at a rate of approximately 0.63 milligrams per liter (mg/L) times the iron concentration, or approximately ten mg/L. Following chlorination, the flow stream will be split and fed to a number of filter vessels, each capable of handling approximately 190 liters per minute. It is not necessary to break the pressure head through the filters, which means that the water can be pumped directly from the wells to and through the filters. The exit pressure should be sufficient to move the water into the slow sand filters downstream of the pressure filters of the respective water supply schemes, either Pottuvil/Ulla pressure filters or the clear well downstream of the Panama pressure filters.

2.3.2 Recommended Treatment/Filtration Process for Pottuvil/Ulla Scheme

As illustrated in Figure 5, the proposed treatment process consists of two central components:

(a) Iron and manganese reduction

(b) Filtration for surface water microorganisms

Iron and Manganese Reduction

The proposed concept for iron and manganese reduction is to use pressure filters equipped with manganese dioxide media and chlorine as the oxidant. Chlorine will be fed upstream of the filters at a rate of approximately 0.63 mg/L times the iron concentration, or approximately ten mg/L. Following chlorination, the flow stream will be split and fed to a number of filter vessels, each capable of handling approximately 190 liters per minute. The exit pressure should be sufficient to move the water into the slow sand filters downstream.

The manganese dioxide media has a long life and may not need replenishment for 15 to 20 years. Chlorine will be fed at a rate to yield a free chlorine residual in the elevated storage tank of 0.1 to 0.2 mg/L. This slight excess residual ensures that sufficient chlorine is available throughout the depth of the filter media.

The concept for the chlorination system is to use a gas chlorination system with 900 kilograms (one ton) cylinder supply. The daily chlorine use, assuming a production of 5,000 $m^{3/}d$, will be approximately 52 kilograms. One cylinder will last approximately 18 days if full production is sustained during this time.

2.3.3 Recommended Treatment/Filtration Process for Panama Scheme

The source of water supply to Panama is deep groundwater. Chlorination will be carried out before the water is fed to manganese dioxide filters, at a dose sufficient to provide a residual, approximately 0.1 to 0.2 mg/L in the elevated storage tank. This will provide a potable water that is acceptable aesthetically and safe to drink. The concept for the chlorination system is to use a gas chlorination system with 900 kilogram (one ton) cylinder supply. The daily chlorine use for a production of 600 m^3/d of disinfected water will be approximately five kilograms. One cylinder will last approximately 180 days if full production is sustained during this time

As shown in Figure 10, the proposed treatment process consists of pressure filtration using manganese dioxide media for reduction of the iron and manganese levels. Chlorine will be used as the oxidant. Chlorine will be fed upstream of the filters at a rate of approximately 0.63 mg/L times the iron concentration, or approximately 7.3 mg/L.

Figure 10. Typical Fe/Mn Pressure Filter

Following chlorination, the flow stream will be split and fed to a number of filter vessels, each capable of handling approximately 190 liters per minute. It is not necessary to break the pressure head through the filters, which means that the water can be pumped directly from the wells to and through the filters. The manganese dioxide media has a long life and may not need replenishment for 15 to 20 years. Chlorine will be fed at a rate to yield a low residual as water exits the pressure filters. Figure 10 shows a picture of a typical four-tank MnO_2 pressure filter plant.

2.4 SLUDGE DISPOSAL METHOD

The sludge in both treatment systems is primarily of iron and manganese origin and released with backwash water from manganese dioxide filters. The quantity of sludge from iron and

manganese removal can be conservatively taken as 2.0m/L for each milligram of iron or manganese removed from the water. Here, for the purpose of estimating the sludge quantity, the concentrations of iron and manganese are taken as 3.2 mg/L (iron) and 0.2 mg/L (manganese) for Panama and 13.7 mg/L and 0.8 mg/L for Heda Oya (Pottuvil) schemes respectively. Based on these concentrations the annual sludge production from the two schemes are estimated as:

Panama = 919 kg/year

Pottuvil = 31,598 kg/year

Backwash water will be treated by settling prior to offsite discharge to existing drainages. Improvements to the existing stormwater drainage systems will be completed by CH2M HILL during construction as needed to facilitate water flow from the site to the sea. Solids removed from the settling basin will be dried and hauled offsite by the NWSDB. Proper offsite disposal of these residues will be the responsibility of the NWSDB.

2.5 EMERGENCY RESPONSE SYSTEM

The greatest potential environmental emergency in both schemes is the accidental release of chlorine gas. There is specific regulation in Sri Lanka that relates to storage and handling of chlorine gas. Additionally, NWSDB has its own guidelines for chlorine gas handling. These guidelines are explained later in this section. The United States Environmental Protection Agency (USEPA) has set regulations to minimize the risk of injury, death or damage to operational personnel and minimize off-site impacts on public and environmental receptors as a result of accidental chlorine leakages. Risk management of potential chlorine exposure is necessary for all treatment systems where gas chlorine is in use. The United States' 40 CFR Part 68 Accidental Release Prevention Program Rule (ARPPR) applies to water treatment facilities that have regulated substances such as chlorine in inventories in excess of minimum quantities (1,000 kilograms for gas chlorine) defined in the regulations. It is mandatory that all such facilities develop and maintain a Risk Management Program. In addition there are other regulations in the United States under the Department of Transport, Occupational Health and Safety Administration, among others, on transport, handling, and use of chlorine.

The daily chlorine requirements at Pottuvil and Panama treatment plants are 52 kilograms and five kilograms, respectively. The NWSDB uses 68 kilogram cylinders in all its small water treatment plants. In general, the NWSDB treatment sites do not maintain large quantities of chlorine gas. Around ten cylinders for Pottuvil and two cylinders for Panama are the more likely inventory scenarios. As such, quantity of chlorine inventory likely to exceed the USEPA threshold limit of 1,000 kilograms, although the risks are reduced due to smaller cylinders size commonly used in Sri Lanka. Key components of the USEPA recommended Risk Management Plan are:

1. Off-Site Consequence Analysis
2. Five-Year Accident History (not applicable in this case)
3. Document Management System
4. Prevention Program
5. Emergency Response Program

NWSDB safety procedures relating to the risk of chlorine exposure include provision of: (a) neutralization tank close to chlorine cylinders; and (b) gas masks and other protection gear for personnel working in proximity to chlorine cylinders. The present practice of NWSDB with regard to safety measures does not include an Emergency Response Plan (ERP). Therefore it is strongly recommended that NWSDB put an ERP in place as an aspect of operations (rather than design), particularly considering the proximity of residences and institutions to the treatment plant sites. Salient features of such a plan include:

- Established procedures for informing the public and emergency response agencies should an accidental release occur.
- Educate community on the purpose and implementation of the ERP
- Established procedures for first aid and emergency medical treatment for human exposure and sicknesses.
- Training of personnel at site on emergency response and medical treatment.
- Conduct emergency response drills.

3. PROJECT ALTERNATIVES

3.1 GENERAL

This chapter describes project alternatives considered, including the no action alternative. The selection criteria leading to the final selection of the project components are also described.

The following alternatives to the proposed project were considered as part of this study:

1. No action alternative
2. Source alternatives
3. Location alternatives
4. Treatment method alternatives

The selection criteria leading to the final alternative is given below.

1. Optimum baseline water quality (water quality of existing sources) that would minimize the supplemental treatment cost
2. Best treatment output based on the selected treatment alternative
3. Least cost in terms of both the initial and recurrent expenditure

Extensive details of the alternatives considered are presented in the feasibility study reports by SLTRP (Refer to Section 1.1.2). This section presents essential features of alternatives and the screening criteria leading to the final selection.

3.2 ALTERNATIVES AVAILABLE AND THEIR RELATIVE IMPORTANCE

3.2.1 No Action Alternative

The no action alternative was rejected on the basis of the SLTRP mandate, the GoSL need for development support in the wake of the tsunami, and NWSDB's mandate to supply water in all possible circumstances.

3.2.2 Alternative Water Sources Option

The following alternative for sourcing water supply were examined during the feasibility studies.

1. Augmentation of surface water capacity from Rota Tank through the construction of a channel from Rota Ara.
2. Groundwater extraction from well fields located at Panama Tank, Coconut Site, Karanda Oya, Arugam Bay North West and Konjan Aru, Cemetery Site and Heda Oya.

3.2.3 Alternative Sites for Treatment Plant

An alternative treatment plant site has been considered for the Pottuvil/Ulla scheme at the premises of a private owner at Sawalegama (Refer to picture below)

Treatment Plant Alternative site (inside Sawalegama): Pottuvil/Ulla Water Supply Scheme

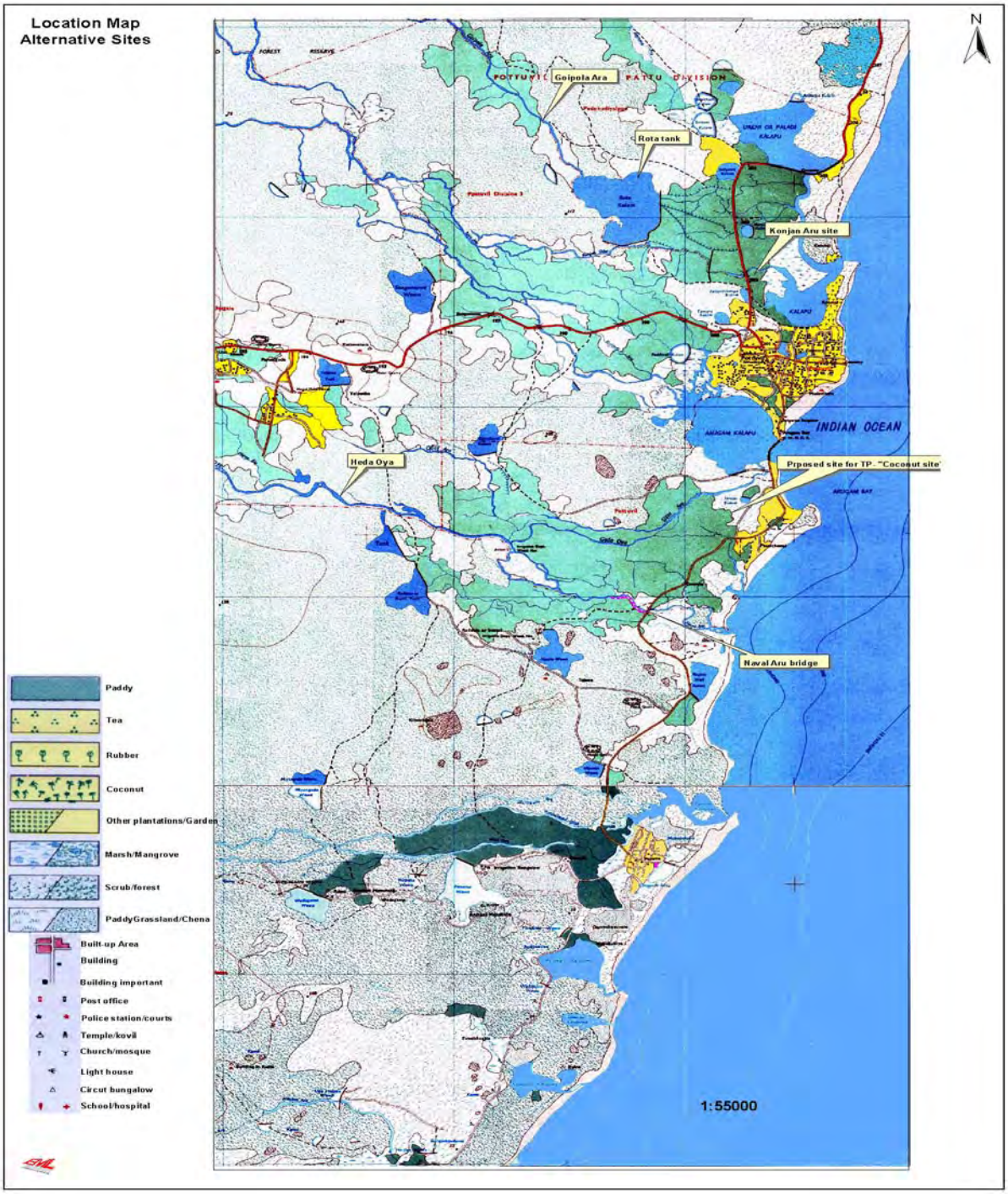
3.2.4 Alternative Treatment Process Options

The considered alternative treatment options are

1. Oxidation/Precipitation and Filtration
2. Ion Exchange
3. Manganese Greensand
4. Manganese Dioxide

All the alternative sites are presented in Figure 11

Figure 11. Alternative Sites



3.3 FINAL SELECTION FROM ALTERNATIVES CONSIDERED

From alternative water source options, groundwater extraction was selected as the most feasible option. The main reason is that the Irrigation Department did not grant approval for water draw off from Rota Tank, based on their opinion that irrigation use is a priority for this tank, and concern exists that supply is insufficient for both purposes.

For groundwater extraction, the Cemetery Road Site and Heda Oya wells were selected as the most feasible alternative sites as the yield is sufficient to satisfy demand and water quality is good, requiring only iron and manganese treatment.

A manganese dioxide treatment method was selected as a primary treatment option because of low cost, low use of chemicals, low labor requirement, and low energy cost for inter filter backwashing.

4. METHODOLOGY OF THE ENVIRONMENTAL ASSESSMENT

This chapter describes the methodology employed in conducting this EA, details of the Environmental Impact Checklists, details of site reconnaissance for information assimilation, methodology for the social impact assessment, and the ecological impact assessment.

4.1 GENERAL

A multidisciplinary team of experts performed the EA to identify the baseline environmental conditions and impact of construction and operation activities, and to propose mitigatory measures. Specially designed environmental checklists were used to elicit information and to identify potential environmental impacts. Details on the team are presented in Annex 1.

4.2 ENVIRONMENTAL IMPACT CHECKLIST

A specially designed environmental checklist was utilized during site visits, and were later analyzed to identify the probable environmental impacts. This checklist is presented in Annex 3.

4.3 SITE RECONNAISSANCE

The team field staff carried out site reconnaissance to assess environmental concerns. During site visits, staff performed the following activities:

- Visited all the sites of the project area, including treatment plant sites, tube well field, pipe routes and distribution areas, where on-the-spot assessments were made.
- Visited the sites considered as alternative sites (Rota Tank, Konjan Aru test well area, alternative treatment plant site of Pottuvil/Ulla).
- Evaluated the ecology (flora and fauna) of the sub influential areas (a radius of 500 meters from the site center) of each project site. Random evaluation techniques were used for the assessment. Special attention was paid to assessing the mobility of large animals, such as elephants in the project area.
- Met several key line agency personnel including the agriculture officer (Agriculture Department) and officials of the Pottuvil Divisional Secretary.
- Community members in the project area were consulted at random by the EA team to validate findings carried out by the Participatory Coastal Management Team of SLTRP. Other social information was obtained from the report: “Community consultations supporting construction of water treatment plants in Pottuvil and Panama,” conducted by SLTRP. (See Annex 8)

4.4 SOCIAL IMPACT ASSESSMENT METHODOLOGY

Two approaches were used in the social impact assessment, including consultation with affected or interested residents and project beneficiaries and socioeconomic data collection.

In the consultation process, staff visited project areas and interviewed key informants and residents, both individually and in groups, to discuss the issues and obtain a representative sampling of resident information in the project areas. Much of the literature on social aspects of the area was available as printed documents or in Web sites. Additional data was gathered through interviews with area key officials. Staff obtained a substantial amount of data, some quite recent, particularly concerning tsunami damage, while other data were dated a few years back, but still relevant. Some data were not available for the Lahugala project area.

In terms of data collection, staff first gathered data on socioeconomic aspects from secondary sources, which included reports, studies, and other literature. Secondly, staff visited proposed sites and gathered data on social aspects through rapid appraisal techniques, including key stakeholder interviews and focal group discussions. Key informants and participants of focal group discussions were selected after discussions with local officials – including the Divisional Secretary (DS) and Grama Niladhari (GN) – as well as through ad hoc interviews with affected residents. Most of the "ad-hoc" interviews were held with residents of the Panama area, where we were informed that some residents living close to the test wells and to the site were affected due to the drop in the levels of their wells during the testing period. Other participants for key informant and focal group discussions were selected on the advice of the Grama Niladharis and prominent residents of the area. A total of four key informants were interviewed in both areas, while three focal groups comprising five to eight persons were interviewed. The focal groups comprised of hotel owners and business persons in one group and members of welfare society in another group in the Pottuvil area. The third group comprised farmers and fishermen in the Panama area. Data from state and other agencies in the site area was obtained by interviewing key officials, community leaders, and other stakeholders.

4.5 ECOLOGICAL IMPACT ASSESSMENT METHODOLOGY

Information on the biological environment and impacts on the ecology of the sites was collected during a field visit to the Heda Oya area, the proposed route of the transmission lines and the Panama proposed water supply scheme site. The field visits enabled visual surveys of all sites and completion of environmental checklists (assessment forms) for all sites. The checklist can be viewed in Annex 3.

Belt transects were made from the centers of the sites to assess the habitats, fauna and flora using visual observations. Any additional species sighted through opportunistic observations were also included. The conservation status of all recorded species is included in Annex 4 Potential impacts were evaluated based on the experience of the EA preparers and their knowledge of the natural environment of Sri Lanka.

An area within a radius of 500 meters from the site was considered when considering the impacts from major construction activities.

5. EXISTING ENVIRONMENT

This chapter describes the project area environment: The physical environment, topography, land use, geology, water resources and hydrology, details of tsunami impact, groundwater and surface quality, the biological environment (flora and fauna), and demographic characteristics such as income, employment status, education, and health.

5.1 PHYSICAL ENVIRONMENT

5.1.1 Topography and Land Use

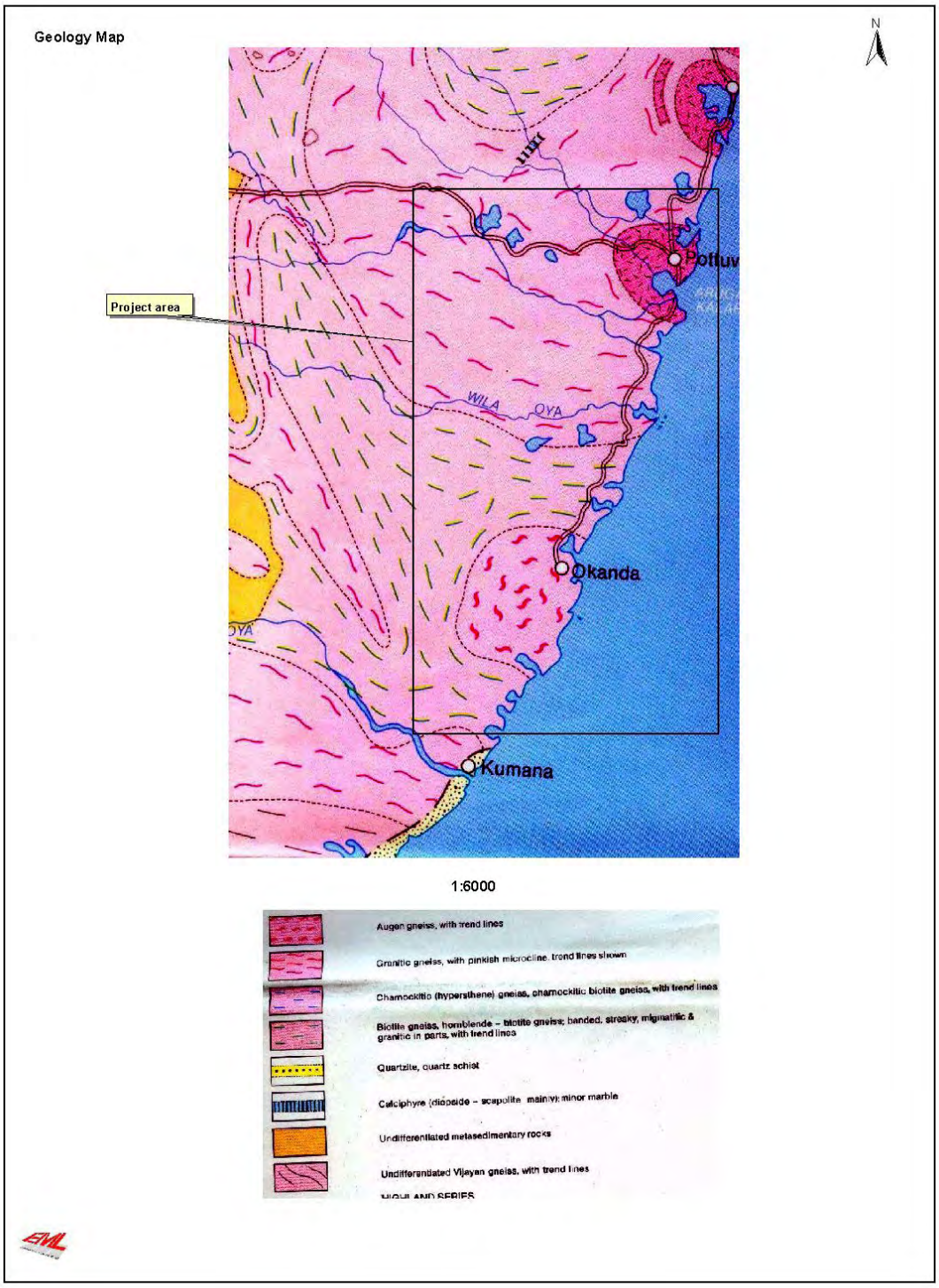
The project area consists of relatively flat, shallow, wide valleys. The rivers (Heda Oya, Wila Oya, and Goipola Ara) flow parallel to each other toward the ocean. Their drainage patterns are likely associated with structural patterns of the shallow underlying bedrock. The general topography of the Pottuvil/Ulla area is flat terrain adjoining coast and lagoons. Drainage flows toward the eastern sea through the medium river network (e.g., Heda Oya Konjan Aru).

The Panama area is a flat area with low-lying flood plains, gravel roads, a rural village, and scrub jungle. (Refer to Figure 3 (prepared using satellite image) for the general topography and land use of the project area.)

Geology

These rocks are confined to the eastern Vijayan metamorphic terrain, according to the geology of Sri Lanka, and are identified as Granatic Gneisses, Biotite Gneisses, Augen Gneisses and Horneblende Biotite Gneisses. Faults and fractures in these rocks may provide water-bearing formations suitable for deep production wells. Alluvial deposits are located along the rivers and these deposits may contain aquifers suitable for shallow production wells. Refer to Figure 12 for a geological map of the area.

Figure 12 –Geology Map



The general land use of Pottuvil consists of a semi urban town, coastal zones, homesteads, and gravel roads. The Ulla area is on the coastal zone while the land use of the Panama area is village homesteads, marshy areas, and water bodies abutting the coastal zone. Refer to Figure 2 and 3 for the general layout of the project sites, Pottuvil/Ulla and Panama water supply schemes.

5.1.2 Impact of the Tsunami

A large number of houses and other premises were damaged by the tsunami in the Pottuvil DS division. The damage was relatively minor in Lahugala DS division, which houses the Panama site. According to statistics[3] more than 150 persons lost their livelihoods, including a large number of fishing boats in the Pottuvil division. Most restaurants and guesthouses catering to tourists in the Pottuvil division were damaged or destroyed, and a large number of households lost their only source of income as a result. Most wells that comprised the primary source of drinking water for the population became polluted due to the tsunami, and consequently, a large number of households have to depend on water supplied by bowsers, particularly in the Pottuvil area.

5.1.3 Water Resources

Several surface and groundwater resources are present around the respective project areas; these are:

- Medium non-perennial streams (e.g., Heda Oya, Konjan Aru, Wila Oya, Goipola Aru)
- Irrigation tanks (e.g., Rota Tank, Panama Tank)
- Dug wells and tube wells

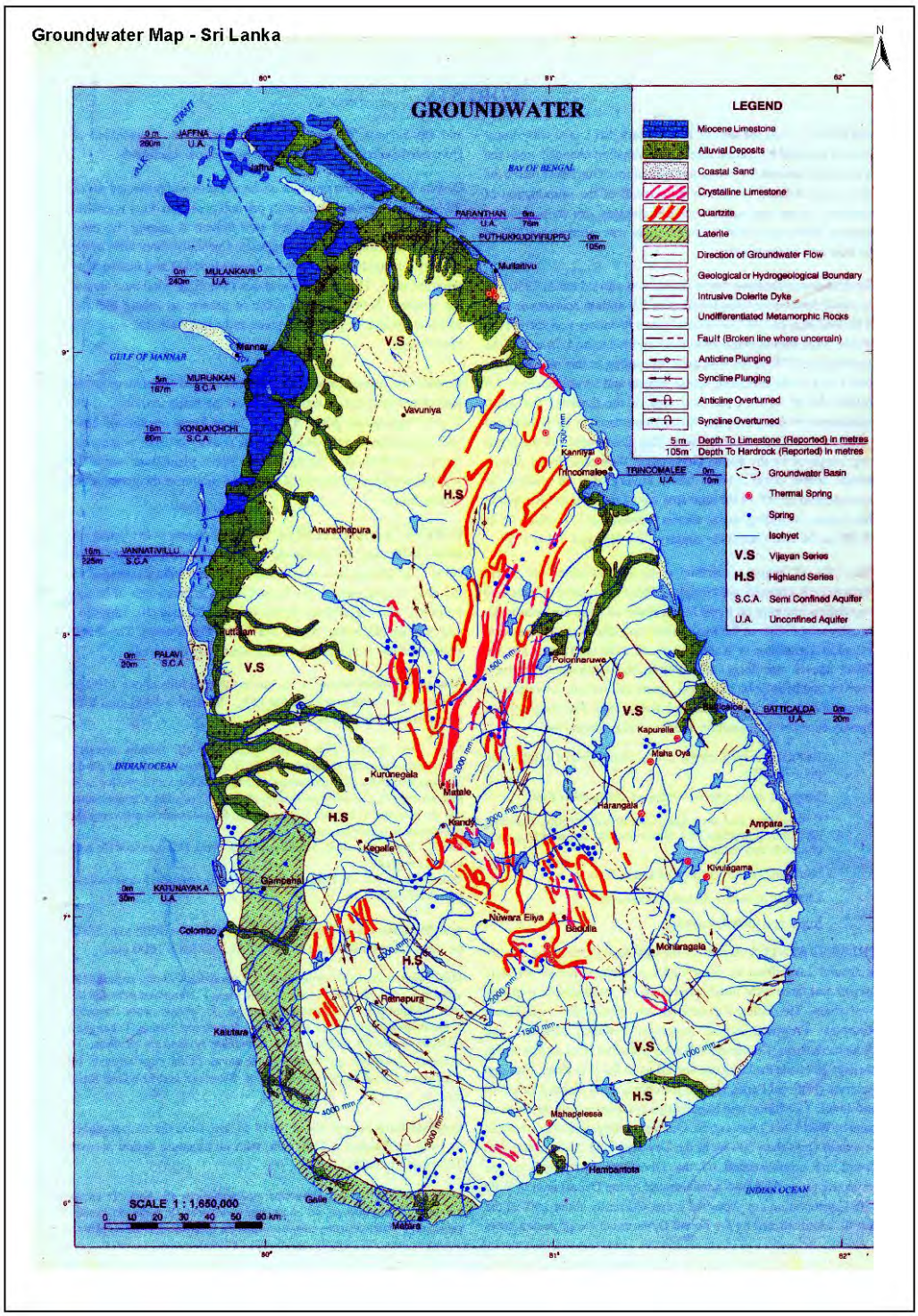
Prior to the tsunami, the communities in the project area had used shallow, hand-dug wells for drinking and other purposes. Most of these wells have been polluted with saline water and other pollutants by the tsunami. This groundwater resource may require two to five years, if not more, to return to normal.

The Pottuvil area has a productive aquifer in inter-granular rocks made up of sand, gravel, and alluvial formation, and it is possible there are moderate aquifers in fractured rocks, according to the groundwater map of Sri Lanka (Figure 13).

The NWSDB and the Water Resources Board have constructed about 50 boreholes in the project area on their plots of land at the request of some institutions and individuals. The depths of these wells vary from 20 to 40 meters and yields vary from zero to 300 liters per minutes (L/min). No agency has carried out a systematic groundwater exploration in the project area, or investigated development of groundwater for a municipal supply, prior to the present project.

[3] Source: Lahugala DS Office.

Figure 13 –Ground Water Map of Sri Lanka



The information given below regarding the potential groundwater sources at proposed water supply scheme locations were obtained from SLTRP study reports [Ref 2 & 3].

Table 1 Details of the Yields Tests Conducted for Pottuvil/Ulla and Panama Water Supply Schemes

Site	Depth (m)		Yield **(lit/min)		Remarks
	Test Well 1	Test Well 2	Test Well 1	Test Well 2	
Panama Cemetery Road Site (See Figure 3)	10.6	13.4	650 (72 hrs) 1,000 (48 hr)	1,000 (48 hr)	One observation well depth 18.6 m
Panama Coconut Site (See Figure 3)	8.5	**	650 (72 hrs)		One observation well depth 10.7 m
Heda Oya Site	7.9	7.9	800 (48 hr)	1,000 (48 hr)	One observation well depth 9.4 m. Installed wash boring transects at two locations (parallel and perpendicular to river)

**Conducted a step-rate test to determine approximate well yield and constant-rate test to determine sustainability

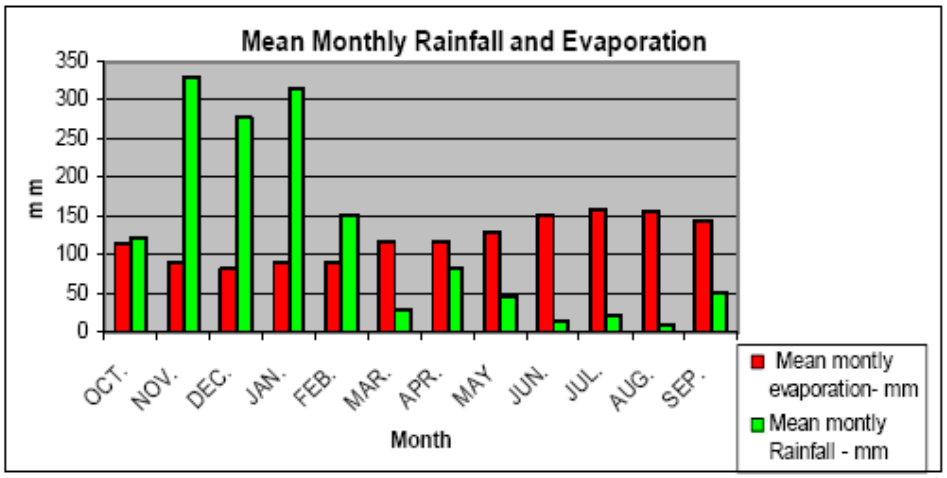
5.1.4 Hydrological Features (drainage pattern, rainfall, river flows, run off)

Climatology of the Project Area

Rainfall

Mean monthly rainfall values, calculated over a period of 75 years, are presented in Figure 14 The monthly mean rainfall exceeds 250 millimeters (mm) for the months of November, December, and January, and is less than 20 mm for the months of June, July, and August.

Figure 14 –Mean monthly Rainfall and Evaporation



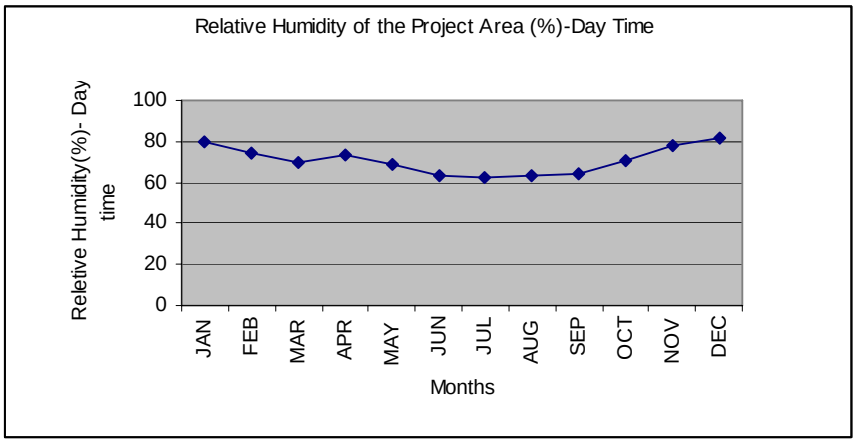
Evaporation

The mean monthly rainfall data recorded at Pottuvil rainfall station (operated by Department of Meteorology) and the evaporation data recorded at the nearest pan evaporation station (Inginiyagala) were compared; the results are presented in Figure 14. The figure shows that the mean monthly evaporation is about 150 mm for the months of June, July, August, and September.

Relative Humidity

As shown in Figure 15, the mean monthly relative humidity ranges between 60 and 80 percent throughout the year.

Figure 15 – Shows the mean monthly Relative Humidity



Hydrology of the Project Area

Catchments

The catchments influencing the surface water bodies in the project area are given in Table 2

Table 2 Shows the Mean stream Flow Values for Streams in Project Area.

Mean Stream Flow Values for Streams in Project Area

R.B.N.	Name of Main Steam	Mean Stream Flow (m^3/sec)	Remarks
35	Wila Oya	3.1	Outfall near Panama
36	Hida Oya	6.2	Outfall near Arugambay
37	Karanda Oya	4.0	Partly into Arugam Bay & partly near Rota Kulam
38	Goipala ARa	Not available	Flow into Rota Kulam and spills into a Kalapuwa North of Pottuvil.

Source: Master plan for the electricity supply of Sri Lanka, 1987

From iso-yield curves developed by the Irrigation Department, the specific yield for catchments in this region can be estimated at 0.36 million cubic meters per square kilometer (MCM/sq km) for the wet season (Maha) and 0.05 MCM/sq km for the dry season (Yala). These values indicate that there is a great disparity in the water flow in the main streams of each river basin during the Maha and Yala seasons.

Stream Flows
Stream flows of the streams in the project area are shown in Table 2 above.

Irrigation Tanks

Table 3 Mean stream Flow values for streams in Project Area.

There are several irrigation tanks (man-made impoundments) in the vicinity of Pottuvil. Rota Tank was considered as an alternative water supply source for Pottuvil/Ulla area.

Refer to Figure 11 for the location of these streams and irrigation tanks.

5.2 PHYSIO CHEMICAL ENVIRONMENT

5.2.1 Groundwater Quality

The description below summarizes the groundwater quality results obtained from the test wells. Laboratory data sheets are presented in Annex 5. Overall the water quality is good at the selected Panama Cemetery Road and the Heda Oya sites, with the exception of unacceptably high levels of iron and manganese. In addition, there is concern with regard to possible surface water influence on the groundwater because of the presence of Coliform bacteria, which were used as a surrogate at the Heda Oya site. (See Table 4.)

Given below are some of the key water quality parameters obtained during the test well investigations during the Feasibility Studies.

Panama Scheme

Panama Cemetery Site
Water Quality Parameters
Conductivity = 1,000 µS/cm (Maximum permissible level 3500 µS/cm)
—Fe ~ 3.0 – 4.0 mg/L (Ferrous concentration) – (Maximum permissible level 1 mg/L)

—Mn ~ 0.3 mg/L (Manganese concentration) – (Maximum permissible level 0.5 mg/L)
Level of water quality: Acceptable

Panama Coconut Site
Water Quality Parameters
Conductivity ~ 3,800 µS /cm – (Maximum permissible level 3500 µS/cm)

Level of water quality: Not acceptable

Pottuvil/Ulla Scheme

Heda Oya site

Water Quality Parameters
Conductivity ~ 380 μS/cm
—Fe ~ 7 – 12 mg/L (Ferrous concentration) – (Maximum permissible level 1 mg/L)

—Mn ~ 0.8 mg/L (Manganese concentration) – (Maximum permissible level 0.5 mg/L)

Level of water quality: Acceptable according to CEA Standards (1988).

Iron and Manganese at Panama and Heda Oya

Iron and manganese often occur together in groundwater, and no health effects are associated with either element. Their presence in drinking water is merely a concern from an aesthetic standpoint. If the water is allowed to stand in open containers, the reduced forms of the iron and manganese oxidize and form a red-orange precipitate (iron) and a black precipitate (manganese), which gives the water an unwelcome appearance and stains fixtures and laundry.

The Sri Lankan national water quality standards[4] list a maximum desirable level for total iron (as Fe) of 0.3 mg/L and a maximum permissible level of 1.0 mg/L. The maximum desirable level for total manganese (as Mn) is 0.05 mg/L and maximum permissible level is 0.5 mg/L. In comparison to these standards, the test results showed a worst-case total iron level of 3.2 mg/L and manganese of 0.9 mg/L at Panama and 12.5 mg/L and 0.9 mg/L at Heda Oya, which exceed the Sri Lankan standards.

Actual concentrations will vary from these measurements depending on the final well construction, pumping rates, and other variables. Preliminary results suggest that both iron and manganese precipitation will be a concern, again, from an aesthetic standpoint rather than a health one.

[4] Sri Lanka Standard 614:1983, Specifications for Potable Water, Part 1 – Physical and Chemical Requirements.

5.2.2 Surface Water Quality

Coliform Bacteria at Heda Oya

Samples were collected from the test wells and surface water at Heda Oya and analyzed for total and fecal coliform bacteria. Coliform bacteria were used as a surrogate to provide an indication of surface water influence on the water quality. Table 4 summarizes these results. Accordingly, the total coliform density at Heda Oya near the Test Well 1 and 2 exceeds 1,800 colonies per 100 milliliters. The total coliform densities for the Test Wells 1 and 2 were 17 and 25 colonies per 100 milliliters respectively. Similarly the fecal coliform densities for the Test Wells 1 and 2 were nine and one colony per 100 milliliters respectively. Thus total coliform were found in each test well, but the levels showed a 2-log or greater reduction compared to the river (Heda Oya). This indicates that although Heda Oya is the main source of recharge of these test wells, the soil medium is capable of significant reduction of pathogens present in surface water (river water).

It is not possible to draw final conclusions based on these limited test results. However, the results suggest that surface water microorganisms have the potential to reach the wells. It is known that some viruses, giardia, and cryptosporidium organisms survive for longer periods than total and fecal coliform bacteria, and therefore the reduction levels for these pathogens may be less. Based on this information, surface water influence cannot be ruled out.

Table 3 Results of Total and Fecal Coliform bacteria From Heda Oya

Total and Fecal Coliform Results from Heda Oya		
Sample Location	Total Coliform (Colonies per 100 mL)	Fecal Coliform (per 100 mL)
Heda Oya surface water, near Test Well No. 1	> 1,800	> 1,800
Test Well No. 1	17	9
Heda Oya surface water, near Test Well No. 2	>1,800	> 1,800
Test Well No. 2	25	1

5.3 BIOLOGICAL ENVIRONMENT

5.3.1 Ecological Features (terrestrial and marine flora and fauna) in the Project Influence Area

Pottuvil/Ulla Scheme

Well Site

The well field site is situated on the banks of the Heda Oya. The main type of vegetation of this site is riverine (riparian) vegetation/habitat shown in Figure 16 (see following page). This can also be referred to as riverine forests. There are no human settlements on the banks or within 250 meters of the well fields. This appears to be due to the security concerns and threats due to presence of wild elephants. No large animals were sighted drinking water or crossing the Heda Oya during the period of the field visit. The area with a 500 meter radius around the site consists mostly of paddy lands (see Figure 16). Riverine vegetation (RR) and Paddy land (PL) were main vegetation types/habitats found around the well site. Residents reported that elephants frequently visit the Heda Oya area both day and night, which presents an issue for possible human-elephant conflict.

A total of 171 plant species belonging to 64 families with two endemic and one highly threatened species was recorded from the Pottuvil area during the field visit (See Table 5) The endemic species, *Cryptocoryne sp*. and *Derris parviflora*, were located in the Heda Oya site; the former is a highly threatened rare species. A total of 57 faunal species (35 birds, nine butterflies, one reptile, nine mammals, one amphibian and two fish) were recorded from the Pottuvil sites during the field visit. Table 5 summarizes species of fauna and flora recorded with their conservation status, while (Annex 4) has table of the detailed lists of species. Of these, the Sri Lankan elephant *Elephas maximus* and the Sri Lanka Toque Monkey *Macaca sinica*, present concerns as they are endemic and threatened.

As noted above, one species of highly threatened endemic aquatic flora (*Cryptocoryne sp*) was located on the Heda Oya. During the field visit this species was found in a very small population (approximately ten above ground individuals) on the banks of the Heda Oya. The presence of this species must be considered when construction on the well fields is carried out and during the operation of the well fields.

Cryptocoryne sp is an aquatic, erect herb growing up to about 20 cm in height with an underground rizhome. It is a perennial that is submerged during high water levels and exposed when water levels recede in the dry season. The viability of the underground rhizomes is important for resurgence of the population. It has a highly restricted distribution in Sri Lanka and is found the riparian zone and river beds.[5]

Derris parviflora is a woody climber growing up to around ten meters on the tree canopy with compound leaves and white flowers. Its occurrence is uncommon.[6]

[5] Jayasuriya, personal communication.
[6] Jayasuriya, personal communication.

Treatment plant site

The land identified for the treatment plant is a coconut plantation that is currently a privately owned property located along the Pottuvil-Panama road. The owner of the property has created a water hole said to be for breeding of fish, however, there were no fish and it is devoid of vegetation and other visible animals **(**see picture 8 of Pottuvil/Ulla Site). The main type of habitat within the site is agricultural land with weedy herbs and shrubs dominating the under story of the coconut areas (see picture 7 of Pottuvil/Ulla Site). In an area with a radius of 500 meters around the site the predominant habitat types are home gardens, largely bare lands mostly consisting of grass and weeds with scattered trees and shrubs, fallow paddy lands, and closer to the seaward side, coastal scrubland. The list of fauna and flora from the treatment plant site is given in (Annex 4).

Figure 16 –Pottuvil/Ulla Scheme Heda Oya well field.

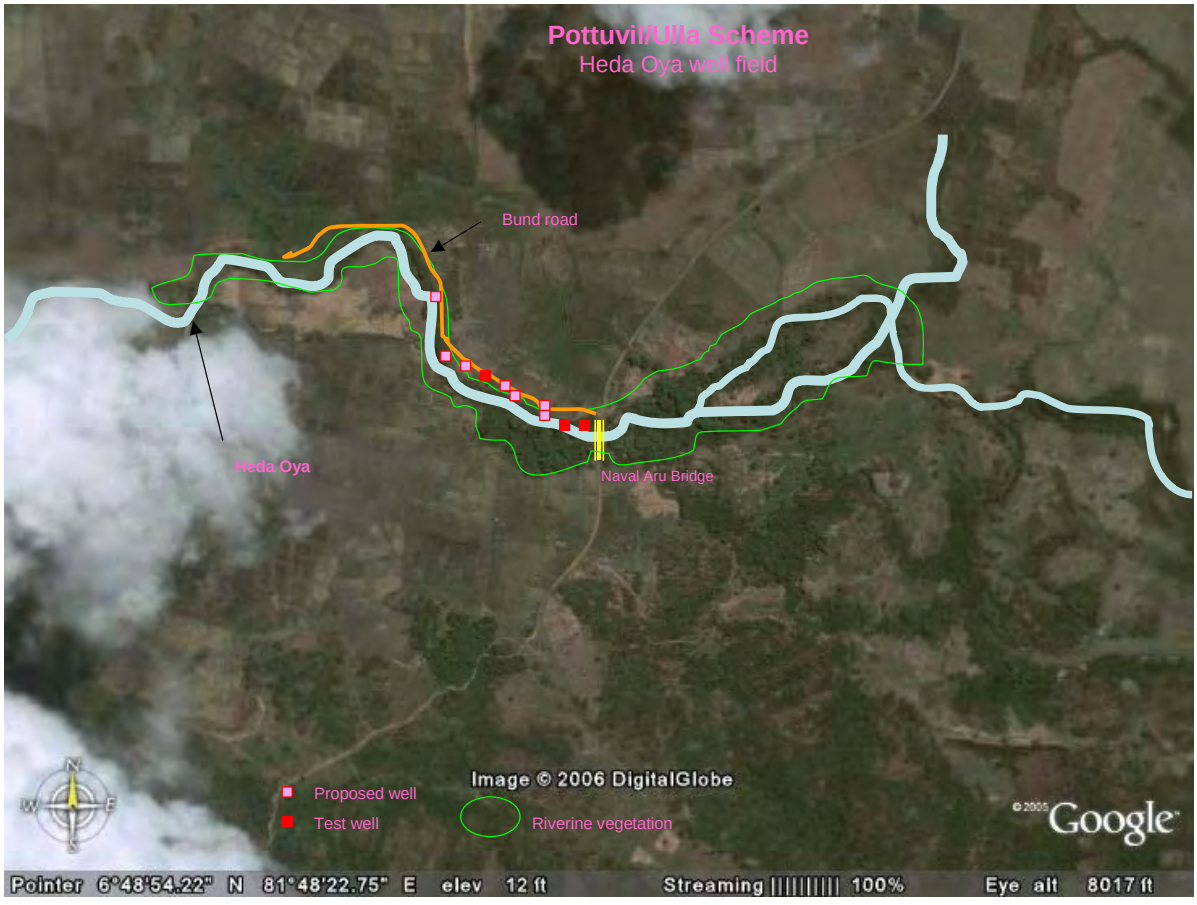


Table 4 Summary of the Fauna and Flora and Their Conservation Status in Heda Oya Well Field Site and Treatment Plant Site

Taxonomic Group	Number of Species	Endemic Species	Nationally Threatened	Exotic Species
Plant	171	02	01*	0
Bird	35	0	0	0
Butterfly	09	0	0	0
Reptile	01	0	0	0
Mammal	09	02	02**	0
Amphibian	01	0	0	0
Fish	02	0	0	0

*- According to the 1999 List of Threatened Fauna and Flora of Sri Lanka
**- According to the IUCN Red List of Threatened Species (www.iucnredlist.org)

Panama site

Treatment Plant and Well Site

Here the well fields and the treatment plant will be located at the same site (see pictures of Panama Site 1-4). The land is predominately abandoned paddy land and dominant forms of vegetation are weedy herbs. The main types of habitats encountered (mainly in the surrounding area) at this site were water bodies, seasonal paddy lands, home gardens, and nearer to the sea, coastal scrubland. The main issue encountered here is flooding of the area during periods of rain as the site is low lying. In addition the site is surrounded on nearly three sides by an area that has retained water. Residents said this water logging has taken place after the tsunami of 2004. There were indications of water flows within an area of 500 meters from the site. Residents said wild elephants visited this area, creating a possible human-elephant conflict at this site as well.

A total number of 151 plant species belonging to 57 families with two endemic species were recorded from the Panama site area of influence (See Table 6)The endemic species are *Derris parviflora* and *Cassine glauca*, both of which were recorded from home gardens within the 500 meter radius area of the treatment plant site. A total of 56 faunal species (30 birds, 11 butterflies, two reptiles, eight mammals, one amphibian and four fish) were recorded from the Panama site during the field visit. Table 6 provides summary information on the species recorded while Annex 4 has tables with detailed lists of species. Again, the species of concern here is the Sri Lankan elephant, which visits this site area. The long-term residents of Panama informed the EA team that elephants visit the area identified for the intake wells as well as the coastal scrubland that lies between the intake well field and treatment area and the sea beach.

Table 5: Summary of fauna and flora and their conservation status from Panama site

Taxonomic Group	Number of Species	Endemic Species	Nationally Threatened	Exotic Species
Plant	151	2	0	27
Bird	30	0	0	0
Butterfly	11	0	0	0
Reptile	2	0	0	0
Mammal	8	1	1	0
Amphibian	1	0	0	0
Fish	4	0	0	0

5.4 SOCIAL ENVIRONMENT

5.4.1 Details of Communities in the Area of Influence

Demographic Characteristics

General

The water supply projects are expected to benefit two communities located within the administrative boundaries of the Pottuvil and Lahugala DS Divisions, which are adjacent to each other and fall within the overall administrative district of Ampara. The total area of the Pottuvil DS division is approximately 269 square kilometers. The Lahugala DS Division is much larger with an area of 617 square kilometers.

There are a total of 27 GN Divisions within the Pottuvil DS Division, with 24 GN Divisions located north of the Arugam Bay bridge, and 12 GN Divisions in the Lahugala DS Division. The Pottuvil DS Division has a much larger population of more than 36,200 persons, with a population density of 135 persons per square kilometer, compared to a total population of only 7,600 persons and a population density of 12 persons per square kilometer in the Lahugala DS division. Details of the demographic characteristics of the population in the two DS divisions are provided in the following tables.

5.4.2 Summary of Population Characteristics

Population characteristics of Pottuvil and Lahugala DS Divisions are provided in Tables 6 and 7, below. More details tables are provided in Annex 2.

Table 6: Summary of Population Characteristics Pottuvil DS Division

Summary of Population Characteristics Pottuvil DS Division						
Name of GN Division	GND No.	Area sq km	No. of Families	Total Population	Population Density per sq km	Family Size
TOTAL		269	9492	36236	135	3.82

Source: Statistics, Pottuvil DS Division 2004, and Resource Profile 2004, Divisional Secretariat

Table 7: Summary of Population Characteristics Lahugala DS Division

Summary of Population Characteristics of Lahugala DS Division						
Name of GN Division	GND No.	Area sq km.	No. of Families.	Total Population	Population Density per sq km	Family Size
Total		617	2023	7588	12.3	3.75

Source: Statistics, Department of Census and Statistics 2001

According to the 2001 population census, the total population of the Pottuvil DS division was 29,696 persons. The population was estimated to have increased to 36,231 in 2004, or an annual increase of about seven percent. The majority ethnic group is Muslims, accounting for 78 percent of the population, followed by Tamils making up about 20 percent and Sinhalese two percent. The population density, which was 109 persons per square kilometer in 2001 has increased to 135 in 2004. The number of households residing within the division was estimated at 9,492, and household size averaged out at 3.8 persons. The entire population of the Pottuvil DS division is expected to benefit from the water project.

Lahugala DS division had a total number of 2,023 households with a total population of 7,600 persons. The majority ethnic group is Sinhalese (92 percent) with small populations of Tamils (seven percent) and Muslims (one percent). The household size works out to 3.75, slightly lower than that of Pottuvil DS division. About 900 households residing in four GN divisions of Panama (Central, North, South and West) with a total population about 3,200 persons are expected to benefit from the Panama water project, in the case of the Lahugala DS division.

Household Income and Poverty

According to the statistics provided by the Pottuvil Divisional Secretariat, over 77 percent of families receive less than Rs 2,500 per month and a large majority of the population (over 90 percent) is below the poverty line (according to Central Bank Statistics 2005). Data on average incomes and distribution pattern of incomes was not available in the case of Lahugala DS division. Data gathered from tsunami affected households suggests that more than 90 percent of the households obtain a monthly income below Rs 5,000 in the Lahugala DS division. Average household income of the population in the Pottuvil DS division is

estimated at around Rs 2,000 per month. The distribution of income in this DS is estimated as follows:

Table 8: Household Income by DS Division

Monthly Income (Rs)	Pottuvil DS Division (No. of households)
500-1,000	5,832
1,001-2,500	1,503
2,501-3,000	780
3,001-5,000	695
> 5,000	722
Total	9,532

Source: Resource Profile 2004, Divisional Secretariat, Pottuvil

Data on Samurdhi (government welfare program that provides monthly cash payments to identified poor families, with payments varying according to the level of income) recipients in the Lahugala DS division showed that over more than 80 percent of the families received Samurdhi benefits in 2004, confirming the high levels of poverty in this division. In the case of Pottuvil DS division, more than 60 percent of the families received Samurdhi benefits and about 77 percent of those receiving Samurdhi benefits received Rs 400 per month while the balance of 23 percent received Rs 140 per month.

The above statistics of Samurdhi recipients appear to confirm that a considerable proportion of the population is poor, with the Pottuvil division being slightly better off than the Lahugala division. No DS division level data is available on the population below the poverty line from the statistics collected by the Census and Statistics Department.

Employment

In the Pottuvil DS division, most families are dependent on agriculture and fisheries for their livelihoods. Trade and tourism are the next two important sources of income. Foreign employment, particularly in the Middle East, has emerged as an important income source in recent years. Details of employment of the population within the Pottuvil DS division are as follows:

Table 9 Employment Details in Pottuvil DS division

Employment Category	Number Employed	%
Employees in the State Sector	635	4.8
Employees in the Private Sector	233	1.7
Self employed including wage labor	2313	17.4
No. of Employers	1976	14.8
Employed Abroad	761	5.7
Farming	4,900	36.8
Fishing	2,500	18.8
Total	13,318	100

Source: Resource Profile 2004, Divisional Secretariat, Pottuvil.

No employment data was available from the Lahugala DS division. Field observations and discussions suggest that farming and fishing are the two main occupations of this community, with some employed in trading activities, wage labor as well as self employment. An estimated 40 percent of the population of this division are in the labor force and about 75 percent of the work force are employed (about 25 percent unemployed). In the case of the Pottuvil DS division, the total workforce (population between the ages 15 to 65) is estimated at 21,742 persons; the number employed is around 13,318, while unemployment is running about 39 percent. However, since the majority of the population is Muslim, the women usually do not work outside the home, in accordance with cultural norms. Assuming that 35 percent of the workforce is voluntarily unemployed, as they are either school going or women, the actual unemployment rate may be in the region of 18 to 20 percent. Of the employed category, only those working for the state and the private sector or working abroad (14 percent) are employed on a regular basis. The rest (86 percent) is employed seasonally, intermittently, or on a part-time basis. The lack of a regular source of employment and income may contribute to high poverty levels in this division.

The skill levels of the local populace is low, thus it is difficult to hire skilled workers such as welders, carpenters, masons, or mechanics. However, there is a good supply of unskilled labor, but they do not have adequate employment opportunities. The housing and building construction activities after the tsunami generated some opportunities for employment, but a large number of the workers are hired from outside of the area by contractors. The education levels of the workforce shows that more than 70 percent have had less than 10 years of schooling, and of this proportion, more than 75 percent have had less than five years of schooling. A considerable proportion of the labor force is largely uneducated or are barely educated, and therefore may find it difficult to obtain gainful employment.

Education

There are a total of 28 State Provincial schools in the division, of which 16 are Muslim schools, five are Tamil schools, and seven are Sinhalese schools. The total population of students in all schools was about 9,000 and the total number of teachers was 300 (30 graduate and 250 trained teachers), giving a student to teacher ratio of 30:1 in the year 2004. There are no private schools. There were about 150 school drop outs (80 female students) up to year nine (drop out rate 1.6 percent) in schools within the division.

The student to teacher ratio ranged between 20:1 to 45:1 in most Muslim and Tamil Schools and between 8:1 and 12:1 in Sinhalese schools within the division. Only one school had been graded as AB (A grade schools have better facilities than B grade schools, while both conduct advanced level (AL) classes in science and arts, while three other schools were graded C, (schools with lesser facilities than A and B grade schools) but with facilities for the conduct of non-science stream AL classes). There are six schools having classes up to Year 11 (General Certificate of Education (GCE – OL (Ordinary Level)) and 16 schools with classes up to year five to eight. Most students from the area study in these schools, except for AL students, who attend schools in the Pottuvil town area since AL studies are not available in the local area schools. The schools lack facilities and resources, including good teachers, furniture and facilities for extra curricular activities. Some schools suffered heavy damage from the tsunami.

Health

Health facilities are poor with one government District Hospital with 55 beds, a staff of three doctors, one registered medical practitioner (RMP) (person with less than a medical degree), one nurse, one pharmacist, one attendant, and 14 minor staff. The cadre of medical staff is about 30, including six doctors, two RMPs, one dentist, ten nurses, two pharmacists, four middle level technical officers, (who conduct laboratory tests as well as perform other tests such as X-rays, ECGs) four midwives, one attendant, one clerk and 29 minor staff, but there are only seven medical and 14 minor staff at present. In addition to the District Hospital, there is a Central Dispensary located at Komari, which is understaffed. In 2004, about 15,000 indoor and 7,500 outdoor patients were treated at the District Hospital and about 4,000 indoor and 1,000 outdoor patients treated at the Central Dispensary. The major medical problems include fever due to virus and Malarial infections, and diarrheal or communicable diseases. Medical facilities in the GN divisions in Panama area are not adequate. Most residents have to come to Pottuvil District Hospital for any medical treatment.

Details of housing conditions, including water services, energy use, and toilet facilities, are provided in Table 11.

Table 10 Status of Housing, Sanitation, Water and Energy Use in 2004

Entity Type	Lahugala DS division	Percentage of Total	Pottuvil DS division	Percentage of Total
Total Number of Housing Units (Households)	2,023	100	9,466	100
Permanent Housing Units	827	41	4,570	48
Semi-Permanent Housing Units	827	41	1,675	18
Improvised Housing Units	369	18	3,221	34
Protected Water Supply within premises	910*	45	4,638	49
Protected Water Supply outside premises	465*	23	2,745	29
Unprotected well	404*	20	1,893	20
River, tank and other sources	244*	12	190	2
Electric lighting			4,175	44
Kerosene lighting			5,291	56
Other sources of lighting			197	2
Water sealed toilets			3,760	39
Not stated			5,816	61
Cooking – firewood	1,820*	90	8,226	86
Cooking – kerosene	182*	9	240	6
Cooking – gas	6*	0.3	267	2
Cooking – other	15*	0.7	543	3

Source: Resource Profile 2004, Divisional Secretariat, Pottuvil: * Estimated values

Between 70 and 80 percent of families live in permanent or semi-permanent houses and the rest live in makeshift housing. There is no pipe borne water supply system in this area. Before the tsunami, people used wells as a water supply. Almost all households obtained water for

drinking and household use from wells. About 50 percent obtain water from protected wells within their housing premises. About 25 to 30 percent obtain water from protected wells outside of their premises, while about 20 percent obtain water from unprotected wells and a small percentage obtain water from rivers, tanks, or other sources. Local groundwater basins are recharged from natural runoff. The area met almost all of its water needs from underground resources, area rivers, and tanks. Since the tsunami, however, the wells have become brackish, and cannot be used for drinking. A temporary water treatment plant has been established in Pottuvil and the drinking water is supplied through bowsers in this area. Only about 40 percent of the households have water sealed toilets; the others have not indicated the type of toilet used. Thus, housing conditions, water supply and sanitation need considerable improvement in the area.

The main energy source used in cooking is firewood, which is used by most of the households. Kerosene and gas are used by a few households. The main source of energy used for lighting in the Pottuvil DS division is kerosene, which is used by 56 percent of the households, while electricity is used by about 44 percent. A similar pattern most likely exists in the Lahugala DS division area. Thus access to grid electricity is much below that of the national level, and the electricity supply is unreliable, with constant disruptions day and night. Modern infrastructure facilities — piped water supply, electricity and sanitation — essential for developing this area for tourism, or for improving the livelihood of the population, are grossly inadequate.

5.4.3 OVERALL COMMUNITY RESPONSE TO PROJECT

The primary approach to gathering information regarding community response to the project was through a process of community consultations undertaken under the participatory coastal management (PCM) component of SLTRP. Detailed findings of this process to date can be found in Annex 8. Additionally, the EA team conducted interviews with randomly selected residents and officials to validate the findings of the consultation process.

A process of community consultations were carried out for the construction of the water treatment plant; the bulk of these community meetings were held in October 2006, with follow-up continuing to the present. Large (ranging from 20 to 100 participants) community meetings were held in Pottuvil, Arugam Bay/Ullai tourist area, and Panama village. Participants were advised of the meetings both by posters displayed in the respective areas, and through invitations issued to representative community leaders, including government officials, religious leaders, and local NGOs and community-based organizations (CBOs).The community meetings were organized through the Local Authority Office and Chairman of Pottuvil and Lahugala (the latter being the LA under which the Panama village is placed) with whom the SLTRP community consultation team has been liaising with from project inception in September 2005. Additional support in convening community meetings was provided by local CBOs, including the Arugam Bay Tourist Association (ABTA) and Arugam Bay Community Development Task Force (ABCDF).

The following key concerns have been expressed by the stakeholders regarding Pottuvil/Ulla and Panama water supply schemes.

Pottuvil/Ulla Scheme:

1. The distribution of the water: it was made clear to the community that the International Federation of the Red Cross is undertaking it, and the SLTRP project is liaising with them.
2. Broad support and enthusiasm was expressed by participants for provision of water to Pottuvil/Ulla due to the present shortage of quality water.
3. The majority of the residents of Pottuvil town and businesses owners in the tourist area interviewed were willing to pay for the water.

Panama Scheme:

1. Stakeholders expressed concerns about lowering of water in existing wells around Panama tube well field.
2. Many residents were concerned and unclear about the costs of obtaining piped water supply. Costs include a one time fee for the connection and monthly charges according to usage.

Despite the general community approval indicated by the community consultation process, it is clear that ongoing liaison and information dissemination will be required prior to commissioning of the systems. This education of the community should be ongoing as construction goes forward, specifically once the tender is awarded and the construction contractor is mobilized in the area. Therefore a second phase of community consultations and information dissemination is recommended after contract award. Payment for connections and regular service should be a focus of this dialogue as it is likely to be an issue of concern, and proper communication can help to ensure that the new facilities will be effectively utilized.

The broad conclusion of the community consultation process carried out by the PCM team as that the proposed water treatment plants are a critical need in the area, and therefore not particularly contentious, despite the existence of key issues requiring follow-up (i.e. payment for connection and service). Therefore the issues involved are not very deep or contentious.

Interviews conducted by the EA team validated that the community response is positive with almost all parties interviewed supporting implementation of the project. Residents have suffered enormous hardships over the past few years, particularly subsequent to the tsunami. The burden of women, who are most affected by lack of good water, will be reduced considerably by this project. A cross-section of the beneficiaries interviewed in both areas was happy about the project and willing to pay for the connection to a well and for the supply of water. Residents of 10 years or more were interviewed and most complained of poor quality of water, with defects ranging from turbidity, salinity, dark color of water, and poor taste. Furthermore, officials interviewed indicated that piped water supply to the area would be an enormous boost to development, particularly tourism and investment in business and trade. The officials serving in the area would also benefit as they suffer personally from shortages of quality water; with the provision of piped water supply, more government officials would be willing to serve in the area, whereas there is currently a considerable reluctance to fill GoSL posts in the area.

6. POTENTIAL ENVIRONMENTAL IMPACTS

All likely construction and operation impacts from the project have been described here, including from: operation of machinery, well drilling, noise and vibration, dust, excess earth disposal, impact on rivers, material transport impacts, access roads, surface and groundwater quality, erosion, pipe laying, labor camps, community health, and riparian impacts.

6.1 CONSTRUCTION IMPACTS

6.1.1 Operations of Machinery

Medium to heavy machinery will be employed for site clearing, trench excavation, and treatment plant construction; this will create noise, dust, vibration, and traffic congestions, as the roads are narrow. These impacts are temporary and mitigable. Operation of machinery could damage road surfaces, as well as soil compaction on unpaved surfaces, and erosion of riverbanks. The Naval Aru bund road could be damaged when accessing the tube well field.

6.1.2 Well drilling

Well drilling equipment could create noise and vibration, contamination of the groundwater or surface water from accidental fuel spilling.

6.1.3 Noise and Vibration

Noise and vibration are temporary and mitigable impacts. Data show general noise levels could be expected in the area (see Table 12). According to present noise legislation, maximum permissible noise levels at boundaries of the land in which the construction activities are undertaken are stipulated in the following table.

Table: 11 Noise level of Pottuvil/Ulla and Panama Area

Scheme	Place	Noise category**	Noise Level Day Time db	Noise Level Night Time db
Pottuvil/Ulla	Heda Oya well field	Rural Residential	55	45
	Transmission line	Rural Residential	55	45
	Treatment plant site	Noise sensitive##	50	45
	Distribution Area	Urban Residential/Noise Sensitive&&	60/50	50/45
Panama	Well field and treatment plant	Rural Residential	55	45
	Distribution area	Rural Residential/Noise Sensitive&&	55/50	45/45

Note: Daytime (defined as 6:00 am – 7:00 pm) and night time (from 7:00 pm – 6:00 am on the following day) respectively.
** Refer Schedule IV – CEA noise regulations 924/12
# Due to presence of Sinhalese School and Agriculture Department Office
&& Schools, Temples and Government Offices

Table 13 gives noise levels of construction equipment and machinery at a distance of seven meters.

Table 12 Noise levels of construction equipment

Equipment	Noise level at Seven Meters in dB (A)
Crow bar	115
Compressor	109
Truck, scraper or grader	94
Pneumatic drill	85
Excavator	112
Loader	112
Roller vibrator	108
Poke vibrator	113
Sound reduced jack hammers and lock drills	82

Source: Southern Highway Supplementary Environmental Impact Assessment Report

Therefore in view of the values given in Table 13, noise levels from machinery in construction could disturb nearby communities since levels tend to exceed permissible day time limits stipulated for construction.

6.1.4 Dust

Operation of machinery could create dust during site clearing and trench excavation. Open loose material near the cut trenches also could create dust because of traffic.

6.1.5 Excess Earth Disposal

Excess earth generated through site clearing and trench excavation, if piled on the road side and if exposed to rain, could create dust and soil erosion. These earth piles could also generate traffic congestion. Dust could give rise to respiratory problems and related diseases among nearby residents, however these impacts are all temporary and mitigable.

6.1.6 Impacts on River Alluvium

There will be impacts on the river alluvium in Heda Oya during the well drilling process. Accidental fuel spillage from the machinery could contaminate surface and groundwater and the sand deposited in the river alluvium.

6.1.7 Material Transport

The impacts created by transportation of construction material (such as cement, sand, and rock) without any precautionary measures such as covering, avoidance of spilling loose material on the road surface could create dust. Frequent vehicle travel for materials transport will also contribute to traffic congestion. These impacts are temporary and mitigable if proper measures are adopted.

6.1.8 Access Roads

Temporary access roads may be required to gain access and transport machinery to the treatment plant sites and the tube well field site. This may lead to clearing of vegetation, which will in turn lead to dust emanation and soil erosion. Some of these impacts may be long lasting if not permanent.

6.1.9 Impacts on River Water Quality

The only construction work carried out near the river is the tube well drilling process. The water quality of the river may be affected if tube well excavation materials such as sand or organic soils are disposed of close to the river, and subsequently washed back into the river. This impact is temporary, of moderate duration and mitigable.

6.1.10 Erosion at Construction Sites

Site clearing will denude the vegetal cover of the land temporarily and, in case of rain, soil erosion could take place. If tube well excavation material is disposed of close to the river, erosion and sedimentation could set in.

6.1.11 Community Health

Impacts on community health are primarily positive as the community will be supplied with good quality water. If pipeline laying leads to dust creation, it may have a negative impact on community health, though temporary, less intense, and mitigable as construction is not large-scale compared to other civil engineering projects such as road construction or canal excavation.

The provision of potable water is expected to improve the health of the population in the two areas. Currently drinking water is a major problem for communities, particularly given the damage caused by the tsunami to wells used for drinking and other household needs. These wells have become saline and cannot be used for drinking or other purposes. A few NGOs had set up temporary water purification plants (three mile post, Kunjan Odai and Rota Wewa). However, we were informed that these plants are now closed. Thus the population is forced to make use of even polluted water for their daily needs. Most people consulted welcomed the water supply project and were willing to pay for the water supply. Thus most of the consumers would be better off with the provision of water supply to the area; health problems from consumption of polluted water is anticipated to decline with the proposed project.

The only health impact that may arise would be near the treatment plants, where chemicals and other waste material from water treatment may cause ground water pollution if such wastes are not disposed of properly. However, the treatment plants are located in less populated areas and therefore the impact of waste from water treatment may only have minimal impacts on the adjacent population. Still, proper waste disposal methods can be employed to reduce or mitigate this risk.

6.1.12 Riparian Impacts

The major socioeconomic impact is one that may arise from reduction in water availability to downstream users. Some residents in the Panama area have indicated that the level of their wells declined after 30 hours of operation of test wells. It is also likely that water flow in the Heda Oya may decline after continuous operation of source wells, particularly after a period of operation of the scheme, or during times of drought. However, it is unlikely that this would have any major impact on irrigation or other users, when one considers the quantum of water extracted for the water supply against the much larger amounts needed for irrigation, fishing, and bathing.

6.1.13 Impacts on Roads Owing to Pipe Laying

Most beneficiaries were of the view that inconveniences from pipe laying were temporary in nature and were not much concerned. They were willing to ignore such inconveniences provided water was supplied to them and the project was approved, as they have already suffered more inconveniences due to the impact of the tsunami.

6.1.14 Labor Camps

Impacts from Sanitary Facilities, Solid Waste Disposal
There is a lack of skilled labor needed for the construction of the project. Currently many residents are being hired for other projects implemented after the tsunami. Thus labor required may have to be hired from outside of the area. This may involve providing residence facilities near the construction areas. Some pollution may result from solid waste disposal and improper sanitary practices.

Social Reaction to Alien workers
There may be some social tension arising between local labor and hired labor from outside, if such groups do not adhere to the social norms of the resident population. This can be avoided by education and prompt action by the supervising officers.

6.1.15 Landscaping and Aesthetics

Landscaping and aesthetics are very important considerations in designing the treatment plant and ancillaries such as the water tanks and slow sand filters. The main landscape features should be preserved as much as possible as this area is a high tourist attraction.

6.1.16 Impacts on Habitats and Species due to Construction

All construction can have impact on the habitats and species of the sites. However, when impacts are prioritized according to their degree of significance, area, and period of impact, the most important can be those on the Heda Oya ecosystem and its riparian habitats due to construction of the well field and operation of the intake wells. Please refer to construction impacts for a list that will be significant. The presence of wild elephants at both sites is a serious issue. It appears that elephants use the Heda Oya site frequently and can damage well fields and other construction.

6.1.17 Impacts on Roads Owing to Pipe Laying

Pipe laying will cause dust, traffic congestion, and inconvenience. These impacts are mitigable and temporary.

It is observed that Panama Road is already damaged with plying of heavy vehicles for the bridge construction. Excavations by the roadside could further damage the road.

The pipe laying construction could also damage un-tarred interior roads at Panama.

6.1.18 Impacts on Schools

The Pottuvil water supply system treatment will be situated near a school; therefore, impacts on school activities may result from noise and vibration, traffic congestion, presence of outside laborers, accidents, etc.

6.2 OPERATIONAL IMPACTS

6.2.1 Impacts on Groundwater Due to Routine Draw Off

Routine draw off will not cause any significant impact on the groundwater wells if the specified water amounts are extracted within the specific time period. However if there are water overdraws from the tube wells then the “cone of depression” will result during the process of groundwater lowering.

Production wells for the Pottuvil/Ulla water system are located about 4.5 km outside of town along the Heda Oya River. These wells will be recharged largely from the river and will not likely to result in any reduction of groundwater levels in the immediate area. Further, there are no known domestic wells near the Heda Oya intake. Production wells for the Panama system are located near the treatment plant.

Direct evidence gathered by our engineers indicates that groundwater of the wells within approximately 100 m based on pump tests that have been executed at the site location and most likely water lowered by 25 to 75 cm. The actual pumping rate of the production wells is only 8 hours a day which allows 16 hours of recharge daily. Actual conditions will depend upon the annual rainfall and recharge rate within the area. There will be some affect, but overall should not completely dry up nearby wells.

There is also a risk of saline water intrusion at the selected sites as the area is abutting a coastal stretch.

6.2.2 Impacts on Surface Water of the Stream (Heda Oya)

Heda Oya is not a perennial source of water and, according to the average rainfall estimates (See Figure 14), the lowest rainfall occurs in March and August, resulting in lowest flows. The tube well field is located in the river alluvium and the drawn water is from shallow tube wells, creating a risk of lowering the flow of Heda Oya in dry periods.

6.2.3 Environmental and Riparian Requirements

The environmental flows downstream of the tube well field should be maintained at a congenial level. To evaluate the water demand status against the standard environmental flow criteria, the method given in IUCN guidelines were used and the results presented in the table below. It is seen from the table that the projected demand for the extreme horizon of 2025 is less than 10 percent of the mean annual flow of Heda Oya. The demand figure is very low when compared to the mean annual flow (about 0.5 percent). It can therefore be inferred that the average draw off from the tube well field will not adversely impact the environmental flow requirements.

Table 14 Criteria for Environmental Flow

MAF&&=6.2 m^3/sec (Heda Oya)			Total Demand Extracted from Heda Oya for Pottuvil/Ulla Schemes for the Extreme Horizon 2025 (m^3/sec)
Criteria**	Environmental Flow as a percentage of MAF m^3/sec	River Habitat Status**	
<10% of MAF	<0.62	Severe degradation	0.064m^3/sec = 5,500 m^3/day
10%-30% of MAF	0.62-1.86	Poor survival	
30%-40% of MAF	1.86-2.48	Moderate habitat	
40% -60%of MAF	2.48-3.72	Good habitat	
>60% of MAF	>3.72	Excellent habitat	

Notes:
*1. ** ➔IUCN – The Essentials of Environmental Flows- 2003.*
2 .&& ➔MAF= Mean annual Flow (of Heda Oya obtained from CH2MHILL – Arugam Bay Water Supply Preliminary Assessment Report – Phase I – May 2006.)

The information above is insufficient to rule out potential impact on the environmental flows. The most critical period is the dry weather flow that will be well below the average especially during the period mid-January to mid-April. No sufficient flow data are available to test this possibility with certainty. Therefore special mitigatory measures may be required to guarantee the downstream environmental flows during the dry season.

6.2.4 Impacts on Sensitive Habitats in the Vicinity (Coastal Zone, Lahugala Sanctuary)

Impacts on Lahugala Sanctuary are unlikely, as it is not situated in the vicinity of the well fields of the Heda Oya. Unless construction activities spill over to the coastal scrubland, impacts on the coastal zone are unlikely. However, attention should be paid to avoiding use of the coastal zone for any construction activities including housing and providing facilities to construction crews.

The presence of wild elephants at both Pottuvil/Ulla and Panama sites can be a serious issue. The well fields of the Heda Oya site, distribution pipes, and the water intake and treatment plant at Panama should be operated with this in mind. Elephants can damage the well fields and other constructions.

The issue of disturbance to elephants and their migratory routes has to be considered during the next phases of this project in conjunction with the Department of Wildlife Conservation (DWLC) of Sri Lanka. As elephants are a threatened species and one that brings about high degrees of reaction from the nature conservation-oriented sections of the Sri Lankan population, it should be treated with due importance and attention. It will be necessary for SLTRP to collaborate with DWLC to determine any appropriate measure to ensure that human-elephant conflict is reduced in the construction and operation of the Heda Oya well fields.

Contamination of surface water can affect aquatic species as well as riparian species that grow close to the edges of the Heda Oya.

6.2.5 Water Treatment and Treated Water Quality

The treatment process is designed to achieve water quality in compliance with Sri Lanka standards for drinking water. It is designed to meet public water supply requirements on a 24/7 basis. Significant health benefits are expected from the improved water supply, which will include improved water quality, and improved service in terms of service hours and quantity.

The negative effects of the treatment are production of sludge, polluted backwash water, and risk of chlorine leaks.

Backwash water contains the iron/manganese sludge/solids, thus it is high in turbidity and color. Solids will be removed from backwash water through sedimentation. As iron and manganese oxides are heavy, typical sedimentation is sufficient to reduce turbidity and color to an acceptable level for disposal of backwash water into inland waterways. If more efficient removal of iron and manganese is required, the alum coagulation and settling process can be considered. The decision on treatment for backwash water shall be taken during the detailed designs based on best practices.

Even at very low concentrations, chlorine can cause eye and throat irritation. At 0.1 parts per million (ppm) concentration and exposure of more than an hour, chlorine gas can adversely affect plants. Chlorine levels of more than 10mg/L are considered immediately dangerous to life and health. The USEPA defines chlorine concentration of 0.0087mg/L in air as a level for concern. Residences and public institutions are presently close to both treatment plant sites. In fact, residences are present within 50 to 100 meters from the center of the treatment plant sites. Considering this close proximity, it is recommended that both plants delineate those areas that could be adversely affected by an accidental release of chlorine. An emergency response plan needs defining as do requirements for community coverage in terms of timely diffusion of information during an emergency response.

6.2.6 Sludge Management

The sludge management method is explained in Section 2.4. This practice – which includes treatment of backwash prior to offsite discharge – is environmentally acceptable as the iron and manganese sludge is not toxic for disposal and land is available. If the pits dug for disposal of iron and manganese sludge are deep enough to create anaerobic conditions, then iron and manganese will transform back to soluble ionic status and leach into the ground water. The associated problem is mainly the objectionable color these ions impart to water. Even if this happens, it will not affect the community adversely since pipe borne water supply will be available to the community. If required, development of anaerobic conditions can be controlled by limiting the depth of sludge disposal pits.

Details of input chemical management (mainly chlorine management) are given under section 6.4.7 below.

6.2.7 Emergency Response System

It is mandatory that all such facilities develop and maintain a Risk Management Program. There are other regulations in the United States to be satisfied by the Department of Transport, and the Occupational Health and Safety Administration, on transport, handling and use of chlorine.

A major environmental emergency that should be anticipated in both schemes is the accidental release of chlorine gas. The USEPA has set regulations to minimize the risk of injury, death or damage to operational personnel and minimize off-site impacts on public and environmental receptors due to accidental chlorine leakages. Risk management against chlorine exposure is necessary for all treatment systems where gas chlorine is in use. In the United States, the 40 CFR Part 68 Accidental Release Prevention Program Rule (ARPPR) applies to water treatment facilities that have regulated substances such as chlorine in inventories in excess of minimum quantities (1,000 kilograms for gas chlorine) defined in the regulations. Three cylinders of 900 kg cylinders each will be used at each location for a potential of 2,700 kilograms of gas chlorine present on site, which is in excess of minimum quantities and thus would call for ARPPR to be applied under USEPA guidelines.

6.2.8 Noise and Vibration during Operation

Noise and vibration could be created by the operation of pumps near the groundwater wells (during extraction) and the storage tanks (during pumping to the tanks). As the Panama treatment plant and the well field is in the village residential area, this impact could become pervasive if not mitigated.

7. PROPOSED MITIGATORY MEASURES

This chapter describes the proposed mitigatory measures for the environmental impacts (construction and operation) identified in Chapter 6.

7.1 CONSTRUCTION IMPACTS

7.1.1. Operations of Machinery

Impacts created by heavy machinery could be mitigated as follows.

Noise and Vibration

This impact could be mitigated by selecting less noisy small- to medium- size machinery for construction activities. For example, mini backhoes are suitable for trench excavation for pipelines since the water supply system components are not large-scale ones. Night work using noise-creating machinery should be avoided as much as possible. Noise levels in all areas should be kept below the stipulated levels. However, in using heavy machinery, temporary noise level enhancement in bouts cannot be mitigated. However this impact is temporary.

Dust

Dust emanation could take place during the trench excavation operations when excavated soils are left in the open by the side of the roads along which vehicles ply. Careful construction planning and supervision can control this. Open spoil soil should be temporarily covered with polyethylene sheets. Careful watering should also should be performed. There may be dust created on temporary access roads and the resulting dust impacts should be minimized by sprinkling water according to a timetable.

Traffic Congestion

Traffic congestion in the main roads should be avoided using a construction plan. If night work could be performed without creating a noise impact, this impact could be mitigated. Generally distribution lines run on the edge of the road using sign boards and traffic controlling laborers with stop signs could minimize this impact. These types of mitigatory measures are very common in such construction projects.

7.1.2 Well Drilling

The noise created by drilling equipment is temporary and the location of residential areas in Heda Oya site is not at close proximity. Residential areas at Panama site are very close.

It is recommended to measure the baseline noise levels at the respective sites and the noise levels at the time of construction (drilling). If the noise levels exceed the residential levels, temporary sound barriers should be established to minimize this impact.

7.1.3 Excess Earth Disposal

No excess earth after laying pipes should be left at road sides or at the treatment plant site. Excess earth should be disposed at a place approved by the local authority. The contractor

before the commencement of work should evaluate such possibilities and identify suitable sites with the concurrence of the Pradeshiya Sabha.

7.1.4 Impacts on River Alluvium

There will be impacts on the river alluvium in Heda Oya during the well drilling process. Accidental fuel spillage from the machinery could contaminate surface and groundwater and also the river alluvium mass.

(See also Section 7.2.1)

7.1.5 Material Transport

All material transport activities should be properly planned. Discussions should be held with the local authorities to establish the most suitable time for material transport that will create minimum public inconvenience. All transported materials should be transported under proper cover to avoid spillage.

7.1.6 Access Roads

Existing roads should be used to the greatest extent possible as access routes to the sites. If essential to create new access routes, those paths should be selected on bare land with little vegetation. Sensitive habitats such as riverine forest near Heda Oya should be avoided. Temporary drains should be established along these roads to avoid soil erosion and drainage congestion. Regular water sprinkling should be undertaken to mitigate the emanation of dust.

7.1.7 Impacts on River Water Quality

All drilled material should be disposed well away from the Heda Oya and the Panama tube well field. Local authorities should be consulted to find a suitable site for excavated material disposal.

7.1.8 Erosion at Construction Sites

Temporary drainage facilities should be established to control erosion. All loose materials such as earth should be well compacted. These mitigatory measures are essential in constructing the water conveyor pipeline and the distribution network.

7.1.9 Community Health

The overall impacts on community health from the project are positive since the community will be supplied with good quality water. If pipeline laying leads to dust creation, it may have a negative impact on community health. These negative impacts are temporary and less intense and can be mitigated as the construction work involved is not large.

However, the proposed project will increase the water consumption, thus there will be an increase in the generation of wastewater. The provision of water supply will influence behavior related to bathing, cleaning, drinking and toilet use. Therefore it is important that people are educated about the importance of safe disposal of wastewater and negative impacts of haphazard disposal of wastewater. The SLTRP will conduct a health education campaign in 2007 to improve health and hygiene practices. The issues related to wastewater disposal will be an important component of health education program. This awareness campaign will be a sufficient measure to mitigate this potential impact.

It is equally important that local authority technical officers and public health inspectors are educated on sound practices of on-site system of wastewater disposal. In fact these officers are responsible for enforcement of regulation on on-site wastewater disposal systems. Accordingly their ability to make sound decisions and provide technical guidance to the public will be very important.

7.1.10 Social Impacts due to Presence of Alien Workers

To mitigate this impact, it is recommended to use local workers as much as possible. Since the project is not large-scale, a large work force may not be necessary. The contractor must monitor any labor camps and their labor supervisors adequately to prevent and mitigate any potential issues.

7.1.11 Mitigatory Measures for Miscellaneous Social Impacts

Mitigatory measures proposed for some of the social impacts identified above can be categorized as follows.

a) Monitoring of public/private wells adjoining the intake wells of the project over a period of time to determine if there is an impact on such wells and to take proper mitigatory measures if there are negative impacts.

b) Awareness and educational programs be undertaken to educate the downstream population about the impacts of this project on their livelihoods, if any.

c) Proper waste disposal methods to be adopted at treatment plants to reduce harmful impacts on the soils and groundwater.

d) If outside labor is used for construction by contractors, education and other awareness programs be undertaken to reduce any tensions with the local population.

e) Health education and awareness campaign.

f) Inclusion of local authorities (PS/DS Chairmen) in monthly contractor progress meetings. This will ensure that local authorities are kept apprised of construction activities and schedule, and have an opportunity to express any relevant concerns they may have.

7.1.12 Labor Camps (sanitary facilities, solid waste disposal)

All labor camps should be provided with basic sanitary facilities. These should be provisions for solid waste disposal and sanitary wastewater treatment. There should be arrangements with the Pottuvil Pradeshiya Sabha for solid waste disposal and contractual stipulations to this effect.

7.1.13 Landscaping and Aesthetics

Landscaping and aesthetics are important considerations in designing the treatment plant and ancillaries such as the water tanks and slow sand filters. The main landscape features should be preserved as much as possible since this area is a high tourist attraction.

7.1.14 Mitigatory Measures for Impacts on habitats and species

Threatened habitats and species

The ecosystem in its most pristine state is that of the Heda Oya, which calls for the construction management plan and the monitoring plan to consider all of the following.

The riparian and aquatic habitats of the Heda Oya should be safeguarded as much as possible during construction and facility operation. The presence of the endemic species (*Cryptocoryne sp*.) which is under threat on a riparian habitat of the Heda Oya needs special attention during construction and operation stages. Prior to commencement of construction, it is recommended that a survey of populations of this species be carried out and that these areas should be avoided as much as possible. A safeguarded area should be left around any of *Cryptocoryne sp*. habitats. It is recommended to include this species and its presence in the monitoring plan. In view of increased levels of turbidity and disturbance to riparian areas, a survey of the aquatic vertebrates (fish, especially endemics, amphibians, reptiles and mammals) should be carried out prior to construction. It is expected that there is no significant tree felling associated with construction on the banks of the Heda Oya.

Potential for human-elephant conflict

Presence of elephants is a serious environmental issue for construction plans of the well fields of Heda Oya, the water intake, and treatment plant of Panama. The transmission pipes should not be exposed and should be kept underground as much as possible. Escalation of human-elephant conflict should be prevented, and if that is not possible, it should be minimized. This aspect will require inputs and cooperation with the Department of Wildlife Conservation (DWLC). It is planned that the Heda Oya well head locations will be enclosed in sturdy concrete structures to minimize potential elephant damage to mechanical systems. It is also recommended that the agencies in charge of this project establish contact and liaise with wildlife protection agencies – namely DWLC – to determine any steps that may be taken to minimize potential for harm to the elephants themselves.

7.1.15 Mitigatory Measures for Impacts on Roads Owing to Pipe Laying

As stated above pipe laying will cause dust, traffic congestion and related social inconvenience. These impacts are mitigable and temporary.

To prevent impacts from dust, water sprinkling should carried out regularly. Traffic congestion should be controlled using traffic signals and traffic controlling workers. Night work could be undertaken, assuming that noise levels can be managed adequately . This measure will mitigate traffic congestion as there is hardly any traffic during night time.

These mitigatory measures will minimize social inconvenience, and should be coordinated with local authorities and local police.

As a mitigatory measure for the possible road damage, any area of trench excavation will be reinstated in accordance with RDA requirements; reinstatement of the pipeline corridor will

be to better than existing conditions.[7] In addition, a dilapidation survey should be conducted at the start of the project, and the project should take responsibility for repairing impacts to road surfaces caused by construction equipment to like or better than existing condition.

Finally, it is our understanding based on our meetings with RDA that this complete road will be re-constructed in the near future, as such, we are attempting to coordinate our pipeline work to be complete prior to the road work.

7.1.15 Mitigatory Measures for Impacts on Schools

The contractor should be informed to carry out several mitigatory measures to mitigate the construction related impacts on schools. This will include avoiding activities that generate high volumes of noise during school hours and using traffic control measures – staff and equipment – to ensure safety of students and vehicles. Water should be sprinkled on any adjacent surfaces where dust may be generated. Discussions should be held with the school authorities to understand issues that may arise during construction.

7.2 OPERATIONAL IMPACTS

7.2.1 Impacts on Groundwater Due to Routine Draw Off

As a mitigation measure, the water draw off of the tube wells should be determined through pumping tests, and the salinity of extracted water should be tested against the yield. From this the extraction threshold without cone of depression and the attendant salinity intrusion could be minimized.

Routine draw off will not cause any significant impact on the groundwater wells if the specified water amounts are extracted within the specific time period. However if there are water overdraws then the cone of depression will result. There is also a risk of saline water intrusion at the selected sites as the area is abutting a coastal stretch.

It was reported by the residents of Panama that water levels of some of the domestically dug wells could become depleted when the well field for the treatment plant is constructed. These wells should be identified and their water levels should be monitored to see whether there is any significant drawdown. If there is such an impact, the NWSDB will have the opportunity to provide water directly to these residents from the water supply system at a reduced or waived cost.

7.2.2 Impacts on Surface Water of the Stream (Heda Oya)

Heda Oya is not a perennial source of water and, according to the average rainfall estimates, (See Figure 14) the lowest rainfall occurs in March and August resulting in lowest flows. The tube well field is located in the river alluvium and the drawn water is from shallow tube wells; therefore there is a risk of lowering of the flow of Heda Oya during dry periods. The

[7] A memorandum of understanding between the NWSDB and RDA is currently being prepared to define these construction reinstatement requirements along with short and long term road maintenance requirements.

following table summarizes the yields of the present tube wells, flow of Heda Oya and the expected demand.

Table14: Water Related Parameters of Heda Oya and the Tube Well Field

Parameter	Values m^3/sec	Remarks
Demand for Pottuvil/Ulla (2025)	0.032	Demand is only about 0.5% of the mean annual flow.
Heda Oya Flows	6.2	

The yield of the wells tested have shown that the water draw off could supply the required demand. Further monitoring is needed after construction of the full tube well field. As a mitigatory measure, dry weather flows of Heda Oya should be monitored to check whether the simultaneous water demands and environmental flows could be maintained.

7.2.3 Environmental Flows and Riparian Requirements

Pumping tests should be carried out during dry periods to test whether the tube wells could yield the demand for 2025. During the pumping tests, the discharge of Heda Oya should be monitored to see whether the downstream environmental flows are satisfied.

7.2.4 Impacts on Sensitive Habitats in the Vicinity (Coastal Zone, Lahugala Sanctuary)

The only sensitive habitat affected by the project is the Heda Oya treatment plant site riparian forest. There could also be impacts on Panama site and the pipe route owing to elephant movements.

Heda Oya well field and the Panama scheme site should be provided with sturdy concrete structures to minimize potential elephant damage to mechanical systems. Collaboration with the DWLC should occur to determine if any additional steps can be taken to minimize threats to elephants. Escalation of human-elephant conflict should be prevented and if that is not possible, it should be minimized. This aspect will require inputs and co-operation early on in the design and implementations stages of this project.

7.2.5 Water Treatment and Treated Water Quality

Treated water should conform to Sri Lanka quality standards for potable water. The Sri Lankan standard covers physical, chemical and biological aspects of drinking water quality and is similar to the World Health Organization Drinking Water Quality Guidelines. The NWSDB will be operator of the treatment system. As for all other treatment plants operated by them, quality of the treated water will be tested by the NWSDB. The NWSDB testing procedure normally covers key parameters such as pH, color, turbidity on daily basis, biological parameters once every three to five days and full testing at least once a month.

In addition the raw water quality also should be monitored regularly. Monitoring of raw water quality should be carried out as per the environmental monitoring plan in Chapter 8.

7.2.6 Sludge Management

Key impact areas and proposed mitigation measures are listed below.

1. Sludge disposal – The main concern of sludge disposal will be the practice of inappropriate disposal methods.
2. Backwash water disposal – The main concern is release of backwash water without treatment.

Sludge should not be disposed with municipal solid waste. This is because anaerobic conditions are present in the waste dumps. This can transform the iron/manganese sludge into soluble forms and release to surface water through leaching. This will likely encourage growth of iron bacteria, formation of slime, impart odor and discolor the water bodies.

The quantity of backwash will not be large enough to result in a significant impact. However backwash water drainage could create temporary water stagnation in the vicinity, which requires that a backwash water drain system be in place. As this is a site specific issue based on the outlet elevation, amount of water backwashed, and ground elevations, a suitable design must be developed at the detailed design stage. A gravel mass at the end of the outlet drain or a similar device could be adopted to mitigate temporary water pooling.

7.2.7 Management of Input Chemicals

Chlorine leakage: The following measures are proposed in this regard.

- Good design of chlorine systems will provide a firm basis for safe operation and maintenance and minimize risks. Sound chlorine system design covers areas such as ventilation, fire protection, handling and unloading, storage and feed system in accordance with guidelines and specifications. It is expected that the chlorine systems of the two plants will be designed and constructed according to the standards stipulated by the Chlorine Institute Inc. or similar entity.

- Chlorine concentration above 10mg/L is immediately dangerous to life and health. In case of accidental release, high concentrations can prevail in the immediate area of gas leakage. As such, the most vulnerable group is the treatment plant workers, therefore it is important to provide proper safety gear and safeguards. These shall include masks, neutralizing tanks, and scrubber devices.

- Considering the gap between what is required for proper management of high risk chemicals and current practices of the NWSDB, it is important that the NWSDB is provided with necessary in Risk Management Planning (Refer to Section 2.6) as part of capacity building.

- It is recommended to carry out off-site consequence analyses during the design. This will identify the area covered by toxic end-point for worst-case scenario. The USEPA defines the toxic end point as the area demarcated by chlorine concentration of 0.0087 mg/L in air due to an episode of worst-case scenario. The worst-case scenario is considered as release of one cylinder of chlorine within specified time and under specified meteorological conditions. This will help: (a) to identify the affected areas; (b) inform the preparation of a proper emergency response plan; and (c) determine scope of community awareness building required on the emergency response plan.

7.2.8 Odor at the Treatment Plant

The only odor-emanating agent is chlorine. This could be mitigated generally by the provision of adequate ventilation. Sludge will not have any odor and no special mitigatory measures are necessary in this context.

7.2.9 Emergency Response System

Management of a chlorine gas system begins with proper training for operators. O&M training is the responsibility of the NWSDB and will include proper unloading of chlorine cylinders when they arrive at the site, set-up of the cylinders, connection of cylinders to the chlorine injectors, and emergency response. The most likely failure is for a slow chlorine leak at the connection point. The chlorine house has been designed to be open air for ventilation. Block points are provided for each cylinder to prevent rolling after placement. A chlorine neutralization tank (water filled) is located at one end of the storage room. If a chlorine leak occurs, operators are instructed to move the tank and place it into the neutralization pond per NWSDB standard procedures. Chlorine gas masks are provided by NWSDB at the facility to protect workers during this operation. In addition, SLTRP is providing a one touch cylinder hoist system and extra long gas tubing that will enable an operator to automatically transfer a leaking cylinder to the neutralization pond without staff having to be in close contact.

The concept of risk management as proposed in USEPA regulations can be adopted to suit the conditions and practices in Sri Lanka. Key components of the USEPA recommended Risk Management Plan are:

- Off-Site Consequence Analysis
- Five-Year Accident History (not applicable in this case)
- Document Management System
- Prevention Program
- Emergency Response Program.

The safety procedures of the NWSDB against risk of chlorine exposure include provision of: (a) neutralization tank close to chlorine cylinders; and (b) gas masks and protection gear for workers in close proximity to chlorine cylinders. The present practice of NWSDB safety measures does not include an Emergency Response Plan (ERP). Therefore it is necessary that NWSDB agree to put an ERP in place. An ERP is strongly recommended considering the proximity of residences and institutions to the treatment plant sites. Salient features of such a plan include:

- Establish procedures for informing the public and emergency response agencies should an accidental release occur.
- Establish procedures for proper first aid and emergency medical treatment necessary to treat human exposure and sickness

- Training of personnel at site on emergency response and medical treatment
- Conduct emergency response drills
- Educate community on emergency response plan

7.2.10 Noise and Vibration during Operation

Noise and vibration emanating from the operation of pumps and other treatment plant components should be avoided using suitable sound barriers. Appropriate mitigation measures should be determined at the detailed design stage.

8. ENVIRONMENTAL MONITORING PLAN

This chapter describes the Environmental Monitoring Plan, its duration, parameters to be monitored, responsible agencies, and reporting requirements.

8.1 GENERAL

The Monitoring Plan should be started in Month 1 before construction and the program should be continued until construction is complete. To monitor the operational impacts the monitoring program should be extended to about one year after construction.

Monitoring of the project activities should be undertaken by an interagency committee comprising key agencies with jurisdiction over various entities of the project area. The core line agencies are given below.

1. National Water Supply and Drainage Board
2. Local authorities [Pottuvil PS] through environmental officers.
3. Central Environmental Authority [CEA through environmental officers in the environmental officers of Pradeshiya Sabha]

8.2 SALIENT FEATURES OF THE MONITORING PROGRAM

The following requirements are addressed in the monitoring plan.

1. Impact causing environmental element (physio-chemical, biotic or social)
2. Rendered impact
3. Parameters to be measured or monitored
4. Frequency of monitoring
5. Responsible agency
6. Reporting requirements

8.3 MONITORING PROGRAM AND ENVIRONMENTAL MANAGEMENT ACTION PLAN

The monitoring program is presented in Annex 6 and the Environmental Management Action Plan is presented in Annex 7.

9. CONCLUSIONS AND RECOMMENDATIONS

This chapter describes community response to the project, conclusions reached, and recommendations made by the EA team.

9.1 GENERAL CONCLUSIONS

- Negative impacts are minor and mitigable; they are mostly construction impacts, which are temporary. Contingency impacts (emergencies) are infrequent and mitigable.
- Positive impacts clearly outweigh the negative temporary impacts, which are minor.
- The project activities are compliant with laws and policies. Respective preliminary approvals have been granted by relevant line agencies.
- The project is socially acceptable; no major social protests were observed during the EA study stage.

9.2 RECOMMENDATIONS

1. Execution of the project is recommended with the proposed mitigatory measures and monitoring requirements.
2. All necessary contractual provisions and stipulations regarding mitigatory measures should be included in the contract documents. The provided environmental management plan could be used in this regard. Additional cost items for these should be specified in the bill of quantities if the need arises.
3. Preventive maintenance is essential to avoid contingency impacts. Necessary steps should be taken by NWSDB.
4. It is recommended that environmental monitoring be undertaken by NWSDB under the supervision and guidance of an interagency committee as proposed under the Monitoring Program.
5. Views expressed by the community for the detailed designs should be considered to the extent feasible.
6. With the operation of the water supply scheme, the wastewater output of Pottuvil/Ulla and Panama areas will increase and this will create health impacts on the inhabitants. A health impact mitigation program through awareness building is strongly recommended.

REFERENCES

1. Arjunas Atlas of Sri Lanka – 1997

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7. Panabokke C – Soils of Sri Lanka

8. Report: Community consultations supporting construction of water treatment plants in Pottuvil and Panama (conducted by CH2MHILL – Ms. Tania Weerasooria)

9. EML Consultants – Design of a Community Health Awareness Campaign for USAID Sri Lanka Tsunami Reconstruction Programme – Draft Report – December 2006.

ANNEXES

ANNEX 1: DETAILS OF MULTIDISCIPLINARY TEAM OF EXPERTS

The following table shows the details of the members of the multidisciplinary team of experts.

Table 1 Details of Multidisciplinary Team of Experts

No	Name of the Expert	Position	Qualifications	Role
1	D A J Ranwala	Team Leader	B.Sc. (Eng), M. Eng. (Hydraulic Structures) FIE (SL), C. Eng.	Direct the multidisciplinary team, assess impacts on surface and ground water and prepare the report. Assess construction impacts.
2	Dr. Manitha Weerasooria	Project Manager	B.Sc. (Agri), Ph.D	Activity management
3	Dr. SMF Marikar	Sociologist	Ph.D	Carrying out the Social Impact Assessment
4	Dr. Nirmalee Pallewatta	Ecologist	B.Sc., Ph.D	Carrying out the Ecological Impact Assessment
5	Dr. Vasantha Siriwardhana	Water Supply Engineer	B.Sc. (Eng.), Ph.D, MIE (SL), C. Eng.	Assessment of contingency impacts of the treatment plant and the system, assessment of impacts of chemical storage, sludge disposal
6	Ms. Amy Bodmann	Participatory Coastal Management Lead	B.Sc. (Economics), M.Sc. (Environmental Science & Policy)	Oversight, technical review and quality control

ANNEX 2: POPULATION CHARACTERISTICS OF POTTUVIL DS DIVISION BY GN DIVISIONS

Name of GN Division	GND No.	Area sq. km.	No. of Families.	Total Populat.	Population Density per sq km	Family Size
Pottuvil Unit 1	P/01	0.25	210	975	3900	4.64
Pottuvil Unit 2	P/02	0.25	275	1040	4160	3.78
Pottuvil Unit 3	P/03	0.25	295	1221	4884	4.14
Jalaldeen Square	P/04	0.25	338	1326	5304	3.92
Sarvodyapuram	P/05	18.0	473	1785	99	3.77
Sinnaputhukudiyiruppu	P/06	0.25	459	1693	6772	3.69
Pottuvil 2 Unit I	P/07	0.50	283	1433	2866	5.06
Pottuvil 2 Unit II	P/08	0.25	203	765	3060	3.77
Kundumadu	P/09	1.00	329	1058	1058	3.22
Inspector Etham	P/10	0.50	267	907	1814	3.40
Vattyvely	P/11	0.75	138	595	793	4.31
Pottuvil Town	P/12	0.25	116	587	2348	5.06
Pakkiyavattai – I	P/13	0.50	268	965	1930	3.60
Pakkiyavattai – II	P/14	1.50	285	1045	697	3.67
Kalappukadu	P/15	1.00	900	2598	2598	2.89
VictorThoddam – I	P/16	10.0	330	1895	190	5.74
VictorThoddam - II	P/17	3.00	905	3428	1143	3.79
Sinna Ullai	P/18	5.00	387	1739	348	4.49
Pasarichenai	P/19	7.00	340	1058	151	3.11
Hithayapuram – I	P/20	2.00	440	1550	775	3.52
Hithayapuram – II	P/21	0.25	375	1735	6940	4.63
Sangamankandy	P/22	53.0	196	817	15	4.17
Komari – I	P/23	55.0	381	1505	27	3.95
Komari – II	P/24	58.0	420	1501	26	3.57
Kanakar Kiramam	P/25	28.0	176	698	25	3.97
Hijra Nagar	P/26	22.0	149	565	26	3.79
Razaak Moulana Nagar	P/27	0.25	554	1752	7008	3.16
TOTAL		269	9492	36236	135	3.82

Source: Statistics, Pottuvil DS Division 2004, and Resource Profile 2004, Divisional Secretariat

POPULATION CHARACTERISTICS OF LAHUGALA DS DIVISION BY GN DIVISION

Name of GN Division	GND No.	Area sq km.	No. of Families.	Total Pop	Pop. Density per sq km	Family Size
Kandahindagama	PP/13		74	312		4.22
Hulannunge West	PP/12		128	461		3.60
Hulannunge	PP/11		194	743		3.83
Perani Lahugala	PP/10		135	538		3.99
Lahugala	PP/09		181	737		4.07
Dewalagoda	PP/08		170	630		3.71
Pansalgoda	PP/07		75	278		3.71
Sasthrawela	PP/06		189	696		3.68
Panama Central	PP/05		166	586		3.53
Panama North	PP/04		274	940		3.43
Panama West	PP/03		208	691		3.32
Panama South	PP/02		229	976		4.26
Total		617	2023	7588	12.3	3.75

Source : Statistics, Department of Census and Statistics 2001

ANNEX 3: ENVIRONMENTAL CHECKLIST

Environmental Checklist for Assessing Suitability of Sites for Construction of Water Treatment Plants and Associated Environmental Impacts.

Date : Time :

Name of person/s filling the questionnaire:

No	Item	Details			
LOCATION DETAILS					
1	Name of the Site				
2	District				
3	Divisional Secretary Division (s)				
4	Local Authority				
5	Grama Niladari Division (s)				
6	GPS reference points of the project site				
SITE CHARACTERISTICS					
7	Extent of the land demarcated for the proposed development				
8	Distance from the coast line (m)				
9	Present Land Ownership	State	Private	Other (specify)	
10	Present land-use of the site (physical structures, human activity, ecological features)				
11	Infrastructure facilities available at the site (roads, water, electricity and other)				
12	Does the site /project require any:				
		Yes	No	If yes, give the extent (in ha) or number of trees	
	Reclamation of land, wetlands				
	Clearing of forest				
	Felling of trees				
PROJECT ACTIVITIES					
13	Brief description of the activities proposed to be carried out at the site.	Site Preparation Activities (Demolition of existing structures, ground preparation etc)			

		Construction of new buildings, access roads and other services				
DESCRIPTION OF THE ENVIRONMENT						
PHYSICAL						
14	Topography & Landforms (map)	Attach an extract from relevant 1: 50,000 topographic sheet/ if detailed maps are available provide them				
15	Relief (difference in elevation from highest point to lowest point)	Low <20m	Medium 20-40m	High 40-60	> 60m	
16	Slope	Low <30%	Medium 30-40 %	High 40-60 %	Very High > 60%	
17	Position of activities on Slope	Bottom	Mid-slope	Upper-slope		
18	Soil (Great Soil Group) – Please see the list below					
19	Soil Depth	Shallow < 20cm	Moderate 20 – 100 cm	Deep >100cm		
20	Is there evidence of soil erosion on the site?					
	If yes, erosion on site is	Low	Medium	High		
21	Annual dry period					
22	Source of fresh Surface Water available in the project area	Spring/ Canal	Tank/Reservoir	Perennial Stream	Seasonal Stream	None
23	Present Surface Water Use	Domestic	Washing/Bathing	Irrigation	Animal use	
24	Surface Water Quality	Poor (6-11 yes answers)	Moderate (3-5 yes answers)	Good (0-2 yes answers)		
	Identification of surface water quality problems			Yes	No	
i	Are there latrines within 15 m of the source/s identified in section (21)?					
ii	Are there latrines on higher grounds than the water source?					
iii	Are there other sources of pollution to be identified within 15 m of the water source?					
iv	Are there human settlements upstream or surrounding the water source/s?					
v	Are there agricultural activities in the catchment area upstream of the intake?					
vi	Are agro-chemicals used in agricultural land within the catchment area?					
vii	Do people practice open defecation in or near the water source?					
viii	Are animals bathed in the water-source upstream of the intake?					
xi	Do people wash clothes upstream of the intake?					

x	Is there evidence of soil erosion on the embankments upstream of the intake?					
25	Ground Water Availability on-site	Dug Well	Tube Well	Other (specify)		
26	Present Ground Water Use	Domestic	Washing/Bathing	Irrigation	Animal use	
27	Ground Water Quality	Poor	Moderate	Good		
	Identification of ground water quality problems			Yes	No	
i	Are there latrines within 15 m of the source/s identified in section (25)?					
ii	Are there latrines on higher grounds than the well?					
iii	Are there other sources of pollution to be identified within 15 m of the well? (**any industrial activity that has been harbored previously on this site**)					
iv	Are there intensive agricultural activities in the area?					
v	Are agro-chemicals used in agricultural land within the catchment area?					
vi	Is the groundwater brackish and hard in wells on-site, if any, or wells nearby?					
vii	Is there evidence of salinity intrusion in the groundwater of the area					
28	Incidence of Natural Disasters	Floods	Prolonged droughts	Cyclones/tidal waves	Other	
29	Geological Hazards	Landslides -	Rock falls	Subsidence	Other –	
ECOLOGICAL (Impact Zone to be taken as 500m from the middle of the project site)						
30	Habitat Types in the Project Site (indicate the % of each habitat type)	Natural forest (%), degraded forest(%), natural scrubland(%), degraded scrubland(%), riverine forest, grassland(%), abandoned agricultural land(%), marsh(%), lagoon(%), estuary(%), coastal scrub(%), mangrove(%), salt marsh(%), home-gardens(%), Other (%) (List)				
31	Habitat types within 250m radius from the site periphery (indicate the % of each habitat type)	Natural forest (%), degraded forest(%), natural scrubland(%), degraded scrubland(%), riverine forest, grassland(%), abandoned agricultural land(%), marsh(%), lagoon(%), estuary(%), coastal scrub(%), mangrove(%), salt marsh(%), home-gardens(%), Other (%) (List)				
32	Habitat types within 500m radius from the site periphery (indicate the % of each habitat type)	Natural forest (%), degraded forest(%), natural scrubland(%), degraded scrubland(%), riverine forest, grassland(%), abandoned agricultural land(%), marsh(%), lagoon(%), estuary(%), coastal scrub(%), mangrove(%), salt marsh(%), home-gardens(%), Other (%) (List)				
33	Are there any environmentally and culturally sensitive areas within 250m of the site?	Protected Areas	Migratory pathways of animals	Archeological sites	Wetlands	Mangroves strands
34	Are there any plants of conservation importance within 250m (endemic and threatened species)? If yes, provide a list					
35	Are there any animals of conservation importance					

	within 250m (endemic and threatened species)? If yes, provide a list	

ENVIRONMENTAL SENSITIVITY

36. Does the project wholly or partly fall within any of the following areas?

	Area	Yes	No	Unaware
a	100m from the boundaries of or within any area declared under the National Heritage Wilderness Act No 4 of 1988			
b	100m from the boundaries of or within any area declared under the Forest Ordinance (Chapter 451)			
c	Coastal zone as defined in the Coast Conservation Act No 57 of 1981			
d	Any erodable area declared under the Soil Conservation Act (Chapter 450)			
e	Any Flood Area declared under the Flood Protection Ordinance (Chapter 449)			
f	Any flood protection area declared under the Sri Lanka Land Reclamation and Development Corporation Act 15 of 1968 as amended by Act No 52 of 1982			
g	60 meters from the bank of a public stream as defined in the Crown Lands Ordinance (Chapter 454) and having width of more than 25 meters at any point of its course			
h	Any reservations beyond the full supply level of a reservoir.			
i	Any archaeological reserve, ancient or protected monument as defined or declared under the Antiquities Ordinance (Chapter 188).			
j	Any area declared under the Botanic Gardens Ordinance (Chapter 446).			
k	Within 100 meters from the boundaries of, or within, any area declared as a Sanctuary under the Fauna and Flora Protection Ordinance (Chapter 469)			
l	100 meters from the high flood level contour of or within, a public lake as defined in the Crown Lands Ordinance (Chapter 454) including those declared under section 71 of the said Ordinance			
m	Within a distance of one mile of the boundary of a National Reserve declared under the Fauna and Flora Protection Ordinance			

CONSTRUCTION MATERIAL AVAILABILITY

37	What are the sources available locally from where construction material can be sources legally?	Type	Name of location	Distance from site
		Sand		
		Rubble		
		Timber		
		Tiles		
38	If site preparation involves demolition/renovation of existing buildings, what material can be salvaged for re-use in the proposed new structures?			

ENVIRONMENTAL IMPACT AND MITIGATION / ENHANCEMENT DURING CONSTRUCTION PERIOD									
	IMPACT					MITIGATION/ ENHANCEMENT			
		H	M	L	N/A				
39	Soil erosion (from excavations, cut & fill operations etc)								
40	Water pollution (from siltation, discharge of waste matter etc)								
41	Noise pollution								
42	Solid waste generation								
43	Sewage generation					Cesspool		Sewage Pond	
						Septic Tank		Other	
44	Loss of vegetation cover								
45	Salinity instruction due abstraction of water								
45	Habitat loss or fragmentation								
46	General disturbance to animal behavior								
47	Interference with normal movement of animals								
48	Irreversible/irreparable environmental change								
ENVIRONMENTAL IMPACT AND MITIGATION / ENHANCEMENT DURING OPERATION PERIOD									
49	Sewerage Disposal	Cesspool				Sewage Pond			
		Septic Tank				Other			
50	Solid Waste Disposal								
51	Drinking Water Supply	Common Dug Well	Yes / No			Individual dug well	Yes / No		
		Common Tube Well	Yes / No			Town supply – pipe	Yes / No		
		Spring	Yes / No			Town supply – Stand post	Yes / No		
52	Alteration to storm water drainage pattern	No changes		No major Changes		Major changes			
SUMMARY OF ENVIRONMENTAL IMPACTS ARISING OUT OF THE PROJECT & RECOMMENDATIONS									
53	Identification of environmental impacts due to this Project								
54	Overall observation and recommendations: (a) Does this site								

	require further detailed field assessments to understand and analyze environmental issues? (b.) If the answer is "Yes" briefly describe the issues and type of investigations that need to be undertaken. (c) Will this site be abandoned after this analysis; please state the reasons. (d) Does the proposed site meet the urban planning requirements under the UDA and Local Authority regulations? If the answer is "No", what needs to be done to meet these requirements; if the answer is "Yes", has the project site obtained the necessary approvals? (e) In addition to the above issues, please indicate any additional observations, recommendations if any	

ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN					
Impact	Mitigatory Measure	Monitoring Indicator	Responsible Agency	Frequency of Monitoring	Reporting Procedure

**Great Soil Groups of Sri Lanka: Dry Zone

ANNEX 4 FLORAL AND FAUNAL SPECIES RECORDED IN THE SITES

List of Abbreviations

C	Climber or Creeper
CS	Conservation Status
E	Endemic
EN	Endemic
Ex	Exotic
H	Herb
HA	Habitat
HG	Home Gardens
HO	Heda Oya site
I	Introduced
LN	Local Name
MI	Migrant
N	Native
PF	Paddy fields
PN	Panama site
PT	Pottuvil site
R	River
RL	River outlet and Lagoon
RP	Riparian area
RS	Road sides
RV	Reverine vegetation
S	Shrub
SB	Sand bar
SD	Sand dune and Coastal Scrub area
SS	Species status
ST	Study sites
T	Tree
TR	Threatened
TS	Taxonomic Status
TP	Treatment Plant
WL	Water logged area/Pool
WS	Well Site

ANNEX 4.1 FLORAL SPECIES RECORDED IN POTTUVIL SITE

Family	Species	Common Name	HA	TS	CS	TP	Around TP				WS	Around WS	
						CP	CC	BL	AP	HG	RR	RR	PL
Acanthaceae	*Barleria prionitis*		H	N			1						
Acanthaceae	*Justicia betonica*	Sudu Puruk	H	N			1						
Amaranthaceae	*Achyranthes aspera*	Gas Karal Heba	H	N		1	1	1		1			1
Amaranthaceae	*Aerva lanata*	Pol Pala	H	N		1		1		1			1
Amaranthaceae	*Amaranthus viridis*	Kura Tampala	H	N		1		1		1			1
Amaranthaceae	*Gomphrena celosioides*		H	I		1		1					1
Amaryliidacaea	*Crinum asiaticum*	Tolabo	H	N							1	1	
Amaryliidacaea	*Crinum zeylanicum*		H	N			1						
Anacardiaceae	*Anacardium occidentale*	Caju	T	I						1			
Anacardiaceae	*Mangifera indica*	Amba	T	I						1			
Annonaceae	*Polyalthia longifolia*	Owila	T	N							1	1	
Apocynaceae	*Carissa spinarum*	Heen Karamba	C	N			1						
Apocynaceae	*Ichnocarpus frutescens*	Garandi Wel	C	N		1	1	1					
Apocynaceae	*Thevetia peruviana*	Kaha Kaneru	T	I		1		1		1			
Araceae	*Cryptocoryne sp.*		H	E	HT						1	1	
Arecaceae	*Borassus flabellifer*	Tal	T	I				1		1			
Arecaceae	*Cocos nucifera*	Pol	T	N		1				1			
Arecaceae	*Phoenix pusilla*	Indi	T	N			1	1					
Asclepiadaceae	*Calotropis gigantea*	Wara	S	N		1	1	1		1			1
Asparagaceae	*Asparagus racemosus*	Hatawariya	C	N			1						
Asteraceae	*Eupatorium odoratum*	Podisinnamaran	S	I		1	1	1		1			
Asteraceae	*Launaea sarmentosa*		C	N			1						
Asteraceae	*Mikania cordata*	Vatu Palu	C	N							1	1	
Asteraceae	*Tridax procumbens*		H	I		1		1		1			
Asteraceae	*Vernonia cinerea*	Monara Kudumbiya	H	N		1		1		1			1

Asteraceae	*Xanthium indicum*	Uru Kossa	H	N		1							1
Boraginaceae	*Carmona retusa*		S	N			1						
Boraginaceae	*Cordia curassavica*		S	N				1					
Boraginaceae	*Cordia oblongifolia*		S	N			1						
Boraginaceae	*Ehretia laevis*		T	N			1	1					
Boraginaceae	*Heliotropium indicum*	Ath Honda	H	N		1							1
Capparaceae	*Capparis rotundifolia*		C	N			1						
Capparaceae	*Cleome viscosa*		H	N		1		1		1			1
Capparaceae	*Crateva adansonii*	Lunu Warama	T	N			1						
Caricaceae	*Carica papaya*	Gas Labu	T	I						1			
Celastraceae	*Maytenus emarginata*		S	N			1						
Celastraceae	*Pleurostylia opposita*	Panakka	T	N			1						
Clusiaceae	*Garcinia spicata*	Ela Gokatu	T	N							1	1	
Colchicaceae	*Gloriosa superba*	Niyagala	C	N			1						
Combretaceae	*Terminalia arjuna*	Kumbuk	T	N							1	1	
Combretaceae	*Terminalia catappa*	Kottan	T	I						1			
Commelinaceae	*Commelina sp.*		H	N		1		1	1		1	1	1
Connaraceae	*Connarus monocarpus*	Radaliya	C	N							1	1	
Convolvulaceae	*Evolvulus alsinoides*		H	N		1	1	1					
Convolvulaceae	*Ipomoea pes-caprae*	Bin Tamburu	C	N			1						
Convolvulaceae	*Ipomoea pes-tigridis*	Divi Adiya	C	N			1	1					
Cucurbitaceae	*Coccinia grandis*	Kowakka	C	N			1	1					
Cyperaceae	*Cyperus arenarius*	Mudu Kaladuru	H	N			1						
Cyperaceae	*Cyperus sp.*		H	N					1				
Cyperaceae	*Cyperus stoloniferus*		H	N			1						
Cyperaceae	*Fimbristylis sp.*		H	N					1				
Ebenaceae	*Diospyros ferrea*		T	N			1						
Ebenaceae	*Diospyros malabarica*	Thimbiri	T	N							1	1	
Euphorbiaceae	*Acalypha indica*	Kuppameniya	H	N		1		1			1		
Euphorbiaceae	*Croton bonplandianus*		H	I		1		1		1			1
Euphorbiaceae	*Croton hirtus*		H	I		1		1		1			1
Euphorbiaceae	*Croton laccifer*	Kappetiya	S	N			1	1					
Euphorbiaceae	*Dimorphocalyx glabellus*	Weliwenna	T	N							1	1	

Euphorbiaceae	*Drypetes sepiaria*	Wira	T	N								1	
Euphorbiaceae	*Flueggea leucopyrus*	Katu Pila	S	N			1	1					
Euphorbiaceae	*Jatropha curcas*		T	I				1		1			
Euphorbiaceae	*Jatropha gossypiifolia*		T	I		1	1						
Euphorbiaceae	*Mallotus rhamnifolius*		T	N							1	1	
Euphorbiaceae	*Manihot esculenta*	Maiokka	T	I						1			
Euphorbiaceae	*Manihot glaziovii*	Gas Maiokka	T	I						1			
Euphorbiaceae	*Margaritaria indicus*	Karaw	T	N							1	1	
Euphorbiaceae	*Phyllanthus maderaspatensis*		H	N			1						
Euphorbiaceae	*Phyllanthus polyphyllus*	Kuratiya	T	N			1	1			1	1	
Euphorbiaceae	*Phyllanthus reticulatus*	Kayila	S	N				1			1	1	
Euphorbiaceae	*Suregada lanceolata*		T	N							1	1	
Fabaceae	*Abrus precatorius*	Olinda	C	N			1						
Fabaceae	*Acacia melanoxylon*		T	I						1			
Fabaceae	*Aeschynomene indica*	Heen Diya siyambala	H	N					1				1
Fabaceae	*Alysicarpus vaginalis*	Aswanna	H	N		1		1					1
Fabaceae	*Bauhinia racemosa*	Maila	T	N			1	1		1			
Fabaceae	*Caesalpinia bonduc*	Kumburu Wel	C	N							1		
Fabaceae	*Canavalia rosea*	Mudu Awara	C	N			1						
Fabaceae	*Cassia fistula*	Ahela	T	N				1		1			
Fabaceae	*Cassia occidentalis*		S	N		1		1					1
Fabaceae	*Cassia roxburghii*	Ratu Wa	T	N			1	1					
Fabaceae	*Cassia tora*		H	N		1		1			1	1	1
Fabaceae	*Crotalaria laburnifolia*		H	N		1		1					
Fabaceae	*Crotalaria sp.*		H	N		1		1					
Fabaceae	*Crotalaria verrucosa*		H	N		1		1					1
Fabaceae	*Derris parviflora*	Kala Wel	C	E							1	1	
Fabaceae	*Desmodium triflorum*	Heen Undupiyaliya	H	N		1		1					1
Fabaceae	*Dichrostachys cinerea*	Andara	T	N			1	1					

Fabaceae	*Gliricidia sepium*	Weta Mara	T	I				1		1			
Fabaceae	*Leucaena leucocephala*	Ipil Ipil	T	I				1		1			
Fabaceae	*Mimosa pudica*	Nidikumba	H	I		1		1		1			1
Fabaceae	*Pongamia pinnata*	Magul Karanda	T	N							1	1	

Fabaceae	*Tamarindus indica*	Siymbala	T	I							1		
Fabaceae	*Tephrosia purpurea*	Pila	H	N		1	1	1		1			1
Fabaceae	*Tephrosia villosa*	Bu Pila	H	N				1					
Flacourtiaceae	*Hydnocarpus venenata*	Makulu	T	N							1	1	
Hippocrateaceae	*Reissantia indica*		C	N			1						
Lamiaceae	*Hyptis suaveolens*		H	I		1	1	1		1			1
Lamiaceae	*Leucas zeylanica*	Thumba	H	N		1		1					
Lamiaceae	*Ocimum americanum*	Heen Madurutala	H	I		1		1					1
Lamiaceae	*Ocimum gratissimum*		H	N				1					
Lecythidaceae	*Barringtonia acutangula*	Ela Midella	T	N							1	1	
Loganiaceae	*Strychnos potatotum*	Ingini	T	N			1						
Loranthaceae	*Dendrophthoe falcata*	Pilila	Ep	N			1	1					
Malpighiaceae	*Hiptage benghalensis*		C	N				1					
Malvaceae	*Abutilon indicum*		S	N		1	1	1		1			1
Malvaceae	*Hibiscus micranthus*		H	N			1	1					
Malvaceae	*Sida acuta*	Gas Bavila	H	N		1	1	1		1			1
Malvaceae	*Thespesia populnea*	Suriya	T	N				1		1			
Malvaceae	*Urena lobata*	Bavila	S	N		1		1		1			1
Martyniaceae	*Martynia annua*	Naga Darana	H	I			1						
Melastomataceae	*Memecylon umbellatum*	Kora Kaha	S	N			1						
Meliaceae	*Azadirachta indica*	Kohomba	T	N		1	1	1		1			
Meliaceae	*Walsura trifoliolata*	Kiri Kon	T	N			1						
Menispermaceae	*Pachygone ovata*		C	N			1						
Moraceae	*Ficus benghalensis*	Maha Nuga	T	N				1					
Moraceae	*Streblus asper*	Nitulla	T	N							1	1	
Moringaceae	*Moringa oleifera*	Murunga	T	I						1			
Mulluginaceae	*Gisekia pharnaceoides*	Atthiripala	H	N			1	1					1
Musaceae	*Musa x paradisiaca*	Kesel	T	I						1			
Myrtaceae	*Psidium guajava*	Pera	T	I						1			
Myrtaceae	*Syzygium cumini*	Madan	T	N			1						
Nyctaginaceae	*Boerhavia diffusa*	Pita Sudu Pala	H	N		1	1	1		1			1
Ochnaceae	*Ochna obtusata*	Mal Kera	S	N			1						
Oleaceae	*Jasminum angustifolium*		C	N			1						
Pandanaceae	*Pandanus sp.*	Watake	S	N							1	1	
Passifloraceae	*Passiflora foetida*		C	I				1			1		

Pedaliaceae	*Pedalium murex*	Et Nerenchi	H	N			1			1			
Periplocaceae	*Hemidesmus indicus*	Iramusu	C	N		1	1	1					
Poaceae	*Cynodon dactylon*		H	N		1	1	1	1	1			1
Poaceae	*Panicum maximum*	Rata Tana	H	I							1		
Poaceae	*Panicum repens*	Etora	H	N		1		1	1				1
Poaceae	*Spinifex littoreus*		C	N			1						
Polygonaceae	*Polygonum tomentosum*		H	N							1	1	
Rhamnaceae	*Scutia myrtina*		C	N			1						
Rhamnaceae	*Ziziphus oenoplia*	Eraminiya	C	N			1	1					
Rubiaceae	*Benkara malabarica*		T	N			1						
Rubiaceae	*Canthium coromandelicum*	Kara	T	N			1						
Rubiaceae	*Catunaregam spinosa*	Kukuruman	T	N			1						
Rubiaceae	*Hydrophylax maritima*		C	N			1						
Rubiaceae	*Morinda coreia*	Ahu	T	N			1						
Rubiaceae	*Nauclea orientalis*	Bakmi	T	N							1	1	
Rubiaceae	*Pavetta indica*	Pavatta	S	N			1						
Rubiaceae	*Psilanthus wightianus*		S	N			1						
Rubiaceae	*Tarenna asiatica*	Tarana	S	N			1						
Rutaceae	*Atalantia monophylla*	Yakinaran	T	N			1						
Rutaceae	*Clausena indica*	Gon Karapincha	S	N			1						
Rutaceae	*Glycosmis mauritiana*		S	N			1						
Rutaceae	*Limonia acidissima*	Divul	T	N		1		1		1			
Rutaceae	*Murraya koenigii*	Karapincha	S	N							1		

Rutaceae	*Murraya paniculata*	Atteriya	S	N							1	1	
Rutaceae	*Paramignya monophylla*	Wellangiriya	C	N				1			1		
Rutaceae	*Pleiospermium alatum*	Tumpath Kurundu	T	N			1						
Rutaceae	*Toddalia asiatica*	Kudu Miris	C	N			1						
Salvadoraceae	*Azima tetracantha*		C	N			1						
Sapindaceae	*Allophylus cobbe*	Kobbe	C	N							1	1	
Sapindaceae	*Lepisanthes tetraphylla*	Dambu	T	N							1	1	
Sapotaceae	*Madhuka longifolia*	Mi	T	N							1	1	
Sapotaceae	*Manilkara hexandra*	Palu	T	N			1						
Scrophulariaceae	*Scoparia dulcis*		H	I		1		1	1				1

Solanaceae	*Physalis micrantha*		H	N		1		1					1
Solanaceae	*Solanum melongena*		H	N				1					1
Sterculiaceae	*Pterospermum suberifolium*	Welan	T	N							1	1	
Tiliaceae	*Berrya cordifolia*	Halmilla	T	N							1		
Tiliaceae	*Grewia damine*	Daminiya	T	N				1			1		
Tiliaceae	*Grewia helicterifolia*	Bora Daminiya	T	N							1	1	
Tiliaceae	*Grewia orientalis*		C	N				1	1		1	1	
Verbenaceae	*Lantana camara*	Gandapana	S	I		1	1	1					
Verbenaceae	*Vitex altissima*	Milla	T	N							1	1	
Verbenaceae	*Vitex leucoxylon*	Nabada	T	N							1	1	
Vitaceae	*Cissus quadrangularis*		C	N			1						
Vitaceae	*Cissus vitiginea*		C	N			1						

4.2 **Floral species recorded in Panama**

Family	Species	Common Name	HA	TS	CS	TP & WS	Around TP & WS			
						SP	CC	WB	SP	HG
Acanthaceae	*Barleria prionitis*		H	N			1			
Acanthaceae	*Hygrophila schulli*	Niramulliya	H	N		1			1	
Acanthaceae	*Justicia betonica*	Sudu Puruk	H	N			1			
Amaranthaceae	*Achyranthes aspera*	Gas Karal Heba	H	N		1	1		1	1
Amaranthaceae	*Aerva lanata*	Pol Pala	H	N		1				1
Amaranthaceae	*Amaranthus viridis*	Kura Tampala	H	N		1				1
Amaranthaceae	*Gomphrena celosioides*		H	I		1			1	
Amaryliidacaea	*Crinum zeylanicum*		H	N			1			
Anacardiaceae	*Anacardium occidentale*	Caju	T	I						1
Anacardiaceae	*Lannea coromandelica*	Hik	T	N			1			
Anacardiaceae	*Mangifera indica*	Amba	T	I						1
Apocynaceae	*Carissa spinarum*	Heen Karamba	C	N			1			
Apocynaceae	*Ichnocarpus frutescens*	Garandi Wel	C	N			1			
Apocynaceae	*Thevetia peruviana*	Kaha Kaneru	T	I						1
Arecaceae	*Borassus flabellifer*	Tal	T	I						1
Arecaceae	*Cocos nucifera*	Pol	T	N						1
Arecaceae	*Phoenix pusilla*	Indi	T	N			1			
Asclepiadaceae	*Calotropis gigantea*	Wara	S	N		1	1		1	
Asclepiadaceae	*Pergularia daemia*	Meda Hangu	C	N			1			
Asparagaceae	*Asparagus racemosus*	Hatawariya	C	N			1			
Asteraceae	*Eupatorium odoratum*	Podisinnamaran	S	I			1			1
Asteraceae	*Launaea sarmentosa*		C	N			1			

Asteraceae	*Tridax procumbens*		H	I		1	1			
Asteraceae	*Vernonia cinerea*	Monara Kudumbiya	H	N		1			1	
Asteraceae	*Xanthium indicum*	Uru Kossa	H	N		1				
Boraginaceae	*Carmona retusa*		S	N			1			
Boraginaceae	*Cordia curassavica*		S	N			1			
Boraginaceae	*Cordia dichotoma*	Lolu	T	N			1			
Boraginaceae	*Cordia oblongifolia*		S	N			1			
Capparaceae	*Capparis rotundifolia*		C	N			1			
Capparaceae	*Cleome viscosa*		H	N		1			1	1
Capparaceae	*Crateva adansonii*	Lunu Warama	T	N			1			
Caricaceae	*Carica papaya*	Gas Labu	T	I						1
Celastraceae	*Cassine glauca*	Neralu	T	E			1			
Celastraceae	*Maytenus emarginata*		S	N			1			
Celastraceae	*Pleurostylia opposita*	Panakka	T	N			1			
Colchicaceae	*Gloriosa superba*	Niyagala	C	N			1			
Combretaceae	*Terminalia arjuna*	Kumbuk	T	N				1		
Combretaceae	*Terminalia catappa*	Kottan	T	I						1
Convolvulaceae	*Evolvulus alsinoides*		H	N		1				
Convolvulaceae	*Ipomoea pes-caprae*	Bin Tamburu	C	N			1			
Convolvulaceae	*Ipomoea pes-tigridis*	Divi Adiya	C	N			1			
Cucurbitaceae	*Coccinia grandis*	Kowakka	C	N			1			
Cyperaceae	*Cyperus arenarius*	Mudu Kaladuru	H	N			1			
Cyperaceae	*Cyperus sp.*		H	N			1			
Cyperaceae	*Cyperus stoloniferus*		H	N			1	1		
Cyperaceae	*Fimbristylis sp.*		H	N				1		
Dracaenaceae	*Sansevieria zeylanica*	Niyanda	H	N			1			
Ebenaceae	*Diospyros ferrea*		T	N			1			
Euphorbiaceae	*Acalypha indica*	Kuppameniya	H	N			1			
Euphorbiaceae	*Croton bonplandianus*		H	I		1			1	1

Asteraceae	*Tridax procumbens*		H	I		1	1			
Asteraceae	*Vernonia cinerea*	Monara Kudumbiya	H	N		1			1	
Asteraceae	*Xanthium indicum*	Uru Kossa	H	N		1				
Boraginaceae	*Carmona retusa*		S	N			1			
Boraginaceae	*Cordia curassavica*		S	N			1			
Boraginaceae	*Cordia dichotoma*	Lolu	T	N			1			
Boraginaceae	*Cordia oblongifolia*		S	N			1			
Capparaceae	*Capparis rotundifolia*		C	N			1			
Capparaceae	*Cleome viscosa*		H	N		1			1	1
Capparaceae	*Crateva adansonii*	Lunu Warama	T	N			1			
Caricaceae	*Carica papaya*	Gas Labu	T	I						1
Celastraceae	*Cassine glauca*	Neralu	T	E			1			
Celastraceae	*Maytenus emarginata*		S	N			1			
Celastraceae	*Pleurostylia opposita*	Panakka	T	N			1			
Colchicaceae	*Gloriosa superba*	Niyagala	C	N			1			
Combretaceae	*Terminalia arjuna*	Kumbuk	T	N				1		
Combretaceae	*Terminalia catappa*	Kottan	T	I						1
Convolvulaceae	*Evolvulus alsinoides*		H	N		1				
Convolvulaceae	*Ipomoea pes-caprae*	Bin Tamburu	C	N			1			
Convolvulaceae	*Ipomoea pes-tigridis*	Divi Adiya	C	N			1			
Cucurbitaceae	*Coccinia grandis*	Kowakka	C	N			1			
Cyperaceae	*Cyperus arenarius*	Mudu Kaladuru	H	N			1			
Cyperaceae	*Cyperus sp.*		H	N			1			
Cyperaceae	*Cyperus stoloniferus*		H	N			1	1		
Cyperaceae	*Fimbristylis sp.*		H	N				1		
Dracaenaceae	*Sansevieria zeylanica*	Niyanda	H	N			1			
Ebenaceae	*Diospyros ferrea*		T	N			1			
Euphorbiaceae	*Acalypha indica*	Kuppameniya	H	N			1			
Euphorbiaceae	*Croton bonplandianus*		H	I		1			1	1
Euphorbiaceae	*Croton hirtus*		H	I		1				
Euphorbiaceae	*Croton laccifer*	Kappetiya	S	N			1			
Euphorbiaceae	*Flueggea leucopyrus*	Katu Pila	S	N			1			

Euphorbiaceae	*Jatropha curcas*		T	I						1
Euphorbiaceae	*Jatropha gossypiifolia*		T	I			1			
Euphorbiaceae	*Manihot esculenta*	Maiokka	T	I						1
Euphorbiaceae	*Manihot glaziovii*	Gas Maiokka	T	I						1
Euphorbiaceae	*Phyllanthus maderaspatensis*		H	N			1			
Euphorbiaceae	*Phyllanthus pinnatus*		S	N			1			
Euphorbiaceae	*Phyllanthus polyphyllus*	Kuratiya	T	N			1			
Euphorbiaceae	*Phyllanthus reticulatus*	Kayila	S	N			1			
Fabaceae	*Abrus precatorius*	Olinda	C	N			1			
Fabaceae	*Acacia melanoxylon*		T	I						1
Fabaceae	*Aeschynomene indica*	Heen Diya siyambala	H	N		1			1	
Fabaceae	*Alysicarpus vaginalis*	Aswanna	H	N		1			1	
Fabaceae	*Bauhinia racemosa*	Maila	T	N			1			
Fabaceae	*Bauhinia tomentosa*	Pethan	S	N			1			
Fabaceae	*Canavalia rosea*	Mudu Awara	C	N			1			
Fabaceae	*Cassia fistula*	Ahela	T	N			1			1
Fabaceae	*Cassia occidentalis*		S	N		1			1	
Fabaceae	*Cassia roxburghii*	Ratu Wa	T	N			1			
Fabaceae	*Cassia tora*		H	N		1			1	
Fabaceae	*Crotalaria laburnifolia*		H	N					1	
Fabaceae	*Crotalaria sp.*		H	N		1				
Fabaceae	*Crotalaria verrucosa*		H	N		1			1	
Fabaceae	*Derris parviflora*	Kala Wel	C	E			1			
Fabaceae	*Desmodium triflorum*	Heen Undupiyaliya	H	N		1			1	
Fabaceae	*Dichrostachys cinerea*	Andara	T	N			1			
Fabaceae	*Gliricidia sepium*	Weta Mara	T	I						1
Fabaceae	*Leucaena leucocephala*	Ipil Ipil	T	I						1
Fabaceae	*Mimosa pudica*	Nidikumba	H	I		1			1	1
Fabaceae	*Tephrosia purpurea*	Pila	H	N		1			1	
Fabaceae	*Tephrosia villosa*	Bu Pila	H	N		1			1	
Hippocrateaceae	*Reissantia indica*		C	N			1			
Hippocrateaceae	*Salacia sp.*	Himbutu Wel	C	N			1			

Lamiaceae	*Hyptis suaveolens*		H	I		1	1		1	1
Lamiaceae	*Leucas zeylanica*	Thumba	H	N					1	1
Lamiaceae	*Ocimum americanum*	Heen Madurutala	H	I		1			1	1
Lamiaceae	*Ocimum gratissimum*		H	N			1			
Lauraceae	*Cassytha filiformis*		Pr	N			1			
Linaceae	*Hugonia mystax*		C	N			1			
Loganiaceae	*Strychnos potatotum*	Ingini	T	N			1			
Loranthaceae	*Dendrophthoe falcata*	Pilila	Ep	N			1			
Lythraceae	*Lawsonia inermis*	Maruthondi	S	N			1			
Malvaceae	*Abutilon indicum*		S	N			1			
Malvaceae	*Hibiscus micranthus*		H	N			1			
Malvaceae	*Sida acuta*	Gas Bavila	H	N		1	1		1	1
Malvaceae	*Thespesia populnea*	Suriya	T	N						1
Malvaceae	*Urena lobata*	Bavila	S	N		1			1	
Melastomataceae	*Memecylon umbellatum*	Kora Kaha	S	N			1			
Meliaceae	*Azadirachta indica*	Kohomba	T	N			1			1
Meliaceae	*Walsura trifoliolata*	Kiri Kon	T	N			1			
Menispermaceae	*Pachygone ovata*		C	N			1			
Moringaceae	*Moringa oleifera*	Murunga	T	I						1
Mulluginaceae	*Gisekia pharnaceoides*	Atthiripala	H	N		1	1		1	
Musaceae	*Musa x paradisiaca*	Kesel	T	I						1
Myrtaceae	*Psidium guajava*	Pera	T	I						1
Myrtaceae	*Syzygium cumini*	Madan	T	N			1			

Nyctaginaceae	*Boerhavia diffusa*	Pita Sudu Pala	H	N			1			
Ochnaceae	*Ochna obtusata*	Mal Kera	S	N			1			
Oleaceae	*Jasminum angustifolium*		C	N			1			
Passifloraceae	*Passiflora foetida*		C	I			1			
Pedaliaceae	*Pedalium murex*	Et Nerenchi	H	N		1	1		1	
Periplocaceae	*Hemidesmus indicus*	Iramusu	C	N			1			
Poaceae	*Cynodon dactylon*		H	N		1	1	1	1	
Poaceae	*Panicum repens*	Etora	H	N		1		1	1	
Poaceae	*Spinifex littoreus*		C	N			1			
Rhamnaceae	*Scutia myrtina*		C	N			1			
Rhamnaceae	*Ziziphus mauritiana*	Debara	T	N			1			
Rhamnaceae	*Ziziphus oenoplia*	Eraminiya	C	N			1			
Rhizophoraceae	*Cassipourea ceylanica*		S	N			1			
Rubiaceae	*Benkara malabarica*		T	N			1			
Rubiaceae	*Canthium coromandelicum*	Kara	T	N			1			
Rubiaceae	*Catunaregam spinosa*	Kukuruman	T	N			1			
Rubiaceae	*Hydrophylax maritima*		C	N			1			
Rubiaceae	*Morinda coreia*	Ahu	T	N			1			
Rubiaceae	*Pavetta indica*	Pavatta	S	N			1			
Rubiaceae	*Psilanthus wightianus*		S	N			1			
Rubiaceae	*Psydrax dicoccos*	Panderu	T	N	VU		1			
Rubiaceae	*Tarenna asiatica*	Tarana	S	N			1			
Rutaceae	*Atalantia monophylla*	Yakinaran	T	N			1			
Rutaceae	*Clausena indica*	Gon Karapincha	S	N			1			
Rutaceae	*Glycosmis mauritiana*		S	N			1			
Rutaceae	*Limonia acidissima*	Divul	T	N			1			1
Rutaceae	*Paramignya monophylla*	Wellangiriya	C	N			1			
Rutaceae	*Pleiospermium alatum*	Tumpath Kurundu	T	N			1			
Rutaceae	*Toddalia asiatica*	Kudu Miris	C	N			1			

Salvadoraceae	*Azima tetracantha*		C	N			1			
Salvadoraceae	*Salvadora persica*	Malithan	T	N			1			
Sapindaceae	*Allophylus cobbe*	Kobbe	C	N			1			
Sapotaceae	*Manilkara hexandra*	Palu	T	N			1			
Scrophulariaceae	*Scoparia dulcis*		H	I		1			1	
Solanaceae	*Physalis micrantha*		H	N					1	
Solanaceae	*Solanum melongena*		H	N					1	
Tiliaceae	*Grewia orientalis*		C	N			1			
Typhaceae	*Typha angustifolia*	Hambu Pan	H	N				1		
Verbenaceae	*Lantana camara*	Gandapana	S	I			1			
Verbenaceae	*Premna latifolia*		T	N			1			
Vitaceae	*Cissus quadrangularis*		C	N			1			
Vitaceae	*Cissus vitiginea*		C	N			1			

4.3 List of faunal species recorded from the three sites

Birds

Scientific Name	LN	SS	CS	HB	ST
Family – Phasinidae					
Pavo cristatus	Indian Peafowl	-	-	-	PN/HO/PT
Family – Alcedinidae					
Alcedo atthis	Common Kingfisher	-	-	RV	PN/HO/PT
Halcyon capensis	Stork-billed Kingfisher	-	-	RV	HO
Halcyon smyrnesis	White-throated Kingfisher	-	-	RV	HO
Family – Meropidae					
Merops philippinus	Blue-Tailed Bee-Eater	-	-	PF	PN/PO
Merops orientalis	Green Bee-eater	-	-	PF	PN/HO/PT
Family – Ardeidae					
Ardeola grayii	Pond Heron	-	-	WL	PN/HO/PT
Casmerodius albus	Great Egret	-	-	WL/PF	PN/PO
Bubulcus ibis	Cattle Egret	-	-	PF	PN/HO/PT
Family – *Coracidae*					
Coracias bengalensis	Indian Roller	-	-	HG	PN/HO/PT
Scolopacidae					
Actitis hypoleucos	Common Sandpiper	-	-	WL	PN/PO
Charadriidae					
Himantopus himantopus	Black winged Stilt	-	-	WL	PN/PO
Vanellus indicus	Red-Wattled Lapwing	-	-	WL	PN/PO
Family – Columbidae		-	-		

Birds

Scientific Name	**LN**	**SS**	**CS**	**HB**	**ST**
Columba livia	Domestic Pigeon	-	-	HG	PN/PO
Streptopelia chinensis	Spotted Dove	-	-	HG/PF	PN/HO/PT
Rallidae					
Amaurornis phoenicurrus	White Breasted Waterhen	-	-	WL	PN
Corvidae		-	-		
Corvus macrorhynchos	Large-Billed Crow	-	-	RV	HO
Corvus splendens	House Crow	-	-	HG	PN/PO
Family – Cuculidae					
Centropus sinensis	Greater Coucal	-	-	HG	PN/PO
Family – *Jacanidae*					
Hydrophasianus chirurgus	Phesant-tailed Jacana	-	-	WL	PN/PO
Family – Burhinidae		-	-		
Esacus recurvirostris	Great Thick-knee	-	-	WL	PA
Family –*Accipitridae*					
Haliastur Indus	Brahmany Kite	-	-	PF	HO/PA
Spilornis cheela	Serpent Eagle	-	-	RV	HO
Family – Hirundinidae					
Hirundo daurica	Red-Rumped Swallow	-	-	PF	PN/PO
Family –Sylvidae					
Orthotomus sutorius	Common Tailorbird	-	-	SD/HG	PN/HO/PT
Family – Timaliidae		-	-		
Turdoides affinis	Common Babbler	-	-	HG	PN/HO/PT
Family – Nectariniidae					
Nectarinia asiatica	Purple Sunbird	-	-		PO
Nectarinia zeylonica	Purple-Rumped Sunbird	-	-		PO/PA

Birds

Scientific Name	**LN**	**SS**	**CS**	**HB**	**ST**
Family - Phalacrocoracidae					
Phalacrocorax carbo	Great Cormorant	-	-	WL	PO
Phalacrocorax niger	Little Cormorant	-	-	WL	PO/PA
Family – Picidae					
Dinopium benghalense	Black rumped Flameback	-	-	HG	PO
Family – Psittacidae					
Psittacula kramerii	Rose-Ringed Parakeet	-	-	HG/PF	PN/HO/PT
Family – Pycnonotidae					
Pycnonotus cafer	Red-Vented Bulbul	-	-	HG	PN/HO/PT
Pycnonotus luteolus	White-browed Bulbul	-	-	HG	PN/HO/PT
Family – Sturnidae					
Acridotheres tristis	Common Mynah	-	-	HG	PN/HO/PT
Family – Turdinae					
Saxicoloides fulicata	Indu Kalupolkichcha	-	-	HG	PO
Copsychus saularis	Magpie Robin	-	-	HG	PO/PA

Amphibians				
Scientific Name	**LN**	**SS**	**CS**	**HB**
Family- Ranidae				
Limnonectus limnocharis	Paddy Field Frog	-	-	PN/HO/PT

Reptiles				
Scientific Name	**LN**	**SS**	**CS**	**ST**
Family – Agamidae				
Calotes calotes	Green Garden Lizard	-	-	PN/HO/PT

Family – Colubridae				
Ptyas mucosa	Rat snake	-	-	PN

Butterflies

Scientific Name	**LN**	**SS**	**CS**	**ST**
Family – Nymphalidae				
Danaus chrysippus	Plain Tiger	-	-	PN/HO/PT
Euploea core	Common Crow	-	-	PN/PT
Acraea violae	Tawny Costor	-	-	PN/HO/PT
Family –*Pieridae*				
Appias albina	Common Albatross	-	-	PT
Eurema blanda	Three-Spot Grass Yellow	-	-	PN/HO
Eurema hacabe	Common Grass Yellow	-	-	PN/HO/PT
Family –Papilionidae		-	-	PN/HO/PT
Graphium Agamemnon	Tailed Jay	-	-	PN /PT
Pachliopta aristolochiae	Common Rose	-	-	PN/HO/PT
Pachliopta hector	Crimson Rose	-	-	PN/HO/PT
Papilio demoleus	Lime Butterfly	-	-	PN/PT
Chilasa clytia	Common mime	-	-	PN/HO

Fishes				
Scientific Name	**LN**	**SS**	**CS**	**ST**
Family: Aplocheilidae				
Aplocheilus parvus	Dwarf panchax	-	-	PN
Family: Bagridae				
Mystus kelertius	Yellow catfish	-	-	PN

Family: Cichlidae				
Etroplus suratensis	Green Chromide	-	-	PN/HO
Oreochromis mossambicus	Tillapia	-	-	PN/HO

Mammals				
Scientific Name	**LN**	**SS**	**CS**	**ST**
Family – Scuridae				
Funambulus palmarum	Palm Squirrel	-	-	PN/HO/PT
Family- Bovidae				
Bos indicus	Domestic cow	-	-	PN/PT
Bubalus bubalis	Domestic water buffalo	-	-	PN/HO
Family- Canidae				
Canis familiaris	Domestic dog	-	-	PN/HO/PT
Felis cattus	Domestic cat	-	-	PN/HO/PT
Family-Cercopithecidae				
Semnopithecus priam	Grey Langur	-	-	PN/HO/PT
Macaca senica	Taquk Monkey	**En**	-	HO
Family- Pteropodidae				
Pteropus giganteus	Flying fox	-	-	PN/HO/PT
Family-Elephantidae				
Elephas maximus	Elephant*	-	**T**	PN/HO

APPENDIX 5: WATER QUALITY DATA RECEIVED FROM NSWDB

Water Quality Data Received from NWSDB through 17th July 2006

Investigation Site	Borehole Well No.	No. of hours after pumping	Water Level (m) from G.L.	Sample collected on	Report No.R( )	Color (5/30)	Turbidity (2/8)	pH (7-8.5) (6.5-9)	E.C. (750/3500)	Chloride (Cl) (200/1200)	Total Alkalinity [CaCO3] (200/400)	Free Amonia (.06)	Albuminoid Ammonia (0.15)	Nitrate [N] (10)	Nitrite [N] (0.01)	Fluoride [F] (0.6/1.5)	Total Phosphate [PO4] (2.0)	Total Residue (500/2000)	T.Hardness [CaCo3] (250/600)	Total Iron [Fe] (0.3/1.0)	Sulphate [SO4] (200/400)	Manganese [Mn] (.05/.5)
Panama Cemetery Rd.	PAN_CM_TS1	2	1.5	19/5/06	R(1)	143	39	6.36	691	140	8	0.29		3.5	0.003	0.09	0.25		90	2.17	13	0.9
Panama Cemetery Rd.	PAN_CM_TS1			25/05/06	R(2)	30	18.6	6.4	1015	210.8	44	0.2	0	0.1	<0.002	0.01	0.04	705	140	7	25	
Panama Cemetery Rd.	PAN_CM_TS1			26/05/06	R(3)	30	25.6	6.4	891	191.7	20	0.2	0	0.1	<0.01	0.01	0.04	617	124	7.8	26	
Panama Cemetery Rd.	PAN_CM_TS1			28/05/06	R(4)	10	2.5	6.3	904	184	24	0.2	0	0.1	<0.01	0.01	0.04	625	104	0.9	57	
Panama-Coconut	PAN_CT_TS1			3/6/2006	R(5)	10	4.5	7.2	2582	648	132	0.24	0	0.1	<0.01	0.01	0.04	1914	220	0.6	57	
Panama-Coconut	PAN_CT_TS1			4/6/2006	R(6)	10	6.1	7.1	3045	805	100	0.56	0	0.1	<0.01	0.5	0.04	2300	220	0.5	88	
Panama-Coconut	PAN_CT_TS1			6/6/2006	R(7)	20	8	7	3228	862.65	160	0.56	0	0.01	<0.01	0.3	0.04	2452	380	1.1	88	
Heda Oya	POT_HO_TS1			8/6/2006	R(8)	120	128.4	6.8	452	42.17	184	0.88	0	0.01	<0.01	0.01	0.4	307	124	10.8	86	
Heda Oya	POT_HO_TS1			9/6/2006	R(9)	80	62.8	6.8	384.4	268	200	0.8	0	0.1	<0.01	0.01	0.34	298.7	140	1.1	88	
Kojan Aru	POT_KA_TS1	0	1	5/7/2006	R(10)	60	22.4	6.6	1261	165	288	0.96	0	0.1	0.08	0.34	1.6	841	148	0.8	75	

Water Quality Data Received from ITI through 21 August 2006

Investigation Site	Borehole Well No.	No. of hours after pumping	Water Level (m) from G.L.	Sample collected on	Report No.R( )	Color (5/30)	Turbidity (2/8)	pH (7-8.5) (6.5-9)	E.C. (750/3500)	Chloride (Cl) (200/1200)	Total Alkalinity [CaCO3] (200/400)	Free Amonia (.06)	Albuminoid Ammonia (0.15)	Nitrate [N] (10)	Nitrite [N] (0.01)	Fluoride [F] (0.6/1.5)	Total Phosphate [PO4] (2.0)	Total Residue (500/2000)	T.Hardness [CaCo3] (250/600)	Total Iron [Fe] (0.3/1.0)	Sulphate [SO4] (200/400)	Manganese [Mn] (.05/.5)
Kojan Aru	POT_KA_TS1	1	1	29/07/06	SS6953	30	not detected	6.8	1310	176	248	0.32	not detected	not detected	1.1	0.5	4.2	902	179	not detected	120	0.34
Panama Cemetery Rd.	PAN_CM_TS2	1	1	29/07/06	SS6953	not detected	6	6.35	1008	219	33	0.2	0.08	not detected	not detected	not detected	not detected	697	102	3.3	90	0.14
Heda Oya	POT_HO_TS2	1	1	29/07/06	SS6953	40	22	6.37	377	38	106	not detected	0.1	not detected	0.38	0.38	2.5	233	61	7.3	not detected	0.72
Kojan Aru	POT_KA_TS1	1	1	19/08/06	SS7587									0.3	not detected		5.5					
Kojan Aru	POT_KA_TS2	1	2	19/08/06	SS7587									0.4	not detected		10.7					
Panama Cemetery Rd.	PAN_CM_TS2	1	1	19/08/06	SS7587															3.1		0.22
Heda Oya	POT_HO_TS2	1	1	19/08/06	SS7587															12.54		0.82
Panama Cemetery Rd.	PAN_CM_TS2	1	1	3/9/2006	SS8331							0.02		0.1	not detected		3.6			2.8		0.11
Heda Oya	POT_HO_TS1	1	1	3/9/2006	SS8331							0.77		0.2	not detected		2.8			8.9		1.3
Heda Oya	POT_HO_TS1	1	1	3/9/2006	SS8331							0.64		0.1	not detected		4			7.1		0.88
Heda Oya	surface water near TS1	1	1	3/9/2006	SS8331							0.16		0.3	0.03		1.6			3.5		0.22
Heda Oya	surface water near TS2	1	1	3/9/2006	SS8331							0.19		0.4	not detected		1.7			1.7		1.1

APPENDIX 6: MONITORING PROGRAMME

MONITORING PROGRAMME- CONTINGENCY IMPACTS
(During Contingencies)

Affected Environment	Main Failure Mode	Suseptible System Component	Impacts Likely to Cause	MONITORING PROGRAMME				
				Parameter to be Measured or Monitored	**Frequency**	**Responsible Agency**	**Reporting Requirements**	**Remarks**
PHYSIO CHEMICAL 	Sudden bursts and resulting leaks	Coveroy pipes from tube well field to the treatment plant & the other distributing lines.	Shoratages of water supply to some areas. Public inconvenience because of water puddles on the road.	Possible sudden leaks. Preventive maintenance & vigilance.	On detection or report	NWS&DB[PP]	See Note Below	Continual monitoring required using sudden leak detection techniques
BIOTIC 	Routine leaks.	Coveroy pipes from tube well field to the treatment plant & the other	Impacts as above but to a lesser extent.	Possible sudden leaks. Preventive maintenance & vigilance.	On detection or report	NWS&DB[PP]	See Note Below	System should be examined for routine leaks
	Breakdowns	Pumps	Water supply shortage & resulting social inconvenience.	Social inconvenience.	On breakdown	NWS&DB[PP]	See Note Below	Liaising with LA & social groups.
		Treatment plant	Impacts as above		On breakdown	NWS&DB[PP]	See Note Below	
SOCIAL 	Non function of the system owing to worker's strikes etc.	All components above.	Impacts as above but in more severe forms.		In the event of strike	NWS&DB[PP]	See Note Below	A rare event

NOTE1: NWS &DB should carry out monitoring with the assistance of Environmental Officers in Pradeesheya Saba. The reports should be sent to CEA.

NOTE2: Risk management procedure given in EA should be followed.(Section 7.2.9)

MONITORING PROGRAMME- OPERATIONAL IMPACTS
(At Operational Stage)

ENVIRONMENT	IMPACT	MONITORING PROGRAMME				
		Parameter to be Measured or Monitored	**Frequency**	**Responsible Agency**	**Reporting Requirements**	**Remarks**
PHYSIO-CHEMICAL 	**Water & Water Quality**					
	Impacts from substandard water quality of treated water.	&& Water Quality parameters	Weekly in the first 3 months & thereafter once in three months	NWS&DB[PP], CEA	See Note 1 below	Can be relaxed further based on results
	Atmosphere					
	Air quality degradation near treatment plant	Air quality parameters	Weekly in the first 3 months & thereafter once in three months	NWS&DB[PP], CEA	See Note 1 below	Routine procedure
	Noise level degradation near Treatment Plant	Noise level	Weekly in the first 3 months & thereafter every six months	NWS&DB[PP], CEA	See Note 1 below	Can be relaxed further based on results
	Odour problems	Odour causing gases	Weekly	NWS&DB[PP]	See Note 1 below	Routine procedure
	Sludge Recipient Entities					
	Pathogenic organisms in sludge	Disease causing pathogens	Monthly	NWS&DB[PP],LA	See Note 1 below	Routine procedure
	Insitu sludge disposal impacts odour	Odour causing gases	Monthly	NWS&DB[PP],LA	See Note 1 below	Routine procedure
	Insitu sludge disposal impacts groundwater contamination if any	Water quality parameters in nearby wells	Ad Hoc or on social complaints.	NWS&DB[PP]	See Note 1 below	Check if contamination suspected
	Heavy metals in sludge	Heavy metals	Monthly	NWS&DB[PP]	See Note 1 below	Routine procedure
BIOTIC 	**No longterm impacts on biotic environment detected if the suggested mitigatory measures are adopted.**					
SOCIAL 	**Psyco Physiological - Odour & Noise**					
	Social inconvenience owing to noise near treatment plant		In case of social complaints.	LA	See Note 1 below	
	Social inconvenience owing to odour near treatment plant				See Note 1 below	
	Public Health - Toxic Gases & Pathogens (Disease Related)					
	Health hazards owing to exposure to pathogens in sludge				See Note 1 below	
	Miscellaneous - Fisheries , Riparian					
	Impacts on water users of Heda Oya	Fisher community response	During dry months	NWS&DB[PP], LA	See Note 1 below	Important at initial stages
	Impacts on groundwater water users of near by wells of Panama treatment plant site.	Well water levels	Weekly	NWS&DB[PP], LA	See Note 1 below	Important at initial stages

&& ==> COD, BOD, DO, Ph, Turbidity etc.

LA= Local Authority, SLT = Sri Lanka Telecom Resources CEB= Ceylon Electricity Board RDA= Road Development Authority, PP= Project Proponent, EMP= Environmental Management Plan, NWS&DB= National Water Supply & Drainage Board

NOTE : NWS &DB should carry out monitoring with the assistance of Environmental Officers in Pradeesheya Saba. The reports should be sent to CEA.

MONITORING PROGRAMME- CONSTRUCTION IMPACTS

(At Construction Stage)

ENVIRONMENT	IMPACT	MONITORING PROGRAMME				
		Parameter to be Measured or Monitored	**Frequency**	**Responsible Agency**	**Reporting Requirements**	**Remarks**
PHYSIO-CHEMICAL	**Water & Waterbodies**					
	Contamination of surface water by construction equipment	Water Quality	As directed by the Engineer	NWS&DB[PP], Contractor	See note below	
	Contamination of sea water by construction materials				See note below	Usual for any construction
	Roads & Other Construction Sites					
	Road settlement by inadequate backfilling	Soil & Road backfill quality	As directed by the Engineer	NWS&DB[PP], Contractor, RDA	See note below	Necessary stipulations will be included in contract documents via EMP
	Siltation & erosion at construction sites and roads(distribution lines)	Topographic Levels, Status of erosion protection measures	As directed by the Engineer	NWS&DB[PP], Contractor,RDA	See note below	
	Atmosphere					
	Air quality degradation at construction sites by dust	Water spreading	Twice a Day or as directed	NWS&DB[PP], Contractor	See note below	Necessary stipuilatiions will be included in contract documents.
	Noise level enhancement	Work phasing	As directed by the Engineer	NWS&DB[PP], Contractor	See note below	
	Utilities- Along Conveyor Pipe & Distribution Lines					
	Damage to electrical utilities	liasing activities with CEB	As directed by the Engineer	NWS&DB[PP], Contractor, CEB	See note below	
	Damage to telecommunication utilities	liasing activities with SLT	As directed by the Engineer	NWS&DB[PP], Contractor, SLT	See note below	Mainly contractor is responsible.
	Damage to shops & Houses	liasing activities with LA	As directed by the Engineer	NWS&DB[PP], Contractor, LA	See note below	Necessary insurance finances
	Damage to roads	liasing activities with LA	As directed by the Engineer	NWS&DB[PP], Contractor, LA	See note below	will be provisionally kept.
	Traffic					
	Vehicular traffic congestion in roads exposed to construction	Traffic diversion activities, by pass roads	While construction in progress	NWS&DB[PP], Contractor,RDA, LA	See note below	Necessary construction schedules
	Human traffic hindrance in roads	Traffic diversion activities, by pass roads	While construction in progress	NWS&DB[PP], Contractor,RDA, LA	See note below	should be prepared
BIOTIC	**Fauna - Inland**					
	Disturbance to elephants in the vicinity of treatment plant	Movement of elephants	During construction	NWS&DB[PP], DWL	See note below	
	Flora - Inland & Marine					
	Disturbance to flora in Heda Oya riverine forest(Destruction of threatened & rare species identified in EA)	Flora in riverine forest especially rare & threatened species in the riverine forest.	Before construction starts	NWS&DB[PP], DWL	See note below	
SOCIAL	**Psyco Physiological - Odour & Noise**					
	Social inconvenience owing to noise	Social response, e.g. protests or complaints	Continually	NWS&DB[PP], Contractor, LA	See note below	Monitoring social response and getting feed back is very important
	Social inconvenience owing construction equipment				See note below	
	Social inconvenience owing to dust				See note below	
	Social inconvenience owing to traffic				See note below	
	Social protests triggered by impacts.				See note below	
	Changed conditions because of alien worker gangs				See note below	
	Public Health					
	Dust related health hazards	Social reponse e.g. protests or complaints	Continually	NWS&DB, contractor, LA[PHI]	See note below	All necessary precations should be taken to avoid health hazards
	Noise related health hazards				See note below	
	Health hazards to workman				See note below	
	Miscellaneous -Riparian					
	Impacts on water users of Heda Oya	Protests or Complaints	Continually	NWS&DB[PP], ID	See note below	

LA= Local Authority, SLT = Sri Lanka Telecom Resources CEB= Ceylon Electricity Board RDA= Road Development Authority, PP= Project Proponent, EMP= Environmental Management Plan, NWS&DB= National Water Supply & Drainage Board, DWL= Department of Wildlife

ANNEX 7 ENVIRONMENTAL MANAGEMENT PLAN

Construction Stage

Environmental Issues				Protection And Preventative Measures That Have To Be Taken By The Contractor
1.	Earthwork and Soil Conservation			
	1.1	Disposal of Debris and Spoil [for pipe trench excavation & other construction at tube well & treatment plant site]		
			(a)	Excavated spoil shall be disposed of only at a location specified by the approving authority under recommended guidelines.
			(b)	All other debris and residual spoil material, including any remaining earth shall be disposed only at locations approved by the engineer for such a purpose. If directed by the Engineer the contractor shall obtain the necessary approval from the relevant local authority for disposal of debris and spoil at the specified location.
			(c)	The debris and spoil shall be disposed in such a manner that (i) drainage paths are not blocked (ii) the disposed material should not be washed away by runoff/floods and (iii) should not be a nuisance to the public.
			(d)	If the Engineer consents, the contractor can dispose the debris and spoil as a filling material provided that the contractor can ensure that such material is used for legally-acceptable purposes with disposal conducted in an environmentally acceptable manner.
			(e)	Priority shall be given to re-use, recycle opportunities available for waste construction materiel and debris
			(f)	In removal temporary storage transport and disposal of construction materiel and waste, proper consideration shall be given to health aspects, particularly with regard to waste such as asbestos. In all such case proper safety precaution shall be taken in disposal of such materiel.
	1.2	Protection of Ground Cover and Vegetation [for pipe trench excavation & other construction at tube well & treatment plant site]		
			(a)	Construction vehicles, machinery and equipment shall be used and stationed only in the areas of work and in any other designated areas by the Engineer.
			(b)	Contractor shall provide necessary instructions to drivers and operators not to destroy ground vegetation cover unnecessarily.
			(c)	Instead of machinery manual work should be carried out at designated places as directed by the engineer.
	1.3	Prevention of Soil Erosion[for pipe trench excavation & other construction at tube well & treatment plant site]		
			(a)	Work that leads to heavy erosion shall be avoided during the raining season. If such activities need to be continued during the rainy season, prior approval must be obtained from the Engineer by submitting a proposal on actions that will be undertaken by the contractor to prevent erosion.
			(b)	The work, permanent or temporary, shall consist of measures as per design or as directed by the Engineer to control soil erosion, sedimentation and water pollution to the satisfaction of the Engineer. Typical measures include the use of berms, dikes, sediment basins, fiber mats, mulches, grasses, slope drains and other devices. All sedimentation and pollution control works and maintenance thereof are deemed as incidental to the earthwork or other items of work and no separate payment will be made for their implementation.

	1.4	Contamination of Soil by Fuel and Lubricants [Generally within the project area]		
			(a)	Servicing of vehicle/machinery and equipment shall be carried out only in designated locations/service stations approved by the Engineer.
			(b)	Waste oil, other petroleum products and untreated wastewater shall not be discharged on ground so that it causes soil pollution. Adequate measures shall be taken against pollution of soil by spillage of petroleum/oil products from storage tanks and containers. All waste petroleum products shall be disposed of in accordance with the guidelines issued by the CEA or the engineer.
			(c)	Sites used for vehicle and plant service and maintenance shall be restored back to their initial status. Site restoration will be considered as incidental to work.
2.	Water – Protection of Water Sources and Quality			
	2.1	Contamination from Fuel and Lubricants		
			(a)	All vehicle and plant maintenance and servicing stations shall be located and operated as per the conditions and/or guidelines issued by the Engineer/Central Environmental Authority.
			(b)	No discharges of oil etc. should be allowed to contaminate water of Heda Oya
	2.2	Locating, Sanitation and Waste Disposal in Construction Camps		
			(a)	Setting up of labor camps shall have the Engineer's approval and shall comply with any guidelines/recommendations issued by the CEA/LA. Construction laborers' camps shall not be located within 60m of waterways, near to a site or premises of religious, cultural or archaeological importance, school or any other sensitive area.
			(b)	Labor camps shall be provided with adequate and appropriate facilities for disposal of sewerage and solid waste. The sewage systems shall be properly designed, built and operated so that no pollution to ground or adjacent water bodies/watercourses takes place. Garbage bins shall be provided in the camps and regularly emptied. Garbage should be disposed off in a hygienic manner, to the satisfaction of the relevant norms. Compliance with the relevant regulations and guidelines issued by the CEA/LA shall be strictly adhered to.

			(c)	Contractor shall ensure that all camps are kept clean and hygienic. Necessary measures shall be taken to prevent breeding of vectors.
			(d)	Contractor shall report any outbreak of infectious disease of importance in a labor camp to the Engineer and the Medical Officer of Health (MOH) or to the Public Health Inspector (PHI) of the area immediately. Contractor shall carry out all instructions issued by the authorities, if any.
			(e)	Contractor shall adhere to the CEA recommendations on disposal of wastewater. Wastewater shall not be discharge to ground or waterways in a manner that will cause unacceptable surface or ground water pollution.
			(f)	All relevant provisions of the Factories Act and any other relevant regulations aimed at safety and health of workers shall be adhered to.
			(g)	Contractor shall remove the labor camps fully after construction is complete, empty septic tanks, if instructed by the engineer shall be closed; remove all garbage, debris and clean and restore the area back to its former condition.
	2.3	Waste of Water and Waste Minimization		
			(a)	Contractor will minimize waste of water in the construction process/operations.
			(b)	Contractor shall educate and made employees aware of water conservation, waste minimization and safe disposal of waste.
	2.5	Extraction of Water		
			(a)	Contractor is responsible for arranging adequate supply of water for the project purpose throughout the construction period. Contractor shall not obtain water for his purposes including for labor camps from public or community water supplies without approval from the relevant authority.
			(b)	Contractor shall not extract water from groundwater or from surface water bodies without permission from the Engineer. If directed by the Engineer the contractor must obtain approval from the relevant agency for extraction of water prior to the commencement of the project.
			(c)	Contractor may use the natural sources of water subject to the provision that any claim arising out of conflicts with other users of the said natural sources of water shall be made good entirely by the contractor.

3.	Prevention of Water Logging			
	3.1	Blockage of drainage paths and drains		
			(a)	Contractor's activities shall not lead to water logging as a result of blocked drainage paths and drains. The contractor shall take all measures necessary or as directed by the Engineer to keep all drainage paths and drains clear of blockage at all times.
			(b)	If water logging or stagnation of water is caused by contractor's activities, contractors shall provide suitable means to (a) prevent loss of access to any land or property and (b) prevent damage to land and property. Contractor shall compensate for any loss of income or damage as a result.
4.	Air Pollution			
	4.1	Generation of Dust		
			(a)	Contractor shall effectively manage the dust generating activities such as earthwork during periods of high winds.
			(b)	All stockpiles of material generating dust shall be located sufficiently away from sensitive receptors.
			(c)	All vehicles delivering materials shall be covered to avoid spillage and dust emission.
			(d)	Contractor shall avoid (where possible) and take suitable action to prevent dirt and mud being carried to the roads (particularly following wet weather).
			(e)	Contractor shall enforce vehicle speed limits to minimize dust generation.
			(f)	Contractor shall spray water for dust suppression on all exposed areas as required (note: the use of waste water / waste oil for dust suppression is prohibited).
			(g)	All cleared areas shall be rehabilitated progressively.
			(h)	All earthworks shall be protected to minimize generation of dust.
			(i)	All existing highways and roads used by vehicles of the contractor, or any of his sub-contractor or supplies of materials or plant and similarly roads which are part of the works shall be kept clean and clear of all dust/mud or other extraneous materials dropped by such vehicles.
			(j)	Clearance shall be effected immediately by manual sweeping and removal of debris, or, if so directed by the Engineer, by mechanical sweeping and clearing equipment, and all dust, mud and other debris shall be removed satisfactorily. Additionally, if so directed by the Engineer, the paved areas/road surfaces shall be hosed or watered using appropriate equipments.
			(k)	Plants, machinery and equipment shall be so handled (including dismantling) to minimize generation of dust.
			(l)	Contractor shall take precautions to reduce the level of dust emission from the batching plants up to the satisfaction of the Engineer in accordance with the relevant emission norms.

	4.2	Odor and Offensive Smells		
			(a)	Contractor shall take all precautions to prevent odor and offensive smell emanating from chemicals and processes applied in construction works or from labor camps. In a situation when/where odor or offensive smell does occur contractor shall take immediate action to rectify the situation. Contractor is responsible for any compensation involved with any health issue arisen out of bad odor and offensive smells.
			(b)	The waste disposal and sewerage treatment system for the labor camps shall be properly designed, built and operated so that no odor is generated. Compliance with the regulations on health and safety as well as CEA guidelines if any shall be strictly adhered to.
	4.3	Emission from Construction Vehicles, Equipment and Machinery		
			(a)	The emission standards promulgated under the National Environment Act shall be strictly adhered to.
			(b)	All vehicles, equipment and machinery used for construction shall be regularly serviced and well maintained to ensure that emission levels comply with the relevant standards.
5.	Noise Pollution and Vibration			
	5.1	Noise from Vehicles, Plants and Equipment.		
			(a)	All machinery and equipment should be well maintained and fitted with noise reduction devices in accordance with manufacturer's instructions.
			(b)	All vehicles and equipment used in construction shall be fitted with exhaust silencers. During routine servicing operations, the effectiveness of exhaust silencers shall be checked and if found to be defective shall be replaced. Notwithstanding any other conditions of contract, noise level from any item of plant(s) must comply with the relevant legislation for levels of sound emission. Non-compliant plant(s) shall be removed from site.
			(c)	Noise limits for construction equipment used in this project (measured at one meter from the edge of the equipment in free field) such as compactors, rollers, front loaders, concrete mixers, cranes (moveable), vibrators and saws shall not exceed the stipulated noise levels of EA
			(d)	Maintenance of vehicles, equipment and machinery shall be regular and proper, to the satisfaction of the Engineer, to keep noise from these at a minimum.
			(e)	Workers in vicinity of strong noise, and workers working with or in crushing, compaction, batching or concrete mixing operations shall be provided with protective gear.

	5.2	Vibration		
			(a)	Contractor shall take appropriate action to ensure that construction work does not result in damage to adjacent properties due to vibration.
			(b)	Prior to commencement of any activity that generates vibration (such as blasting), the Contractor shall undertake a condition survey of existing structures within the zone of influence, as agreed with the Engineer.
			(c)	Contractor shall carry out monitoring at the nearest vibration sensitive receptor during blasting or when other equipments causing vibration are used.
			(d)	Contractor shall modify the method of construction until compliance with the criteria occurs, in the instance that vibration levels exceed the relevant vibration criteria.
			(f)	Contractor shall pay due consideration to vibration impacts of blasting on adjoining structures. Explosive loads shall be determined so that excessive vibration can be avoided and blasts shall be controlled blasting in nature. Notwithstanding to these provisions contractor is liable for any damage caused by blasting work.
6.	Impact on Flora			
	6.1	Loss or Damage to Trees and Vegetation [Heda Oya tube well site , Pottuvil/Ulla & Panama treatment plant site]		
			(a)	All works shall be carried out in a manner that the destruction to the flora and their habitats is minimized. Trees and vegetation shall be felled / removed only if they impinge directly on the permanent works or necessary temporary works. In all such cases contractor shall take prior approval from the Engineer.
			(b)	Contractor shall make every effort to avoid removal and/or destruction of trees of religious, cultural and aesthetic significance. If such action is unavoidable the Engineer shall be informed in advance and carry out public consultation and report on the same should be submitted to the Engineer.
			(c)	Contractor shall adhere to the guidelines and recommendations made by the Central Environmental Authority, if any, with regard to felling of trees and removal of vegetation.
			(d)	Suggested mitigatory measures in the EA should be adopted.
7.	Impact on Fauna			
	7.1	Loss, Damage or Disruption to Fauna		
			(a)	All works shall be carried out in such a manner that the destruction or disruption to the fauna and their habitats is minimized.
			(b)	Construction workers shall be instructed to protect fauna aquatic life as well as their habitats. Hunting, poaching and unauthorized fishing by project workers is not allowed.
			(c)	Suggested mitigatory measures in the EA should be adopted.
			(d)	Contractor should liaise with the officials of Department of Wildlife at all stages of construction.

8.	Disruption to Users			
	8.1	Loss of Access		
			(a)	At all possible times, work in the sites shall be planned and carried out in a way that will minimize obstruction to other uses of the site and the surrounding area. The contractor should identify such uses and consult the people on such matters and notify them of anticipated times of construction activities.
			(b)	At all times, Contractor shall provide safe and convenient passage for vehicles and pedestrians livestock to and from side roads and property accesses connecting the access road. Work that affects the use of access roads and existing accesses shall not be undertaken without providing adequate provisions to the prior satisfaction of the Engineer.
			(b)	The works shall not interfere unnecessarily or improperly with the convenience of public by use and occupation of public or private roads, railways and any other access footpaths to or of properties whether public or private.
			(c)	On completion of the works, all temporary obstructions to access shall be cleared away, all rubbish and piles of debris that obstruct access be cleared to the satisfaction of the Engineer.
	8.2	Traffic Jams and Congestion [Conveyor & Distribution Pipes]		
			(a)	Contractor shall assess the impact of his activities on traffic in access roads and plan for minimizing traffic-related inconvenience to public shall be submitted to the Engineer for approval. If directed by the Engineer the contractor shall obtain the consent for the traffic arrangement from the Local Police.
			(b)	Any temporary diversion of traffic to facilitate construction work shall have the approval of the Engineer. If directed by the Engineer the contractor shall obtain the consent for the traffic arrangement from the Local Police.
			(d)	Contractor shall ensure that the running surface is always property maintained, particularly during the monsoon so that no disruption to the traffic flow occurs.
			(e)	The temporary traffic detours shall be kept free of dust by frequent application of water, if necessary.
			(f)	Personnel used for traffic control by the contractor shall be properly trained, provided with proper gear including communication equipment and luminous jackets for night use. All signs, barricades, pavement markings used for traffic management should be to the standards and approved by the Engineer/ Police.
	8.3	Traffic Control and Safety		
			(a)	Contractor shall take all necessary measures for the safety of traffic during construction and provide, erect and maintain such barricades, including signs, markings, flags, lights and flagmen as may be required by the Engineer for the information and protection of traffic using the access roads.

9.	Accidents and Risks			
	9.1	Public and Worker Safety		
			(a)	All reasonable precautions will be taken to prevent danger of the workers and the public from accidents such as fire, explosions, blasts, falling rocks, falling to excavated pits, breaking flood diversions, chemical sprays, unsafe power supply lines etc.
			(b)	Contractor shall comply with requirements for the safety of the workmen as per the International Labor Organization (ILO) convention No. 62 and Safety and Heath regulations of the Factory Ordinance of Sri Lanka to the extent that those are applicable to this contract. The contractor shall supply all necessary safety appliances such as safety goggles, helmets, masks, boots, etc., to the workers and staff.
			(c)	Contractor should obtain all necessary insurance covers.
	9.2	Prevention of Risks of Electrocution		
			(a)	All electrical wiring and supply-related work should conform to relevant Sri Lankan Standards. Adequate precautions will be taken to prevent danger of electrocution from electrical equipment and power supply lines including distribution boards, transformers, etc. Measures such as danger signboards, danger/red lights, fencing and lights will be provided to protect the public and workers. All electric power driven machines to be used in the construction shall be free from defect, be properly maintained and kept in good working order, be regularly inspected to the satisfaction of the Engineer.
	9.3	Risk at Hazardous Activity		
			(a)	All workers employed in hazardous activities shall be provided with necessary protective gear. These activities include mixing asphalt material, cement, lime mortars, concrete etc., welding work, work at crushing plants, blasting work, operators of machinery and equipment such as power saws, etc.
			(b)	The use of any toxic chemical shall be strictly in accordance with the manufacturer's instructions. The Engineer shall be notified of toxic chemicals that are planed to be used in all contract-related activities. A register of all toxic chemicals delivered to the site shall be kept and maintained up to date by the Contractor. The register shall include the trade name, physical properties and characteristics, chemical ingredients, health and safety hazard information, safe handling and storage procedures, and emergency and first aid procedures for the product.

10.	Health and Safety			
	10.1	Prevention of Vector-based Diseases		
			(a)	Contractor shall take necessary actions to prevent breeding of mosquitoes at places of work, labor camps, plus office and store buildings. Stagnation of water in all areas including gutters, used and empty cans, containers, tires, etc. shall be prevented. Approved chemicals to destroy mosquitoes and larvae should be regularly applied.
			(b)	Contractor shall keep all places of work, labor camps, plus office and store buildings clean devoid of garbage to prevent breeding of rats and other vectors such as flies.
	10.2	Workers Health and Safety		
			(a)	Contractor shall comply with the provisions in Health and Safety regulations under the Factory Ordinance with regard to provision of health and safety measures and amenities at work place(s).
	10.2	First Aid		
			(a)	At every workplace, a first aid kit shall be provided as per the regulations. At every workplace an ambulance room containing the prescribed equipment and nursing staff shall be provided.
	10.3	Potable Water		
			(a)	In every workplace and labor camps potable water shall be available through out the day in sufficient quantities. Water should be easily accessible. In general cold potable water is acceptable.
	10.4	Hygiene		
			(a)	Contractor shall provide and maintain necessary (temporary) living accommodation and ancillary facilities for labor to standards and scale approved by the resident engineer.
			(b)	At every workplace and labor camp a sufficient number of bathing facilities, latrines and urinals shall be provided in accordance with the Health and Safety regulations and/or as directed by the Engineer. These bathroom and toilet facilities shall be suitably located within the workplace/buildings. Latrines shall be cleaned at least three times daily in the morning, midday and evening and kept in a strict sanitary condition. If women are employed, separate latrines and urinals, screened from those for men and marked in the vernacular shall be provided. There shall be an adequate supply of water, within and close to latrines and urinals.
			(c)	The sewage system for the camp must be properly designed, built and operated so that no health hazard occurs and no pollution to the air, ground or adjacent watercourses takes place. Compliance with the relevant legislation must be strictly adhered to.
			(d)	Garbage bins must be provided in the camp and regularly emptied and the garbage disposed off in a hygienic manner. Construction camps shall have a clean hygienic environment and adequate health care shall be provided for the work force.
			(d)	Unless otherwise arranged for by the Local Authority, the contractor shall arrange proper disposal of sludge from septic tanks. The contractor shall obtain approval for such disposal from the Public Health Inspector of the area.

11	Protection of Archaeological, Cultural and Religious Places and Properties			
	11.1	Chance Found Archaeological Property		
			(a)	All fossils, coins, articles of value of antiquity and structures and other remains or things of geological or archaeological interest etc. discovered on the site and/or during construction work shall be the property of the Government of Sri Lanka, and shall be dealt with as per provisions of the relevant legislation.
			(b)	Contractor shall take reasonable precaution to prevent his workmen or any other persons from removing and damaging any such article or thing and shall, immediately upon discovery thereof and before removal acquaint the Engineer of such discovery and carry out the Engineer's instructions for dealing with the same, awaiting which all work shall be stopped in the respective area.
			(c)	If directed by the Engineers the Contractor shall obtain advice and assistance from the Department of Archaeology of Sri Lanka on conservation measures to be taken with regard to the artifacts prior to recommencement of work in the area.
12	Environmental Enhancement			
	12.1	Handling Environmental Issues during Construction		
			(a)	Contractor will appoint a suitably qualified Environmental Officer following the award of the contract. The Environmental Officer will be the primary point of contact for assistance with all environmental issues during the pre-construction and construction phases. He/She shall be responsible for the ensuing implementation of this EMAP. This environmental officer should liaise with the Environmental Officer of the local authority
			(b)	Contractor shall appoint a person responsible for community liaison and to handle public complaints regarding environmental/social related matters. All public complaints will be entered into the Complaints Register. The Environmental Officer will promptly investigate and review environmental complaints and implement the appropriate corrective actions to arrest or mitigate the cause of the complaints. A register of all complaints is to be passed to the Engineer within 24 hrs of when they are received, with the action taken by the Environmental Officer on complaints thereof.
			(c)	Contractor shall develop suitable method to receive complaints. The complain register shall be placed at a convenient place, easily accessible by the public.
			(d)	The employer shall develop a monitoring plan for implementation of the EMAP. The contractor shall be responsible for reporting the implementation of the EMAP to the employer based on an agreed reporting format either monthly or periodically, as agreeable. The report should carry observations of the Engineer who will continuously monitor compliance with the EMAP. Periodic field supervision shall be undertaken by the employer (or representatives) to make observations on the implementation progress of the EMP.
13	Impact on Utilities			
	12.1	Impacts on electrical, telecommunication lines		
			(a)	The contractor should take all precautions to avoid the impacts on utilities such as electrical & telecommunication cables. Necessary utility plans should be obtained from the relevant line agencies.

14	Minimization of Social Inconvenience			
	12.1	Minimization on impacts on the society		
			(a)	The contractor should take all precautions to minimize the impact on the social groups. The contractor should interact with various affected social groups through the "*Grama Niladari"*, Divisional Secretary , "*Pradeesheeya* Saba" etc. Their ideas concerns should be well addressed in order to avoid social protests during construction

Operational Stage

Environmental Issues				Protection And Preventative Measures That Have To Be Taken By The Contractor
1.	Water Quality			
	1.1	Impacts from substandard water quality of treated water		
			(a)	The contractor during the operation & maintenance period should regularly (as stipulated in the Monitoring Programme" check the water quality at the source (tube wells) before treatment , just after treatment before distribution & at distribution points . The water quality after the treatment and at distribution points should conform to the national standards.

2.	Atmosphere			
	2.1	Air quality degradation near treatment plant		
			(a)	The contractor during the operation & maintenance period should regularly (as stipulated in the Monitoring Programme" check the air quality near the treatment plant sites.
	2.2	Noise Level Degradation Near Treatment Plant		
			(a)	The contractor during the operation & maintenance period should (as stipulated in the Monitoring Programme) check the noise level near the treatment plant sites
	2.3	Odor causing gases		
			(a)	The contractor during the operation & maintenance period should (as stipulated in the Monitoring Programme) check odor causing gases near the treatment plant sites

3.	Sludge Recipient Entities			
	3.1	Pathogenic Organisms in sludge		
			(a)	The contractor during the operation & maintenance period should regularly (as stipulated in the Monitoring Programme" check the air quality near the treatment plant sites.
	3.2	Ordor from sludge		
			(a)	The contractor during the operation & maintenance period should (as stipulated in the Monitoring Programme) check the noise level near the treatment plant sites
	3.3	Groundwater contamination from sludge		
			(a)	Sludge should be disposed to sludge beds only. Sludge could be removed from beds only after making sure that it does not contain any harmful material.
	3.4	Heavy metals in sludge		
			(a)	The contractor during the operation & maintenance period should (as stipulated in the Monitoring Programme) check the heavy metals in sludge.

4.	Social Impacts			
	4.1	Social inconvenience owing to odor & noise near treatment plant		
			(a)	The contractor should take all action to mitigate noise & odor near he treatment plant. In case of social complaints the contractor should liaise with the local authorities and address the concerns of social groups.
	4.2	Public Health hazards owing to pathogens in sludge		
			(a)	All precautions should be taken in handling sludge as stipulated in the EA.
	4.3	Impacts on water users in Heda Oya		
			(a)	The environmental flow requirements at Heda Oya should be maintained especially during dry months as stipulated in EA.
	4.4	Impacts on water users of wells near Panama treatment plant site.		
			(a)	The contractor should monitor the water level status of the wells which are located close to Panama treatment plant site. Water levels of these ells should be observed weekly especially during dry season to check whether is any impacts.

Contingency Stage

Environmental Issues		**Protection And Preventative Measures That Have To Be Taken By The Contractor**
1.	Contingency Impacts (sudden leaks, routine leaks, break downs & non function of the plant owing to strikes etc.)	
	1.1	Contingency impacts are not very common but possible. All precautions should be taken to avoid contingency impacts by adopting the mitigatory measures given in the EA & the monitoring plan. Preventive maintenance should be essentially carried out so that these types of contingency impacts are minimized.

ANNEX 8 COMMUNITY CONSULTATION REPORT