Kingdom of Cambodia
Nation Religion King

Ministry of Industry, Mining and Energy
Department of Potable Water Supply

Cambodia Provincial and Peri-Urban Water Supply and Sanitation Project

Initial Environmental Impact Assessment Report

Prek Changkran (M21)

District of Sithor Kandal
Prey Veng Province

Phnom Penh, February 2003
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LIST OF ABBREVIATIONS

ADP  Average Daily Production
BOD  Biochemical Oxygen Demand
COD  Chemical Oxygen Demand
CPPUWSSP Cambodia Provincial and Peri-Urban Water Supply and Sanitation Project
DBL  Design/Build/Lease
DD  Detailed Design
DPWS  Department of Potable Water Supply
DPWT  Department of Public Works and Transport (Municipality)
EA  Environmental Assessment
EEA  Environmental Examination Application
EIA  Environmental Impact Assessment
EMiP  Environmental Mitigations Plan (part of an EMP)
EMoP  Environmental Monitoring Plan (part of an EMP)
EMP  Environmental Management Plan
ESF  Environmental Safeguard Framework
FIRR  Financial Internal Rate of Return
FS  Feasibility Study
FT  Fraser Tomas (Engineering Consultants)
GHD  Gutteridge, Haskins & Davey (Engineering Consultants)
IEIA  Initial Environmental Impact Assessment
IP  Indigenous People
JICA  Japan International Cooperation Agency
LCPSS  Low Cost Pilot Sewerage System
Lpcd  Liters per capita per day
Mg/l  Milligrams per liter
MIME  Ministry of Industry, Mines, and Energy
MoA  Ministry of Agriculture
MoE  Ministry of Environment
MPP  Municipality of Phnom Penh
MWRM  Ministry of Water Resources and Meteorology
MPWT  Ministry of Public Works and Transport
NGO  Non Governmental Organization
PCD  Pollution Control Department (Ministry of Environment)
PG  Provincial Government
PMU  Project Management Unit
PO  Project Owner
PPWSA  Phnom Penh Water Supply Authority
RGC  Royal Government of Cambodia
ToR  Terms of Reference
TSS  Total Suspended Solids
WB  World Bank
WHO  World Health Organization
WSS  Water Supply and Sanitation
WTC  Willingness to Connect
PROJECT SUMMARY

General
The purpose of the Environmental Assessment is to identify and evaluate the significance of any potential environmental impacts on the proposed construction and development program for a new water supply system for Prek Changkran (District of Sithor Kandal, Prey Veng Province) and to incorporate preventive and mitigation measures to ensure that residual environmental impacts are acceptable and are within the applicable limitation standards prescribed by the Ministry of Environment and the World Bank.

The Local Government of Prek Changkran has initiated the current project, with support of the Provincial Government of Prey Veng and the Department of Potable Water Supply (DPWS) of MIME. The actual ‘Project Owner’ is the Ministry of Industry, Mines and Energy.

Project description
Based upon the evaluation of the various options for a possible water supply scheme, MIME, with support of the Engineering Consultants GHD/FT, has prepared a viable project proposal. The project will provide piped water supply for a population estimated at 6,893 persons, with service initially to some 51 to 60 percent of the population within the service area at 40 l/cd, increasing to 60 l/cd and serving 90 percent of the population in the service area. Preliminary calculations indicate a design water demand (ADP) of 630 m3/day.

The water source will be groundwater, to be abstracted through deep wells. The necessary treatment will be applied to comply with Cambodian drinking water quality standards. A treatment plant will be established on the land identified by the Commune, comprising of aeration, slow sand filters and disinfection. The treated water will be pumped from a clearwater tank through a booster pump into the system. The distribution network will be located along the main roads. A single metered connection will be provided to each house, where it is assumed that household “water jar” storage will continue to be used.

No resettlement will be required. The project will not negatively affect any indigenous people.
Land Acquisition
The scheme is based on the treatment plant being located in the Commune-owned land identified as being available west of the Commune Office, across a seasonal river which forms drainage outlet from the rice fields behind the town. This has been adopted not only because it is readily available but also it is immediately adjacent to the best source of water as identified below. It is also reasonably central to the extremities of the town.

The land for the proposed wells and pumping stations should be purchased (or made available by the Commune) with official documentation as soon as the locations of wells are confirmed by the private operator. The treatment plant will be established on the land identified by the Commune, behind the existing Commune office.

It is anticipated that 1,650 m² of land will be required. The acquisition of land will be facilitated by MIME as part of their responsibility to the project. If possible, the PMU representative will facilitate the issuance of "Deed of Donation" or statements on the willingness to sell prior to the construction to avoid any conflict with the lot owner.

Consultations
After series of meetings/consultations with concerned Provincial Government Officials of the Prey Veng Province and the local officials and residents of Prek Changkran, the Project was approved and endorsed. Overall, the project is perceived to be of great help to the community since it will significantly improve the quality of the drinking water supply and public health conditions by reducing common cases of water borne diseases (diarrhea, gastroenteritis and parasitism). The project will further stimulate socio-economic growth through increase in the number of commercial and economic activities thus adding revenue to the community.

The Willingness to Connect (WTC) indicated that 70% of the 1313 households within the service area of Prek Changkran approved a tariff of 1995 Riel/m³.

Environmental Conditions
Located in the Mekong delta, a flat area with limited natural drainage, the increase of wastewater flows may create stagnant water in the residential areas. During the wet season, the areas is flushed by the large amount of rain, possibly even flooding.

MIME is aware of the possible risks of higher Arsenic concentrations in wells to be drilled in the Mekong Delta. The risk however is considered acceptable as appropriate mitigation measures are incorporated into the project design and preparation process if higher concentrations are encountered in the drillings.

It should be noted that the 'Arsenic problem' generally applies to private shallow wells, where people have no choice in selection the location of the well, and have no resources to provide proper treatment. The PPUWSSP will develop piped water supply systems, where the both the source and the treatment can relatively easily be adjusted according to the local conditions.

As Prasat is located in the Mekong Delta with a high groundwater table, additional attention will be given to problems related to onsite sanitation. As the regular septic tanks are not working properly in these areas, the option of introducing alternative technologies and/or communal facilities (public toilets) will be discussed and investigated during the project.
Environmental Management Plan

To mitigate possible general adverse environmental impacts (e.g. drainage, sanitation, damage to soils and water and economic losses), discussions are held with all major stakeholders. The findings and conclusions on the actions to be taken have been summarized in an Environmental Management Plan (EMP), including:

- An Environmental Mitigation Plan (EMiP), outlining the measures to be taken to mitigate adverse environmental impacts;
- An Environmental Monitoring Plan (EMoP), defining the environmental parameters to be observed and reported;
- Overview of the implementation arrangements, defining the responsibilities and timing.

Implementation and Monitoring arrangements

The responsibilities for implementation and monitoring of the Environmental Safeguard Framework (ESF) are summarized in the table below. The Ministry of Industry, Mines and Energy has the overall responsibility for the proper implementation of the Environmental Safeguard Framework (ESF), i.e. project implementation and compliance monitoring. The actual project management will be the responsibility of the Project Management Office (PMO) in Phnom Penh. Consultants will be engaged to provide assistance during project preparation, and for supervising design and construction of the systems.

The daily supervision of the construction and operation of the MIME sub-projects will be carried out by the Provincial Project Management Units (PMU). PMU staff will report to the PMO.

### Responsibilities for ESF Implementation and Compliance Monitoring

<table>
<thead>
<tr>
<th>Agency</th>
<th>Principal project linkages</th>
<th>Compliance Monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIME/PPWSA PMOs</td>
<td>Main linkage to MoE and WB-EASUR</td>
<td>Implements compliance monitoring agreements.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Prepares compliance monitoring reports for MoE and WB.</td>
</tr>
<tr>
<td>Provincial PMUs</td>
<td>Report to MIME PMO.</td>
<td>Implements compliance monitoring procedures: e.g. review of compliance monitoring reports and field inspections.</td>
</tr>
<tr>
<td>Ministry of Environment (MoE)</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>WB Operations Department (EASUR)</td>
<td>Provides 'No-Objection Letters' to MIME/PPWSA for sub-project implementation, after clearance from EASES</td>
<td>Implements compliance monitoring procedures: e.g. review of compliance monitoring reports and field inspections.</td>
</tr>
<tr>
<td>WB Environmental Department (EASES)</td>
<td>Provides Environmental Clearances for (sub)-projects to EASUR</td>
<td>Implements compliance monitoring procedures: e.g. review of compliance monitoring reports and field inspections.</td>
</tr>
<tr>
<td>Supervision Consultants</td>
<td>Support PMOs and PMUs.</td>
<td>Supervises work of DBL contractors.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Support PMO/PMUs to prepare monitoring reports.</td>
</tr>
<tr>
<td>DBL Contractors</td>
<td>Report directly to MIME-PMO</td>
<td>Implement EA requirements.</td>
</tr>
</tbody>
</table>
The water supply system operator and the PG, with the assistance of PMO/consultants, will monitor compliance with the operating permit and carry out the requisite data collection during both the construction and operational phases. Monitoring reports to be submitted to the MoE and the PMO will include:

- Presentation of the collected data;
- Discussion on the compliance or non-compliance to the EMP and operating permit;
- Conclusions and recommendations.

The PMO is requested to summarize the finding of the quarterly monitoring reports and submit an annual compliance report to the World Bank.
## Environmental Mitigation Plan (EMIP) for Prek Changkran, Prey Veng

<table>
<thead>
<tr>
<th>Phase</th>
<th>Mitigation measures</th>
<th>Responsibility</th>
<th>Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-construction</td>
<td>Lack of control of water source: Acquire land directly around the facilities (or secure a possible purchase); Reduction in flow: Locate the well in an area where other water users are not affected; Disturbance of land use and economic activities: Usage of public areas; Provision for proper compensation; Risk of Arsenic in groundwater: design of proper treatment facility.</td>
<td>MIME, World Bank</td>
<td>Prior to DBL Contracts</td>
</tr>
<tr>
<td>Construction</td>
<td>Disturbance of land use due to drilling/construction: Minimize impacts, Restore damages. Loss of natural vegetation: Replanting of affected areas. Disturbance of stream channels, aquatic plant and animal habitats: Erosion and sedimentation control. Soil and water contamination (e.g. spilling of oil products and other construction materials): Control (collection, disposal) of waste water. Hindrance (noise, air pollution, traffic, etc) due to drilling/construction activities: Minimize hindrance; Usage of main roads when possible. Soil erosion and compaction: Proper runoff and erosion control measures; Heavy traffic restrictions. Safety hazards: Proper safety and warning measures; Provision of temporary crossings/bridges; Public information campaign.</td>
<td>Operator, with supervision of MIME consultant</td>
<td>Continuous during construction phase.</td>
</tr>
<tr>
<td>Operation</td>
<td>Public health hazards due to increase of wastewater: Support the construction of proper on-site sanitary facilities (if lacking); Improve storm drainage system for sullage; Contamination of the groundwater: Acquire and fence a protection zone directly around the well; Regulate potential polluting activities in recharge zone; Monitor water level and groundwater abstraction. Lowered groundwater table: Space wells at larger distances; Avoid over-abstraction and consequent lowering of groundwater table; Calculate safe yield (abstraction); Assure/proof that other water users are not affected. Increase of noise: Usage of electrical submersible pumps; Construction of pumping house. Water availability: keep traditional water sources available.</td>
<td>Operator, with supervision of MIME</td>
<td>To be determined during feasibility study.</td>
</tr>
</tbody>
</table>
### Environmental Monitoring Plan (EMoP) for Prek Changkran, Prey Veng

<table>
<thead>
<tr>
<th>Phase</th>
<th>Monitoring activities</th>
<th>Responsibility</th>
<th>Implementation</th>
</tr>
</thead>
</table>
| Pre-Construction | • Land acquisition: Check if the required land has been acquired properly, or that a proper "Deed of Sale/Donation" has been prepared.  
                 • Resettlement and Compensation: If applicable, check if proper arrangements are made and documented. | MIME, World Bank                    | Prior to DBL Contract               |
| Construction | • Hindrance to local population: Noise, air pollution (odor, TSP, fume emissions), land damage, traffic.  
                 • EMP compliance of the contractors: Erosion control, vegetation protection, soil and water contamination.  
                 • Safety precautions of contractors. Conform professional standards.  
                 • Sanitary control: Proper construction of on-site facilities; Proper construction of sullage drainage system. | Operator, with supervision of MIME consultant | Continuous, through regular construction supervision. |
| Operation   | • Quality of distributed water: conform official standard procedures (microbiology, standard parameters, Arsenic, heavy metals);  
                 • Groundwater resources: water level (2 X per month (after pumping recovery period); operation of pumps (abstraction). | Operator, with supervision of MIME | Regular, according to professional standards. |
1 INTRODUCTION

1.1 Background of the Project

The 'Provincial and Peri-Urban Water Supply and Sanitation' project (PPUWSSP) is being prepared and implemented by the Department of Potable Water Supply (DPWS) of the Ministry of Industry, Mining and Energy (MIME), and the Phnom Penh Water Supply Authority (PPWSA), Kingdom of Cambodia. The PPUWSSP is financed through a loan from the World Bank.

The MIME component aims at financing water supply and sanitation projects targeting provincial towns and district towns that express demand for improved services and low-income communities in urban centers. It finances investments that (i) respond to what consumers want and are willing to pay, (ii) facilitate and develop private sector participation in financing, operating and maintaining constructed facilities, while designing specific instruments that ensure inclusion of low income communities residing in the service areas.

Upon the request of the local governments, the town of Prek Changkran, Province of Prey Veng (Figure 1-1), has been included in the first batch of the project. Preaek Changkran has expressed its interest in the project as it does not have a proper water supply system yet. During the dry season, serious water shortages occurs.

Figure 1-1 – Location map of the project area

The purpose of the present Initial Environmental Impact Assessment (IEIA) is to identify possible environmental and social impacts arising from the proposed construction and development of a piped water supply system for Prek Changkran, Province of Prey Veng (M21).
Many sections of the current report have been obtained from the Feasibility Study reports, prepared by Ministry of Industry, Mines and Energy, with support of the Engineering Consultant GHD/FT.

1.2 Environmental Assessment

The EA has been prepared in accordance with the guidelines of the Ministry of Environment (MoE, see also section 1.3), combined with World Bank guidelines on Environmental Assessment. Both within the Cambodian and the World Bank regulatory framework an environmental clearance is required before the project implementation can start. Environmentally sound practices have been incorporated in the project planning and design, and possible negative impacts have been identified to be mitigated to acceptable levels.

The EA was carried out by a technical team, comprising of engineers and environment specialists (See Annex I - List of EA preparers). Multiple consultations with the staff of MIME, Provincial Government, Commune chiefs, and the local beneficiaries were conducted in order to solicit their comments, reactions and finally seek their proper approval and endorsement of the proposed project (see Annex II – WTC Process documentation and Annex III - Proof of social acceptability).

Desk research was carried out through obtaining available data about the physical, socio-economic, environmental characterization, political profiles from the Engineering Consultants GHD/FT. Data were also gathered and reviewed from the national line agencies/offices such as Ministry of Rural Development (MRD), Ministry of Agriculture (MoA), and Ministry of Environment (MoE). These available reports/literatures and other materials relevant to the conduct of the Environmental Assessment report were compiled and reviewed.

Aside from data gathering activities, actual interview and constant coordination with the members of the Provincial Management Unit (PMU) at the Provincial and Municipal/City levels were carried out to gather first hand information/data.

1.3 Institutional and legal framework

Overall management of the environment lies with the Ministry of Environment (MoE), which was created in 1993. The MoE has wide responsibilities, which are spelled out in the Law on Environmental Protection and Natural Resources Management. At the provincial and city levels, there are corresponding Provincial/City Environment Departments. These local departments have the responsibility of enforcing the environmental legislation coming under the competence of the MoE. However, the daily operational functions of these departments would normally come under the direct control of the provincial/city authorities.

The objectives of the framework Law are to protect environmental quality through the prevention, reduction and control of pollution, to establish an Environmental Impact Assessment (EIA) system, to ensure sustainable use of natural resources, to encourage public participation and to suppress acts which are harmful to the environment.
The framework Law calls for an EA to be conducted for every private or public project, to be reviewed by the Ministry of Environment before submission to the Government for a final decision. All proposed and existing activities are to be covered under this requirement. Sub-decrees are anticipated to provide for the finer details of the system. Furthermore, the MoE has prepared draft guidelines for the set-up and contents of the EIA reports. Although still in draft form, they have been applied as the basis for the IEIA reports.

Accordingly, for new water supply systems ≥ 2,000 connections, a concise Environmental Assessment (EA) will have to be prepared by the Project Owner. This is consistent with the Cambodian Sub-decree on Environmental Impact Assessment Process. The Cambodian Environmental Impact Assessment (EIA) reporting requirements for water supply projects start with 10,000 users. The EIA sub-decree details specific procedures to be followed and lists the nature and size of projects which are required to submit Initial Environmental Impact Assessment (IEIA) or EIAs report.

For smaller systems (< 2000 connections), the Project Owner will have to include Environmental Safeguard Guidelines into the Project design and operation arrangements, but will not be required to seek formal approval from the Ministry of Environment.

Based on the above mentioned documents, the MoE have drafted flowcharts showing the EIA procedure to be applied. For the present project, with MIME being the Project owner, the applied process is shown in Figure 1-2.
Figure 1-2 – Applied EA Process

**Determination of Project EIA Requirements**

- Determination of Scope and Size of Proposed Project
  - < 2000 connections: Include EA in Batch Summary Report

**EIA Process for Proposed Project Approved by Project’s Owner as Ministry and Institution**

- PO Submits EIA & IEIA Report to MoE
- PO Revises IEIA report or Prepare EIA report
- MoE Reviews IEIA Report
- IEIA Report needs Revision
- IEIA Report required
- IEIA Report Consent

- PO Submits IEIA report or Prepare EIA report
- PO Revises to IA CDC & Submits Revised IEIA or EIA Report to MoE
- MoE Reviews Revised IEIA or EIA Report
- IEIA or EIA Report Consent
- IEIA Report needs Revision

- PO Submits EIA Report
- PO Revises EIA Report
- PO Approval

- PO Implements ‘and Monitors’ Project & EMP

**ABBREVIATIONS**

- PO: Project Owner
- MoE: Ministry of Environment
- EMP: Environmental Management Plan
- IEIA: Initial Environmental Impact Assessment
- EIA: Environmental Impact Assessment
- NOL: Non-Objecting Letter from World Bank

Main text 1-4 February 2003
2 PURPOSE OF THE PROJECT

2.1 Objectives

The objective of the project is to supply safe drinking water through a piped water supply system to the town of Prek Changkran, Prey Veng Province. The project is anchored on the principals that:

- Water can be managed as an economic good;
- The project must be "demand-driven" oriented meaning, that the prospective end users must be willing and capable to pay for services (see section 5.3);
- The system will be operated and managed by a private operator (see section 3.4).

The project design is consistent with the water supply and sanitation policy framework of Cambodia, and finance investments that (i) respond to what consumers want and are willing to pay, (ii) facilitate and develop private sector participation in financing, operating and maintaining constructed facilities, and (iii) ensure inclusion of low income communities residing in the service areas.

2.2 Public participation

Public participation and consultations of the PPUWSSP focused on the three main objectives mentioned above. Strategies were developed that would promote these principles during the conduct of the Rapid Feasibility Study. Among these strategies are the series of presentation and consultation activities with the different stakeholders at the local level. The areas for consultation and negotiations were focused on the following:

- Technical options for the water supply system, including environmental and social implications, the project investment cost, and the required equity contribution;
- Cost recovery options and water tariff structure;
- Operation and management scheme for the system; and
- Project implementation arrangement (Design/Build/Lease) of the water utility.

There were two levels of consultations during the feasibility study. The first level was with the local governments (see section 5.1). The second level of consultation focused on for the prospective users in the service areas (see section 5.2).

To proceed to full preliminary design for Prek Changkran, at least 51% of the heads of households living within the proposed service area for Province should have indicated their support for the new scheme during the Willingness-to-Connect Survey (see section 5.3).
3 PROJECT DESCRIPTION

3.1 Service area

The proposed service area or the project is shown in Figure 3-1. Scheme includes the originally-intended commune of Prek Changkran and also the adjacent commune of Lvea. The two communes comprise a ribbon development some 10.5 km long and one property deep, following a narrow ‘spine’ road along the southern ‘escarpment’ of the Tonle Touch River, which forms a levee bank at this location. The levee is some 5 meters higher than the adjacent country. There is no tightly-defined town center, but market, commercial, minor industrial and institutional development is interspersed with linear housing along the escarpment. There are few minor roads intersecting with the ‘spine’ road.

Service area contains 1313 households. Number confirmed by direct count. Because the levee bank is fully occupied with existing properties to its full length and width, there is no room for expansion without filling adjacent land to a depth of 5 meters – which is considered impracticable on cost grounds, in normal circumstances. Therefore for this town, the annual growth factor of demand has been reduced to 0.5% to allow for some increase in the size of existing families.

3.2 Summary of Infrastructure

The proposed infrastructure to be constructed for the project is summarized in Table 3-1. The listing is based on the feasibility study, as prepared by GHD/FT. Figure 3-1 shows the layout of the proposed infrastructure.

Table 3-1 – Summary of proposed infrastructural works

- Groundwater abstraction via deep bores.
- The establishment of a treatment plant on the land identified by the Commune.
- Treatment comprising aeration, slow sand filters and disinfection.
- Pumping from a Clearwater tank through a booster pump into the system.
- Distribution network along the main roads.
- A single metered connection provided to each house, where it is assumed that household “water jar” storage will continue to be used.
Figure 3-1 – Proposed service area and infrastructure (DRAFT)
3.3 Water quality standards

There are currently no official drinking water quality standards in Cambodia. In general, the World Health Organization (WHO) guidelines are being applied. Official standards are however under preparation by MIME and WHO, to be submitted to the Coordinating Committee for Development of Water Supply and Sanitation Sector for discussion and subsequent formal processing.

The proposed water quality standards are included in Annex IV, and will be applied for the proposed water supply system. The recommendations are especially important for the Arsenic level. As it seems that the WHO guideline of 10µg/l is unrealistic to apply currently, a (temporary) value of 50µg/l has been proposed for Cambodia. This value has also been applied for the current project.

3.4 Project planning and implementation

Prek Changkran is part of a first batch of the PPUWSSP, to be implemented under World Bank financing, through the joint effort of MIME, the PPWSA, and Ministry of Finance (MoF). MIME has the implementation responsibility for the provincial town program. A Project Management Office (PMO) has been established by the MIME in Phnom Penh for directing, supervising and coordinating all day-to-day implementation activities. The Provincial Government of Prey Veng has established a Project Management Unit (PMU) for actual implementation of the water system (see Annex I).

The adopted strategy for implementing the water supply systems in the towns is to bid a Design/Build/Lease (DBL) scheme to private operators. Under the DBL scheme, MIME will enter into a contract with a private operator who will be responsible for the design, construction and operation of a cluster of systems. The lease contract is expected to cover a period of fifteen (15) years and will establish the conditions and provisions under which the operator must operate and maintain the water system. After the 15 years contract period, the private operator should turn over the water system in operating conditions to MIME or may enter into a new agreement with MIME to renew the lease contract for a similar period of time.

The project is expected to commence in the middle of 2003 with the bidding for the DBL contract. Total project implementation is expected to cover a period of 18 months. The confirmation of the water sources recommended in the feasibility study, particularly the drilling and construction of exploratory/production well, is considered a critical activity. In fact only when capacity and quality of the water sources are confirmed and detailed design can be prepared including any necessary revision in the scheme outlines in the feasibility study.
4 DESCRIPTION OF ENVIRONMENTAL RESOURCES

4.1 Physical resources

Topography
In geographic terms Prek Changkran is situated in northern Prey Veng, 17 kilometers northwest from Prey Veng provincial town, and 123 km by road from Phnom Penh. The town is located on the south side of the Tonle Touch River, along an ‘escarpment’ which forms a sort of levee bank. The escarpment is some 5 meters higher than the adjacent country and is broadly continuous, being broken at intervals by side channels which drain the rice fields behind.

The escarpment and the town development follow a contour around 13 meters above the dry-season level of the river and undulate with the surrounding ground. The town has a developed area of some 60 hectares consisting of the ribbon development of mainly residential properties, described above.

The most noticeable topographical features of the town area are the seasonal rivers that cut through the escarpment and drain the rice fields behind to the Tonle Touch River. These secondary rivers are bridged to carry the escarpment road, resulting in eleven bridges that will have to be modified to carry the main water pipe for the proposed system (or separate pipe bridges will be needed). Some of the bridges over the side channels have been washed away in the past.

Road access is difficult even in the dry season and follows the river escarpment, sometimes on the north bank and sometime on the south – with the need to descend to the bed of the river and cross the remnant flow by ferry or temporary bamboo bridges. In the wet season access is restricted to boat along the Mekong and Tonle Touch rivers from Kampong Cham. At the peak of the wet season the town along the escarpment floods to a depth of several meters restricting movement within the town.

Geology
Cambodia can be divided by ‘geological provinces’, as shown in Figure 4-1 (ESCAP, 1993). Preaek Changkran is located in the Central portion of the Tongle Sap-Mekong plains, east of Phnom Penh. This area, including the great Lake Basin of Tongle Sap and the central valley of Cambodia, were formed by the slight subsidence of the broad central area along northwest-southeast axes in the Quaternary, leading to broad areas of a Mid- to Late-Quaternary cover with a thin to moderate thickness.

Quaternary deposits are widespread in Cambodia, especially in the broad central plains of the Mekong and Tongle Sap River systems and across the northern uplands, generally occupying levels from 0 to 40m above sea-level. The Quaternary occupies ‘grabens’ and depressions in the broad area, build up of intercalations of continental and marine rocks revealing a history of periods of transgression and regression of the sea.
In general the following Quaternary units are distinguished:

- The Holocene (Q₄) sediment cover is represented on the coastal and interior plains, and in small upland valleys, by recent deposits of fluvial, lacustrine (lakes), and shallow-sea origin.

- The Middle-Upper Quaternary (Q₂₋₃) a principal sedimentary aquifer, is widespread in the north, southeastern and northwestern sectors of Cambodia, where it is known as the Battambang formation. On the Mekong Plain the upper Quaternary (Q₃) is recognized as the Mochoa formation, occupying the 10-15m terraces in the areas southeast of Phnom Penh. It is composed of grits, sands and clays outcropping on higher relief levels on the outer parts of the central plains.

- Quaternary plateau basalts (QB) of Middle-Upper Pleistocene age and Neogene-Quaternary platform basaltic rocks

- The Lower Quaternary (Q₁) consists of sands, silts and clay-stones of both fluvial and marine origin. It is here combined with the Pleistocene deposits (unit N₂-Q). The Middle Quaternary (Q₂) of the plains comprises red sandy sediments occupying terraces above 15 metres.

The whole of the Tertiary is represented by Pliocene sedimentation. The Neogene-Early Pleistocene (N₂-Q) is seen in large basins in eastern Cambodia. These are represented
by the Bamieu formation, comprising of clay-stones and siltstones usually laid upon well-developed conglomerate horizons. Large volumes of this material fill the broad lowland grabens of the Mekong valley and the Tongle Sap Region, overlain by younger alluvial materials. The deposits of this age are often referred to as the “alluvions anciens”, the “older alluvium”. These sediments generally form terrains and plains in the levels 25-150m above sea level. The upper levels are strongly laterized and this has been used as building materials (for example at Angkor Wat).

Mesozoic and Paleozone sedimentary units and intrusive rocks are generally referred to basement rocks.

**Climate**

The climatic conditions for Prek Changkran are monsoonal. Table 4-1 shows the main climatic parameters recorded in Cambodia.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Wet Season</th>
<th>Dry Season</th>
</tr>
</thead>
<tbody>
<tr>
<td>Months</td>
<td>May - November</td>
<td>December - April</td>
</tr>
<tr>
<td>Wind Direction</td>
<td>Southwest</td>
<td>Northeast</td>
</tr>
<tr>
<td>Cool Months</td>
<td>November</td>
<td>December - February</td>
</tr>
<tr>
<td>Hot Months</td>
<td>May</td>
<td>March - April</td>
</tr>
<tr>
<td>Cambodian Average Rainfall</td>
<td>1300 to 3600 mm per annum</td>
<td>1300 mm per annum</td>
</tr>
<tr>
<td>Phnom Penh Average Rainfall</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean Rainfall</td>
<td>200 mm per month</td>
<td>3 - 15 mm per month</td>
</tr>
<tr>
<td>Evaporation</td>
<td>69 - 105 mm per month</td>
<td>170 mm per month</td>
</tr>
<tr>
<td>Average Temperatures</td>
<td>30 Degree Celsius</td>
<td>April 35 Deg C peak</td>
</tr>
<tr>
<td>Humidity</td>
<td>Sept-Oct 85% average</td>
<td>Jan-April 75% average</td>
</tr>
</tbody>
</table>

Source: GHD/FT, 2002

**Surface Water**

The Tonle Touch River is a substantial natural feature that carries immense flows during the wet season. However during the dry season it dries quickly to a series of shallow interconnected ponds. At the time of the field surveillance of the town the river levels were low and flow was sluggish and shallow at best. The indications, confirmed by the local communities, are that the river cannot be relied upon to provide the secure source required for the new town supply. Abstraction from the river occurs during the wet season, but otherwise wells and deep boreholes presently represent the prime sources of potable water.

**Hydrogeology**

Preaek Chankran is located in the center of the Mekong Basin, a large alluvial area with in general a high groundwater potential. The principal aquifers are the Pliocene/Pleistocene sediments, and to a lesser extent the fissure zone or weathered zone of the basement rocks. The Pliocene/Pleistocene sediments are overlying the basement rocks. The depth of the basement is estimated at a depth more than 150m.

Recharge of the Quaternary aquifers takes place from rainfall and river water infiltration (during the high river levels during July-December). Reported yields (JICA, 1999) from the Pliocene/Pleistocene sedimentary deposits in the 'Mekong groundwater basin', are
high with values of up to 1000 m3/day (> 40 m3/hr), which indicated the good groundwater potential of the area.

Generally reported water quality concerns in Cambodia are higher Iron, Manganese and Arsenic concentrations, all occurring naturally. The highest values are generally reported along the Mekong and Tongle Sap rivers. Also, the quality of the groundwater in the deeper aquifers was not better then in the more shallow aquifers.

Water testing results for four wells indicate that the ground water in the area targeted, to the west of the Commune office, has a low iron level and no detectable arsenic. All other parameters are acceptable. Aeration and disinfection is considered a sufficient treatment.

4.2 Ecological resources

Preaek Changkran is located in a flat agricultural area, mainly used for cultivating rice. The area has no other specific ecological resources and/or protected nature areas in the surroundings.

4.3 Socio-economical resources

Population
A count of houses and institutions was conducted within the identified service areas during the rapid appraisal phase and again confirmed in later town visits and surveys. Major discrepancies in the information provided by commune officials were identified requiring reconciliation with the circumstances identified in the individual towns. All information and statistics on population and household size were rigorously reviewed due to the impact of these on the design and sizing of the scheme. The population to benefit from a reticulated water supply system was derived from the discussions with the communes and their expression of the area they would wish to see reticulated. This was followed by a review of the town development, population densities and the extent to which a viable system could be sustained on technical and operating grounds.

The total population of the service area for Preaek Changkran was estimated by GHD/FT at 6,893 (1,313 houses). The count of commercial establishments and institutions is 4 and 13, respectively.

Population forecasts in Cambodia are hampered by an absence of reliable data and information on population trends. The population forecasts from the 1998 national census indicate an average annual population increase for Cambodia of 2.5 percent. This latter figure has been used for the current project.

Standard of living and Income
In Cambodia, a number of the population live in well-built houses (up to 60% in some towns), although the majority, 62% overall, live in poor quality or makeshift homes. The immediate environment of the homes differs sharply between those located in the core of each town, usually along the main roads, and those on the periphery or in nearby satellite villages, which remain largely rural in character. While development is occurring in the central core of the towns, with new commercial buildings and houses now evident,
the immediate surroundings are often squalid, with prominent deposits of solid waste blocked, stagnant drains. In contrast, the areas around many homes outside the core areas are decidedly well kept, even in the case of some of the poorest quality houses.

With regard to the economic status of the beneficiary group, the survey indicates high levels of poverty, with average incomes equating to some USD 0.54 per person per day (as low as USD 0.48 in Svay Rieng).

As a comparative indicator for the living conditions in Preaek Changkran (GHD/FT, 2002), the town has electricity supply from 6am to 10pm, supplying an estimated 90% of the households. Furthermore it is estimated that around 73% of the households own a TV. (GHD/FT).

Public Health
Reviews of the health sector in Cambodia show that life expectancy and infant mortality, both principal indicators of the state of health of the population, have declined in recent years. However, they remain high by international and regional standards, with some 56 years life expectancy and 89 infant deaths per 1000 live births. Health issues that feature prominently in the project towns include parasite infestations, nutritional deficiencies, sexually transmitted diseases and waterborne diseases (e.g. diarrhea).

Diarrhea is a continuous nuisance among the population, but it also impacts economic activity and is a life threatening hazard, especially for babies and children. The socio-economic survey carried out for this project found that at least 5 percent of households had suffered cases of diarrhea among its members within the previous two weeks. In the worst cases, up to 12 percent of households had suffered diarrhea among its adult members during this period. While the source of infection of diarrhea diseases vary, most can be attributed to polluted water supplies inadequate supplies for drinking, food preparation and hygiene and inadequate sanitation.

Water Supply
There is no piped water supply system in the town yet. People collect rain water during the wet season, and take water from shallow wells during the dry season.

Sanitation
With regard to sanitation in general in Cambodia, many people (at least 49%) use field or bush around their homes for defecation. This arrangement is often considered more or less satisfactory, though many town dwellers (40 %) have latrines and of those that do not, the majority (57%) would like to install one and meet the cost of doing this, suggesting a high level of awareness of sanitation issues and their role in improved living conditions.

In Preaek Changkran, it is estimated that the use of the field, latrines and other facilities is 71.7%, 8.1%, and 20.2%, respectively (FHD/FT, 2002).
5 PUBLIC PARTICIPATION

5.1 General

To ensure that the proposed water supply and sanitation investments lead to sustainable services in the long run interaction between the main stakeholders have been emphasized during project preparation (i.e. DPWS/MIME, the Provincial Governments, District and Commune-level institutions, and the main direct beneficiaries of the project). Creating ownership and responsibility at the various levels is the final objective of the participative process.

During initial meetings with District Governors and Prek Changkran Commune Chiefs a measure of the communities' interest in receiving a piped water supply and to participate in a sanitation program was acquired.

Subsequently, GHD/FT gathered through household questionnaires basic demographic and socio-economic information, information on existing water supply and sanitation costs and arrangements, and basic hopes and aspirations for future improvements in these two services. The survey team took care to ensure that sampling was done evenly through each Commune, gaining a sample that was representative in terms of different income groups and that included any minority groups in each Commune.

Formal discussions also occurred with the Prey Veng Provincial, Sithor Kandal District and Prek Changkran Commune administrations to familiarize the team with the areas and communities and to build up confidence of the administrations and residents in the team members. From these discussions, it became clear that the Commune Chiefs, their committees and the communities want, and would demand, information on a number of issues, primarily:

1. Cost (tariff and connection cost)
2. Scheduling and likely implementation
3. Providers (information about the possible companies, namely the owners)
4. Protection of consumers
5. Roles of Government and authorities

5.2 Consultations with the Prospective Users

The participation of end users (the community) in the design and operation of water supply and sanitation systems is, along with engineering, resource and environmental considerations, key to the sustainability of the services to be established in Prek Changkran. Effective participation ensures that, to the extent practicable, the services provided will be acceptable to the users, appropriate to their conditions, and affordable to them. In order for participation to be effective, representative views from members of different age groups, gender, income categories, religious and minority groups need to be heard and understood.

The project comes at a time when fundamental steps have been taken by the Royal Government of Cambodia to put community representation structures into place, and to develop participatory methods for development at Commune and village level in the
country, but also at a time when processes for developing such structures are still at an early stage. The communication and information strategy for the PPUWSSP has worked with the structures that have been, or are being set up, so as to help strengthen them and avoid the conflicts and confusion that would arise from establishing new structures or processes. The communication and information strategy has also been arranged to ensure regular and feedback to the Commune Councils, the village representatives and their communities.

Specific issues which were seen to require elaboration and answers at the Willingness to Connect stage included:

1. Connection cost and repayment scheme
2. How will the operator be controlled and who will be responsible?
3. If a breakdown occurs who will be responsible for the cost, especially for water meters?
4. Where would the water meter be located for households (and what distance would the free connection be)?
5. How long will it take to implement the project if it goes ahead?

5.3 Willingness-to Connect (WTC)

Process

The WTC area meetings are instruments for the dissemination of key information on the proposed water supply and sanitation improvements, by means of facilitated presentation and discussion, hand-out leaflets and, information sheets and follow-up discussion. The team has prepared a simple text for information brochures designed to introduce the purpose of the project, (with reference to Government policy on water and sanitation), the basic principles behind the private sector involvement, and an outline of what is planned in terms of further project preparation and the construction of facilities. These documents are contained in the Volume of Appendices.

The strategy has therefore focused on a communication process reinforcing the beneficiaries (Commune, village and households) understanding of the project, its rules and thereby increasing ownership. The process has also highlighted the benefits of safe and reliable water supply and sanitation and the means of achieving sustainable and affordable town water supply systems. This underpins the foundations of the WTC process and has worked to establish an environment for a knowledgeable response from the community.
The communications strategy involved the following initiatives in the period leading up to, and during the WTC activities:

- **Information**: Meetings organized with the Commune Chief and Commune Council to reaffirm their understanding of the project rules and the process of project preparation and implementation, especially for the newly-elected Commune Chiefs and Commune Councils.

- **Dissemination**: After the above consultation meetings, the organization of a meeting at village level with the village chief and representatives of the village development committee, where these existed, with the participation of the Commune Chief, Commune Council and MIME / Consultants for preliminary discussion about the project rules, proposed options and service.

- **Decision**: Thereafter a series of focused group discussions with beneficiaries (communities) on the selected options by MIME and Council to discuss the Willingness-To-Connect (WTC). These meetings were arranged with the Commune and Village representatives to determine the most suitable time, venue and structure to ensure strong attendance and participation. With the assistance of the Commune and Village representatives the WTC forms were distributed to the proposed beneficiaries after the meeting, and a date was agreed with the beneficiaries for the return of the “signed WTC agreement forms” to the Commune Chief / MIME, and verification by the Commune Chief.

**Results of the WTC**
The Willingness to Connect (WTC) indicated that 70% of the 1313 households within the proposed service area for Prek Changkran approved a tariff of 1995 Riel/m³.

**Indigenous People**
The project is committed and has the organizational instruments to ensure that Indigenous People (IP) are (i) consulted in matter relating to the project, (ii) provided opportunities for participation in decision making related to the project, and (iii) provided opportunities for participation in project activities.

The project design recognizes that ‘meaningful’ participation by poor and disadvantaged sections of society requires special focus that goes beyond routine project implementation management. In this context, a parallel set of activities has been launched, designed to be self-sustained beyond the project cycle. The key activities aim at empowering beneficiary populations to exercise voice and choice. Specifically, they include: (a) formation of Clean Water Groups or CWGs, by which local residents acquire voice in the construction and operational phases of the water supply infrastructure, and (b) provision of technical assistance to institutionalize CWGs as stakeholder oversight groups to address water and sanitation access concerns, and (c) in the form of hygiene education and support for construction of household toilets.
6 ENVIRONMENTAL IMPACT ANALYSIS

6.1 Methodology

General environmental checklists were used as the basis for developing the project checklist that would suit the assessment intended for the proposed waterworks supply project. Project impacts are classified into the three stages: 1) Pre-construction; 2) Construction, and 3) Operation.

A rapid comparison of the "no project" and "with project" scenarios have been carried out in the form of a Summary Matrix of Environmental Issues/Impacts (Table 6-1). This analysis briefly presents the main environmental issues and possible positive and negative impacts. Impacts are classified as being significant negative environmental impact (---), moderate negative environmental impact (--), none or insignificant environmental impact (o) and beneficial environmental impact (+).

<table>
<thead>
<tr>
<th>Phase</th>
<th>Environmental Parameter</th>
<th>'No Project'</th>
<th>'With Project'</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Construction</td>
<td>Reliability of water availability</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Reliability of water quality</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Land acquisition and resettlement</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td></td>
<td>Disturbance of land use and economic activities.</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Construction</td>
<td>Disturbance of the land use</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td></td>
<td>Loss of natural vegetation</td>
<td>O</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Disturbance of stream channels, aquatic plant and animal</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td></td>
<td>habitats</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td></td>
<td>Soil and water contamination</td>
<td>O</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Hindrance (noise, air pollution, traffic, etc) due to</td>
<td>O</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>construction activities</td>
<td>O</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Soil erosion and compaction</td>
<td>O</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Employment</td>
<td>O</td>
<td>+</td>
</tr>
<tr>
<td>Operation</td>
<td>Public Health</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Contamination of stream channels</td>
<td>O</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Water logging and salinization</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td></td>
<td>Soil erosion</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td></td>
<td>Increase Land Value</td>
<td>O</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Enhance Economic Activity</td>
<td>O</td>
<td>+</td>
</tr>
</tbody>
</table>

Legend:
--- Significant negative environmental impact
-- Moderate negative environmental impact
O None or insignificant environmental impact
+ Beneficial environmental impact

Overall, the project will have a positive impact for the population of Prek Changkran. Reliability and quality of water supplies will significantly improve. Possible negative environmental impacts can be mitigated properly, as elaborated in the sections below.
6.2 Pre-Construction Considerations

Water source selection
Selection of the water source has been done on the basis of security of supply and possibilities for protection of the source. Firstly, the water source should be sufficient to provide enough water during the dry season, and during dryer years. Accordingly, smaller creeks and ponds were considered not acceptable. Moreover, a water source, for which the Local Government may not be able to provide proper protection against pollution, has been rejected for the present water supply system.

Of the options considered for Prek Changkran the only viable water resource is groundwater abstraction. The recommended location is for a small array of three bores to be located along the river escarpment east of the site identified for the treatment plant. The bores will be located clear from development and should not impact on existing bores and supplies.

Land acquisition
Land acquisition will be minimal. The scheme is based on the treatment plant being located in the Commune-owned land identified as being available west of the Commune Office, across a seasonal river which forms drainage outlet from the rice fields behind the town. This has been adopted not only because it is readily available but also it is immediately adjacent to the best source of water as identified below. It is also reasonably central to the extremities of the town.

The land for the proposed wells and pumping stations should be purchased (or made available by the Commune) with official documentation as soon as the locations of wells are confirmed by the private operator. The treatment plant will be established on the land identified by the Commune, behind the existing Commune office.

It is anticipated that 1,650 m2 of land will be required. The acquisition of land will be facilitated by MIME as part of their responsibility to the project. If possible, the PMU representative will facilitate the issuance of “Deed of Donation” or statements on the willingness to sell prior to the construction to avoid any conflict with the lot owner.

The laying of distribution pipes will mainly be located in public property along the roads. Only minor parts of the distribution system will have to be excavated into private property. During the public consultations, the local residents expressed their cooperation to allow the laying of the pipes in their property as “right of way”.

Involuntary resettlement
No resettlement will be required. The project will not negatively affect any indigenous people.

6.3 Environmental impacts during project construction

General
Negative environmental impacts due to the construction of the proposed water works system are limited. Impacts will be mainly on the terrestrial (land), air environment and on affected persons due to noise and possibly relocation. The impacts could be
temporary or permanent, significant or not significant depending on the nature and existing quality of sensitive receptors.

Major activities for the construction will be site-clearing, excavations, pipe-laying, and material hauling. Potential environmental impacts observed in similar construction activities include interference with existing utilities, damage to properties (e.g. displacements, cracks, etc.), and conflicts with existing transportation infrastructure. All damages can be mitigated by applying proper professional construction methods and supervision of compliance with international standards.

Common other impacts from construction activities like dust, noise, limited erosion, and traffic effects can not be fully mitigated, but can be kept within acceptable limits by applying professional standards and construction methods.

The construction of the water supply is not expected to have significant impacts on drainage characteristics of the region. However, it will be important to avoid local flooding or the blocking any natural drainage channel during construction. If applicable, appropriate temporary drainage infrastructure will have to be constructed.

Site specific impacts
Located in the Mekong delta, a flat area with limited natural drainage, the increase of wastewater flows may create stagnant water in the residential areas. During the wet season, the areas is flushed by the large amount of rain, possibly even flooding.

MIME is aware of the possible risks of higher Arsenic concentrations in wells to be drilled in the Mekong Delta. The risk however is considered acceptable as appropriate mitigation measures are incorporated into the project design and preparation process if higher concentrations are encountered in the drillings.

It should be noted that the 'Arsenic problem' generally applies to private shallow wells, where people have no choice in selection the location of the well, and have no resources to provide proper treatment. The PPUWSSP will develop piped water supply systems, where the both the source and the treatment can relatively easily be adjusted according to the local conditions.

To deal with possible higher (or uncertain) concentrations of Arsenic in groundwater, the project will apply the following mitigation measures:
- Selection of the most suitable well locations, based on the findings of a groundwater investigation conducted during the feasibility study (geophysical survey, water quality sampling program);
- Anticipation of water treatment facilities (aeration) in project locations where higher Arsenic concentration could be expected.
- Extensive water quality testing of all new wells, as included in the DBL contract.
- Allocation of a special budget for possible new well or additional water treatment facilities after water testing of the actual completed wells.

Economic impacts
The construction of the system may have some negative impacts on the income of selected people. Agricultural activities are disturbed, and some damage to the soil can be expected due to the construction activities and the increased traffic.
Compensation to affected persons will be applied according to general project rules (using market values) as set out in the Operations Manual, prepared in accordance with standards and regulations of the Government of Cambodia.

Please note that positive economic impacts are expected during construction. A local workforce will be employed by the DBL Operator during construction, estimated at approximately 450 man-months (unskilled labor) until completion of the project.

6.4 Environmental impact during project operation

As the proposed project will improve the existing water supply and sanitary conditions in the town, considerable benefits will be achieved for improving public health situation during the operation of the project. The installation of water meters and appropriate pricing of water will reduce leakage and thus result in water conservation.

It is acknowledged that the construction and improvement of the water supply conditions will increase the amount of toilet waste and wastewater. Especially a possible change from pour flush to flush type toilets and the direct disposal of the effluent of septic tanks into the surface water or drainage system are concerns.

As Prasat is located in the Mekong Delta with a high groundwater table, additional attention will be given to problems related to onsite sanitation. As the regular septic tanks are not working properly in these areas, the option of introducing alternative technologies and/or communal facilities (public toilets) will be discussed and investigated during the project.

The main environmental risk regarding (temporary) disruption of the water supply service (e.g. through mal-performance of the operator) is that currently used water sources may not be available anymore to fall back to. It is therefore necessary to continue protecting the traditional ponds and water sources from pollution and depletion.

There are no environmental harmful materials to be disposed of in case of a failure of the project.

6.5 Summary of significant environmental impact

Depending on the implementation and precautions taken by the contractor, the construction activities may have various adverse environmental impacts. Although most of them are temporary, they should be mitigated in the best possible manner.

In summary, the most significant adverse environmental impacts are:
- Damage to soil and natural habitat (temporary);
- Contamination of soil and water (temporary);
- Hindrance to local population, e.g. noise, air pollution, and traffic (temporary);
- Increase of wastewater flow (continuous), with possible problems with onsite sanitation facilities.
A higher concentration of Arsenic is a potential risk for all water supply systems. Extensive water quality testing will be carried out for the water source during development and operation. If necessary, new water sources will be developed.
7  ECONOMICAL ANALYSIS AND ENVIRONMENTAL VALUE

7.1  General

The project is considered economically feasible and sustainable. The water supply system will operate on a commercial basis, and all operating and maintenance costs are in principle paid through the water fee. By securing a reliable water source, sufficient pressure in the network, a minimum number of connections during the preparation stage, and by creating sufficient incentives and obligations for the operator to provide good services, it is not foreseen that the water supply will be disrupted once initiated.

7.2  Financial Data

The following summarizes the principal financial data, as prepared in the feasibility study by GHD/FT.

**Capital Cost**

*Construction* cost of USD 387,439. Total Project Capital Cost after contingencies etc. of USD 493,360

**Tariff and Financial Returns**

The financial model indicates the following tariffs for the different levels of capital recovery and the required return to the investor at Prek Changkran / Lvea.

<table>
<thead>
<tr>
<th>FIRR to Operator</th>
<th>MIME Capital Recovery</th>
<th>TARIFF S Riel / m³</th>
<th>Net Present Value - USD</th>
</tr>
</thead>
<tbody>
<tr>
<td>20% 90%</td>
<td>2265</td>
<td>$300,708</td>
<td></td>
</tr>
<tr>
<td>20% 50%</td>
<td>1995</td>
<td>$354,671</td>
<td></td>
</tr>
<tr>
<td>20% 0%</td>
<td>1655</td>
<td>-$15,035</td>
<td></td>
</tr>
<tr>
<td>0% 100%</td>
<td>2195</td>
<td>--</td>
<td></td>
</tr>
</tbody>
</table>

For each chosen tariff level the financial model will indicate the FIRR on the total investment, and on the operator's investment, for each ten percent decrease in the recovery of the Government's investment.

**Sensitivity Analysis**

The sensitivity analysis shows the impact on the investor's return for any reduction in sales (revenue) for a 10, 15, and 20 percent reduction. The sensitivity analysis has adopted the option with a 90% Capital recovery by MIME (RGC).
Reduction in demand (revenue) | Reduction in households connected | Residual households | Return to Investor
---|---|---|---
10% reduction | 131 houses | 1182 houses | 13.7%
15% reduction | 197 houses | 1116 houses | 8.3%
20% reduction | 263 houses | 1050 houses | negative

As a separate sensitivity analysis, the capital cost was increased by 5%, leading to an increase in the required tariff by 60 Riel per cubic meter.
8 ENVIRONMENTAL MANAGEMENT PLAN

8.1 Introduction

Based on the findings of the environmental assessment and the discussions held with the concerned local residents, the Local and National Governments, an Environmental Management Plan has been drafted, including an Environmental Mitigation Plan (EMiP) and an Environmental Monitoring Plan (EMoP).

By submitting the present IEIA, the Ministry of Industry, Mines and Energy certifies that to their knowledge all the information in the enclosed IEIA for Prek Changkran (M21) is true, accurate, and complete (see Annex V), and is committed to its proper implementation (see section 9.1).

8.2 Environmental Mitigation Plan

Table 8-1 summarizes the main environmental concerns, the necessary actions and mitigation measures to protect the environment, and the responsibilities of the different parties.

8.3 Environmental Monitoring Plan

In Table 8-2 the required Environmental Monitoring Plan is presented. It is considered necessary that selected data will be collected on a regular basis for the proper implementation and monitoring of environmental mitigation measures, as described in Table 8-1.
### Table 8-1 - Environmental Mitigation Plan

<table>
<thead>
<tr>
<th>Phase</th>
<th>Mitigation measures</th>
<th>Responsibility</th>
<th>Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-construction</td>
<td>Lack of control of water source: Acquire land directly around the facilities (or secure a possible purchase); Reduction in flow: Locate the well in an area where other water users are not affected. Disturbance of land use and economic activities: Usage of public areas; Provision for proper compensation. Risk of Arsenic in groundwater: design of proper treatment facility.</td>
<td>MIME, World Bank Contracts</td>
<td>Prior to DBL</td>
</tr>
<tr>
<td>Construction</td>
<td>Disturbance of land use due to drilling/construction: Minimize impacts, Restore damages. Loss of natural vegetation: Replanting of affected areas. Disturbance of stream channels, aquatic plant and animal habitats: Erosion and sedimentation control. Soil and water contamination (e.g. spilling of oil products and other construction materials): Control (collection, disposal) of waste water. Hindrance (noise, air pollution, traffic, etc) due to drilling/construction activities: Minimize hindrance; Usage of main roads when possible. Soil erosion and compaction: Proper runoff and erosion control measures; Heavy traffic restrictions. Safety hazards: Proper safety and warning measures; Provision of temporary crossings/bridges; Public information campaign.</td>
<td>Operator, with supervision of MIME consultant</td>
<td>Continuous during construction phase.</td>
</tr>
<tr>
<td>Operation</td>
<td>Public health hazards due to increase of wastewater: Support the construction of proper on-site sanitary facilities (if lacking); Improve storm drainage system for sullage; Contamination of the groundwater: Acquire and fence a protection zone directly around the well; Regulate potential polluting activities in recharge zone; Monitor water level and groundwater abstraction. Lowered groundwater table: Space wells at larger distances; Avoid over-abstraction and consequent lowering of groundwater table; Calculate safe yield (abstraction); Assure/proof that other water users are not affected. Increase of noise: Usage of electrical submersible pumps; Construction of pumping house. Water availability: keep traditional water sources available.</td>
<td>Operator, with supervision of MIME</td>
<td>To be determined during feasibility study.</td>
</tr>
<tr>
<td>Phase</td>
<td>Monitoring activities</td>
<td>Responsibility</td>
<td>Implementation</td>
</tr>
<tr>
<td>------------</td>
<td>----------------------------------------------------------------------------------------</td>
<td>-------------------------</td>
<td>--------------------------------------------</td>
</tr>
<tr>
<td>Pre-</td>
<td>Land acquisition: Check if the required land has been acquired properly, or that a proper &quot;Deed of Sale/Donation&quot; has been prepared.</td>
<td>MIME, World Bank</td>
<td>Prior to DBL Contract</td>
</tr>
<tr>
<td>construction</td>
<td>Resettlement and Compensation: If applicable, check if proper arrangements are made and documented.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction</td>
<td>Hindrance to local population: Noise, air pollution (odor, TSP, fume emissions), land damage, traffic.</td>
<td>Operator, with supervision of MIME consultant</td>
<td>Continuous, through regular construction supervision.</td>
</tr>
<tr>
<td></td>
<td>EMP compliance of the contractors: Erosion control, vegetation protection, soil and water contamination.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Safety precautions of contractors: Conform professional standards.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sanitary control: Proper construction of on-site facilities; Proper construction of sullage drainage system.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operation</td>
<td>Quality of distributed water: conform official standard procedures (microbiology, standard parameters, Arsenic, heavy metals);</td>
<td>Operator, with supervision of MIME</td>
<td>Regular, according to professional standards.</td>
</tr>
<tr>
<td></td>
<td>Groundwater resources: water level (2 X per month (after pumping recovery period); operation of pumps (abstraction).</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
9 INSTITUTIONAL RESPONSABILITIES AND CAPACITY

9.1 Project Implementation

The responsibilities for implementation and monitoring of the Environmental Safeguard Framework (ESF) are summarized in Table 9-1. The Ministry of Industry, Mines and Energy has the overall responsibility for the proper implementation of the Environmental Safeguard Framework (ESF), i.e. project implementation and compliance monitoring. The actual project management will be the responsibility of the Project Management Office (PMO) in Phnom Penh. Consultants will be engaged to provide assistance during project preparation, and for supervising design and construction of the systems.

The daily supervision of the construction and operation of the MIME sub-projects will be carried out by the Provincial Project Management Units (PMU). PMU staff will report to the PMO.

Table 9-1 –Responsibilities for ESF Implementation and Compliance Monitoring

<table>
<thead>
<tr>
<th>Agency</th>
<th>Principal project linkages</th>
<th>Compliance Monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIME/PPWSA PMOs</td>
<td>Main linkage to MoE and WB-EASUR</td>
<td>Implements compliance monitoring agreements.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Prepares compliance monitoring reports for MoE and WB.</td>
</tr>
<tr>
<td>Provincial PMUs</td>
<td>Report to MIME PMO.</td>
<td></td>
</tr>
<tr>
<td>Ministry of Environment (MoE)</td>
<td></td>
<td>Implements compliance monitoring procedures: e.g. review of compliance monitoring reports and field inspections.</td>
</tr>
<tr>
<td>WB Operations Department (EASUR)</td>
<td>Provides ‘No-Objection Letters’ to MIME/PPWSA for sub-project implementation, after clearance from EASES</td>
<td>Implements compliance monitoring procedures: e.g. review of compliance monitoring reports and field inspections.</td>
</tr>
<tr>
<td>WB Environmental Department (EASES)</td>
<td>Provides Environmental Clearances for (sub)-projects to EASUR</td>
<td>Implements compliance monitoring procedures: e.g. review of compliance monitoring reports and field inspections.</td>
</tr>
<tr>
<td>Supervision Consultants</td>
<td>Support PMOs and PMUs.</td>
<td>Supervises work of DBL contractors.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Support PMO/PMUs to prepare monitoring reports.</td>
</tr>
<tr>
<td>DBL Contractors</td>
<td>Report directly to MIME-PMO</td>
<td>Implement EA requirements.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Prepare compliance monitoring reports and submit to MIME.</td>
</tr>
</tbody>
</table>
9.2 Compliance Monitoring

All projects are subject to periodic compliance monitoring by the World Bank (and for larger projects also the MoE). The primary purpose of compliance monitoring is to ensure the implementation of sound and standard environmental procedures as defined during the project preparation. Specifically, it aims to:

- Monitor project compliance with the conditions set in the operating permit;
- Monitor compliance with the EMP and applicable laws, rules and regulations; and
- Provide a basis for timely decision-making and effective planning and management of environmental measures through the monitoring of actual project impacts vis-a-vis the predicted impacts in the EA.

The need for compliance monitoring is established at the time the approval of the World Bank and/or MoE is issued, which will allow MIME to issue an operating permit and DBL Contract. The Permit/Contract sets the conditions for the monitoring activities and scheduling. As a minimum requirement in compliance monitoring, the activities to be monitored by the PO should correspond to the conditions in the operating permit and EMP. In addition, the operating permit conditions may also require the proponent to undertake industry self-monitoring and submit the required reports.

General aspects to be covered in the Compliance Monitoring, as detailed in the EMP, includes:

- Coverage of Monitoring;
- Frequency of Monitoring;
- Standard procedures/methods of monitoring (e.g. labeling, transport and handling of samples) and laboratory analysis;
- Selection of sampling stations;
- Manpower requirements; and
- Logistics.

The water supply system operator and the PG, with the assistance of PMO/consultants, will monitor compliance with the operating permit and carry out the requisite data collection during both the construction and operational phases. Monitoring reports to be submitted to the MoE and the PMO will include:

- Presentation of the collected data;
- Discussion on the compliance or non-compliance to the EMP and operating permit;
- Conclusions and recommendations.

The PMO is requested to summarize the finding of the quarterly monitoring reports and submit an annual compliance report to the World Bank.

9.3 Implementing Capacity

Budget / Schedule

A special budget will be allocated for overall Project supervision and monitoring, including compliance monitoring of the EMP. Monitoring will be carried out by MIME and World Bank staff.
Staff skills
The capacity of MIME to properly monitor the project is admittedly limited. Although MIME has skilled and motivated staff, current financial, institutional and logistical constraints will obviously be a major factor in the successful implementation.

To reduce the amount of compliance monitoring, many of the responsibilities have been included in the Operators contract. Regular monitoring reports will be provided, which will include a Chapter on environmental compliance monitoring.

Methodological tools and equipment
The principal equipment required as part of the compliance monitoring is for water quality testing. Most of the field equipment is already available and applied by MIME as part of their ongoing activities. Additional field equipment will be purchased during the project. More specialized water quality testing for the compliance monitoring (e.g. Arsenic) will be carried out by certified laboratories.

Daily water quality testing during the operation of the water supply system is part of the operators contract obligations.

Training
Environmental Management training will be provided 'on-the-Job', as part of the overall monitoring activities to be carried out. Support will be provided by World Bank staff if required.
10 CONCLUSIONS AND SUGGESTIONS

General
The Project, endorsed and approved by the and the beneficiaries of Prek Changkran (Prey Veng Province) and the Ministry of Industry, Mines and Energy is not expected to create adverse potential environmental impacts. The impacts can be prevented and mitigated to an acceptable level using proven engineering practice and other measures. The proposed development of a water supply system would be beneficial to the entire municipality. It will bring significant health improvements through improvement of water supply and sanitary conditions. It will also increase economic development of the area, resulting in increased land values and employment.

The Willingness to Connect (WTC) indicated that 70% of the 1313 households within the service area of Prek Changkran approved a tariff of 1995 Riel/m$^3$.

No resettlement will be required. The project will not negatively affect any indigenous people.

List of Resolved Issues
The provision of clean and safe water will bring a significant improvement in the public health conditions of the participating households. It is expected that a decrease in the number of cases of water-borne diseases (diarrhea, gastroenteritis and parasitism) will occur.

The environmental monitoring program will provide the necessary data for improved environmental management of the water supply facilities. This will enable Ministry of Industry, Mines and Energy to identify and present solutions to possible environmental risks and concerns.

Proper sanitation and wastewater disposal mechanisms will be encouraged through a sanitation component to mitigate the adverse effect of an increase in the production of wastewater, especially in areas with poor drainage and high groundwater levels. As Prasat is located in the Mekong Delta with a high groundwater table, additional attention will be given to problems related to onsite sanitation. As the regular septic tanks are not working properly in these areas, the option of introducing alternative technologies and/or communal facilities (public toilets) will be discussed and investigated during the project.

MIME is aware of the possible risks of higher Arsenic concentrations in wells to be drilled in the Mekong Delta. The risk however is considered acceptable as appropriate mitigation measures are incorporated into the project design and preparation process if higher concentrations are encountered in the drillings.

It should be noted that the 'Arsenic problem' generally applies to private shallow wells, where people have no choice in selection the location of the well, and have no resources to provide proper treatment. The PPUWSSP will develop piped water supply systems, where the both the source and the treatment can relatively easily be adjusted according to the local conditions.
List of Partially Resolved Issues

All possible precautions will be taken to minimize negative impacts during the construction phase. Damage to soil and water will be restored and properly compensated. Other limited negative impacts that can not be fully mitigated (noise, traffic) will only be temporary.

Economic losses due to construction activities will be compensated according to standards developed and agreed upon with the Royal Government of Cambodia.

New issues arising from the IEIA that have been resolved

The IEIA emphasized on proper water source selection and protection, as currently incorporated in the feasibility study and final designs.
11 PRINCIPAL REFERENCES.

**PPUWSS Project**
GHD/Fraser Thomas, 2002 – Prek Changkran Feasibility Study report (M21, Prey Veng).
Parsons – DRAFT technical specifications for the ‘Provincial and Peri-Urban water supply project’.

**Kingdom of Cambodia**
MOE - List of the Projects Require an IEIA or EIA; Annex of Sub-Decree No 72 ANRK. BK. Date 11 August, 1999.
Royal Government of Cambodia (1997) - Sub-decree of Construction License (No. 86)
Royal Government of Cambodia (1999) - Sub-decree on Water Pollution (No: 27.ANRK.BK)

**World Bank Guidelines**
Annex I - List of EA preparers

MIME staff
Mr. Peng Navuth, Director, Public Water Supply Department
Mr. Sin Vaidia, Deputy Director DPWS, PPUWSSP Project Manager
Mr. Cheav Channy, Deputy Chief of Technical Office, DPWS

Local Government Representatives
Mr. Sok Pheng, Director of DIME, PMU Chief
Mr. Suon Sokunth Deputy Director of DIME, PMU Member
Mr. Bin Ly, Chief of Administration Office, PMU Member
Mr. Chea Kakada, Vice Chief of Mine Resource Office, PMU Member
Mr. Meas Chhuna, Vice Chief of Industrial Affair Office, PMU Member

World Bank supervision
Mr. P. Illangovan, Senior Environmental Specialist
Mr. Vijay Jagannathan, Task Team Leader
Mr. Luiz Tavares, Senior Sanitary Engineer

Consultant
Frank Radstake, Environmental and Water Resources Management Advisor

With support from GHD/FT.
General
The meetings and discussions in each town conformed to a set pattern, varied only by the individual requests for change on the part of the Communes:

1. The first day in each Province was devoted to the PMU training and familiarization workshop.

2. On entering a District the teams paid a short courtesy visit to the District Governor and the senior advisors to reinforce the project objectives and rules, and to seek his/her advice on matters they should take into account in their subsequent meetings.

3. The teams would then meet with the Commune Chief(s) and Commune Council members with an established agenda providing for:
   - Introduction of participants and the facilitator
   - Briefing on the meeting – why (project information sheet), objectives and action plan
   - The project – background, rules, roles and responsibilities, structure and implementation, and benefits
   - Feasibility Study – outline of work, technical options, management options, financial options and costs, tariffs
   - Open forum – questions and answers
   - Action planning – arrangements for area-wide meetings of villagers, schedule for meetings, program for area-wide meetings
   - Additional roles and responsibilities – Commune support and attendance at area-wide meetings, roles of Commune Chiefs and Commune before, during and after the village meetings
   - Willingness-To-Connect – how to distribute the agreement forms and generate the 51% positive return required, The involvement of the Commune Chiefs in collecting the returns and validating the responses, and confirmation and synthesis of agreement.

4. The teams also met with the Village Chiefs and members of the Village Development Council, if one existed. More often than not the Commune preferred the two meetings to occur together to ensure the same information was related to all parties and that a uniform interpretation of this was resolved. Where separate meetings occurred, these followed the same agenda as the meetings with the Communes.

5. On reaching agreement for the program and timing of the village meetings the team then departed for another town and meetings there with the Commune and Village Chiefs. After a space of several days the team returned to conduct the area-wide meetings, thus allowing time for local organization and arrangements for the meetings.
6. The area-wide meetings occurred in each village in a location suitable to the villagers. The pictorial displays and samples of fittings, meters and materials were used to support the presentation. The meetings were participatory and encouraged viewpoints and questions. In general the presentation followed the following structure:

- Explanation of the purpose of the meeting – indication of the participatory nature and indication that views were welcome and invited
- The project – background and description, socio-economic benefits
- Presentation of options – summary of Feasibility Study, technical options, financial options, tariffs
- Open forum – questions and answers
- Summation and closure

7. Prepared information kits of all relevant information in the Khmer language were left with the Commune Chief and Commune members, the Village Chiefs and Development Committee members, and key/influential persons within each village – to ensure that advice could be provided to villagers seeking elaboration concerning the project.

8. Following work in each group of towns the teams were debriefed in the Consultants' office in Phnom Penh to embody the lessons learned and to refine the process.

At the conclusion of the above meetings the teams left WTC forms with the Commune Chiefs with instructions for their completion by the villagers. These instructions requested that:

1. The issue and collection of the forms should be controlled to allow these to be reconciled later for the calculation of the WTC ratio.
2. The forms should be distributed and collected by each Village chief.
3. The forms should be verified by the Commune to confirm:
   - The signatory was a bona fide head of household, or so authorized
   - The location of the property was correctly identified
   - There was only one form from each household
   - That the signatory was in fact the identified person (most signatures are in the form of a thumbprint).
4. The forms were collected around a week later and brought to the Consultants' office and subjected to a further audit and recount.
5. The forms have been collated, bundled and boxed for future reference, and will be handed over to MIME for safekeeping.
6. During the in-house audit a number of incomplete forms were observed and separated from the correctly-completed returns. MIME will need to follow-up on these returns to establish the intent of the signatory, to avoid later dispute regarding the provision of a free connection, or otherwise.
Cambodia Provincial and Peri-Urban Water Supply and Sanitation Project (MIME / PPWSA / WB)

Prek Changkran (M21), Prey Veng

Prek Changkran (M21) WTC Summary
The following summarizes the findings of the WTC survey in Prek Changkran, as provided by GHD/FT. More details can be found in the Willingness-to-Connect report.

1. Service Area
The scheme includes the originally-intended commune of Prek Changkran and also the adjacent commune of Lve, added later. The two communes comprise a low to medium ribbon development some 10.5 km long and one property deep, following a narrow 'spine' road along the southern 'escarpment' of the Tonle Touch River, which forms a levee bank at this location. The levee is some 5 meters higher than the adjacent country. The town fully occupies this bank.

There is no tightly-defined town center, but market, commercial, minor industrial and institutional development is interspersed with linear housing along the escarpment. There are few minor roads intersecting with the 'spine' road.

2. Number of Households/ Demand Growth
Service Area contains 1313 households. Number confirmed by direct count. Because the levee bank is fully occupied with existing properties to its full length and width, there is no room for expansion without filling adjacent land to a similar depth of 5 meters – which is considered impracticable on cost grounds, in normal circumstances. Therefore for this town, the annual growth factor of demand has been reduced to 0.5 percent to allow for some increase in the size of existing families.

3. Consultation Process
The feasibility design, and related options, and the tariffs have been presented to, and discussed with the District and Commune governments at Prek Changkran. Similarly the feasibility designs and related tariffs have been conveyed to area-wide meetings of villagers residing within the proposed supply areas. The presentation and meetings have conformed to the communication strategy displayed to, and agreed with MIME.

4. Options
The scheme is based on the treatment plant being located in the Commune-owned land identified as being available west of the Commune Office, across a seasonal river which forms drainage outlet from the rice fields behind the town. This has been adopted not only because it is readily available but also it is immediately adjacent to the best source of water as identified below. It is also reasonably central to the extremities of the town.

The Tonle Touch has no flow in the dry season and groundwater resources represent the only viable supply for the town. Preliminary calculations indicate a required water resource demand (ADP) at year seven and consumption of 60 L/c.d of 630 m3/ day. Although there was no geo-electrical survey, investigation of existing bores shows that a good target location for boreholes is immediately behind the proposed treatment station site, in the adjacent rice fields. The estimated yields are taken as moderate. Although it can be assumed that, close to the river, water will be present in adequate quantities, there is some risk that yields could be affected by silty strata. Hence reasonably conservative assumptions have been adopted, leading to a requirement for three bores, sunk to 60 meters depth to maximise the chance of finding good water.
The present bore water in the location of the intended bore field displays an acceptable quality and it is intended to include provision for iron level reduction through aeration. Treatment will therefore be a simple process of aeration and disinfection.

5. WTC Response

The WTC returns have been audited, recounted and reconciled against the forms issued, the number of returns received, the unused forms and those unaccounted for through non-return from the village households that have refrained from indicating an opinion one way or the other. Similarly the number of households has been reconciled for the calculation of the WTC ratio. The Commune authorities exercised very close control of the form issues and returns in Prek Changkran.

The WTC indicate that 69.9% of 1,995 households within the service area of Prek Changkran approved a tariff of 1,995 Riel /m³. (see Annex III).

Community Questions

The following summarizes the main questions which were raised during the consultations with the beneficiaries of the project.

Question 1: Will the water tariff be changed?
Answer 1: The tariff can only be changed if justified through inflation, and then only through a rigorous process requiring MIME agreement and sign-off.

Question 2: Why is the price expensive compared to Phnom Penh?
Answer 2: The team explained the difference in residential densities, and the higher per capita and per volume costs of the stand-alone Prek Changkran Scheme. The explanation also referred to the unusual shape of the Service Area and the relatively high reticulation costs of the scheme.

Requests for Scheme Variations

There were no requests for scheme variation or extension of the Service Area at Prek Changkran.
Annex III - Proof of social acceptability

**WTC COUNT – VILLAGE RETURNS**

**TOWN M21 – PREK CHANGKRAN**

**COUNTERS / SCRUTINEERS. HOK THY AND SIZANA**

**DATE 12th December 2002**

<table>
<thead>
<tr>
<th>VILLAGE</th>
<th>YES</th>
<th>NO</th>
<th>SPOILT</th>
<th>TOTAL ACC'D FOR</th>
<th>FS COUNT*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prek Changkran Commune</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Be Prey</td>
<td>128</td>
<td>0</td>
<td>1</td>
<td>129</td>
<td></td>
</tr>
<tr>
<td>2. Prek Sandek</td>
<td>108</td>
<td>8</td>
<td>5</td>
<td>121</td>
<td></td>
</tr>
<tr>
<td>3. Prek Chankran Krom</td>
<td>92</td>
<td>0</td>
<td>0</td>
<td>92</td>
<td></td>
</tr>
<tr>
<td>4. Prek Phnoy</td>
<td>140</td>
<td>0</td>
<td>0</td>
<td>140</td>
<td></td>
</tr>
<tr>
<td>5. Prek Changkran Leu</td>
<td>111</td>
<td>5</td>
<td>2</td>
<td>118</td>
<td></td>
</tr>
<tr>
<td>Live Commune</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Live</td>
<td>94</td>
<td>22</td>
<td>0</td>
<td>116</td>
<td></td>
</tr>
<tr>
<td>2. Amkaeng Chres</td>
<td>111</td>
<td>43</td>
<td>2</td>
<td>156</td>
<td></td>
</tr>
<tr>
<td>3. Kaong Tonle Leu</td>
<td>39</td>
<td>43</td>
<td>0</td>
<td>82</td>
<td></td>
</tr>
<tr>
<td>4. Kaong Tonle Krom</td>
<td>95</td>
<td>23</td>
<td>2</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td><strong>Subtotals</strong></td>
<td>918</td>
<td>383</td>
<td>12</td>
<td>1,313</td>
<td>1,313</td>
</tr>
<tr>
<td><strong>WTC Percentage</strong></td>
<td></td>
<td></td>
<td></td>
<td>69.9%</td>
<td></td>
</tr>
<tr>
<td><strong>Forms returned unused by Communes</strong></td>
<td></td>
<td></td>
<td></td>
<td>72</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL FORMS</strong></td>
<td></td>
<td></td>
<td></td>
<td>1,385</td>
<td></td>
</tr>
</tbody>
</table>

* - indicates house count by Consultants in Rapid Appraisal stage and checked

Source: GHD/FT
Annex IV – Applied Water Quality Standards

The following water quality standards are proposed at a seminar workshop on the development of national drinking water quality standards for Cambodia, Phnom Penh, June 24-25, 2002.

Table 1. Standard Values for Bacteriological Quality

<table>
<thead>
<tr>
<th>Bacteria</th>
<th>Standard value (number/100ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I All drinking water supplies under all circumstances</td>
<td>E. coli or thermotolerant (fecal) coliform bacteria</td>
</tr>
<tr>
<td>II Treated water entering the distribution system</td>
<td>E. coli or thermotolerant (fecal) coliform bacteria</td>
</tr>
<tr>
<td>III Treated water in the distribution system</td>
<td>E. coli or thermotolerant (fecal) coliform bacteria</td>
</tr>
<tr>
<td></td>
<td>Total Coliforms*</td>
</tr>
</tbody>
</table>

* In case of large quantities where sufficient samples are examples, it must not be present in 95% of samples taken throughout any 12-months period.

Table 2. Standard Values for Chemical Quality: Health significance

A. Inorganic constituents

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Maximum level (mg/liter)</th>
</tr>
</thead>
<tbody>
<tr>
<td>antimony</td>
<td>0.005</td>
</tr>
<tr>
<td>arsenic</td>
<td>0.01*</td>
</tr>
<tr>
<td>barium</td>
<td>1</td>
</tr>
<tr>
<td>boron</td>
<td>0.5</td>
</tr>
<tr>
<td>cadmium</td>
<td>0.01</td>
</tr>
<tr>
<td>chromium</td>
<td>0.05</td>
</tr>
<tr>
<td>cyanide</td>
<td>0.07</td>
</tr>
<tr>
<td>fluoride</td>
<td>1.5</td>
</tr>
<tr>
<td>lead</td>
<td>0.01</td>
</tr>
<tr>
<td>mercury (total)</td>
<td>0.001</td>
</tr>
<tr>
<td>molybdenum</td>
<td>0.1</td>
</tr>
<tr>
<td>nickel</td>
<td>0.02</td>
</tr>
<tr>
<td>nitrate (as NO₃⁻)</td>
<td>50</td>
</tr>
<tr>
<td>nitrite (as NO₂⁻)</td>
<td>3</td>
</tr>
<tr>
<td>selenium</td>
<td>0.01</td>
</tr>
</tbody>
</table>

* Proposed interim Maximum Allowable Concentration until June 2007: Arsenic 0.01-0.05
### B. Organic constituents

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Maximum level (µg/liter)*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pesticides</strong></td>
<td></td>
</tr>
<tr>
<td>Aldrin/Dieldrin</td>
<td>0.03</td>
</tr>
<tr>
<td>Altrazine</td>
<td>2</td>
</tr>
<tr>
<td>Chlordane</td>
<td>0.2</td>
</tr>
<tr>
<td>DDT</td>
<td>2</td>
</tr>
<tr>
<td>Endrin</td>
<td>0.2</td>
</tr>
<tr>
<td>Heptachlor and Heptachlor epoxide</td>
<td>0.03</td>
</tr>
<tr>
<td>Lindane</td>
<td>2</td>
</tr>
<tr>
<td><strong>Aromatic hydrocarbons</strong></td>
<td></td>
</tr>
<tr>
<td>Petroleum oils &amp; grease</td>
<td>0</td>
</tr>
<tr>
<td>Benzene</td>
<td>10</td>
</tr>
<tr>
<td>Toluene</td>
<td>700</td>
</tr>
<tr>
<td>Xylene</td>
<td>500</td>
</tr>
<tr>
<td>Ethylenzene</td>
<td>300</td>
</tr>
<tr>
<td>Benzo[a]pyrene</td>
<td>0.7</td>
</tr>
<tr>
<td><strong>Cyanobacteriactical toxins</strong></td>
<td></td>
</tr>
<tr>
<td>Microcystin-LR***</td>
<td>1</td>
</tr>
</tbody>
</table>

*Note: The unit used in this table is µg/L = mg/l/1000.

Constituents can be added or deleted depending on the pesticides use in Cambodia.

***Microcystin-LR is an emerging concern in Cambodia in both urban and rural areas using surface water for drinking.

---

#### Table 3. Standard Values for Physical and Chemical Quality: Aesthetic Quality

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Level (mg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taste</td>
<td>Acceptable</td>
</tr>
<tr>
<td>Odor</td>
<td>Acceptable</td>
</tr>
<tr>
<td>Color</td>
<td>10 TCU</td>
</tr>
<tr>
<td>Turbidity</td>
<td>5 NTU</td>
</tr>
<tr>
<td>Aluminum</td>
<td>0.2</td>
</tr>
<tr>
<td>Ammonia</td>
<td>1.5</td>
</tr>
<tr>
<td>Chloride</td>
<td>300</td>
</tr>
<tr>
<td>Copper</td>
<td>2</td>
</tr>
<tr>
<td>Hardness</td>
<td>300 (as CaCO3)*</td>
</tr>
<tr>
<td>Hydrogen Sulfide</td>
<td>0.05</td>
</tr>
<tr>
<td>Iron</td>
<td>0.5</td>
</tr>
<tr>
<td>Manganese</td>
<td>0.5</td>
</tr>
<tr>
<td>pH</td>
<td>6.5 – 8.5 (no unit)</td>
</tr>
<tr>
<td>Silver</td>
<td>0.1</td>
</tr>
<tr>
<td>Sodium</td>
<td>200</td>
</tr>
<tr>
<td>Sulfate</td>
<td>500</td>
</tr>
<tr>
<td>Total Dissolved Solids (TDS)</td>
<td>1000b</td>
</tr>
<tr>
<td>Zinc</td>
<td>5b</td>
</tr>
</tbody>
</table>

TCU - true color unit, NTU – nephelometric turbidity unit

* Secondary standards; compliance with the standard and analysis are not obligatory.

b TDS consist of calcium, magnesium, potassium, sodium, bicarbonates, chlorides and sulphates.
Table 4. Standard Values for Disinfectant and Disinfection By-Products

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Maximum Level (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Disinfectant</td>
<td></td>
</tr>
<tr>
<td>Chlorine (residual)</td>
<td>0.2 – 0.5</td>
</tr>
<tr>
<td>b. Disinfection By-products</td>
<td></td>
</tr>
<tr>
<td>Chlorite</td>
<td>0.2</td>
</tr>
<tr>
<td>2,4,6 trichlorophenol</td>
<td>0.2**</td>
</tr>
<tr>
<td>Formaldehyde</td>
<td>0.9</td>
</tr>
<tr>
<td>Trihalomethanes:</td>
<td></td>
</tr>
<tr>
<td>Bromoform</td>
<td>0.1</td>
</tr>
<tr>
<td>Dibromochloromethane</td>
<td>0.1</td>
</tr>
<tr>
<td>Bromodichloromethane</td>
<td>0.06</td>
</tr>
<tr>
<td>Chloroform</td>
<td>0.2</td>
</tr>
</tbody>
</table>

* Analyze only where chlorination is used for disinfection purposes
** Represents health-based guideline value for phenolic substances

Table 5. Standard Values for Radiological Constituents

<table>
<thead>
<tr>
<th>Constituents</th>
<th>Activity level (Bq/litre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross alpha activity</td>
<td>0.1</td>
</tr>
<tr>
<td>Gross beta activity</td>
<td>1</td>
</tr>
</tbody>
</table>

*Analyze only when appropriate; not for regular monitoring purposes.*
Annex V - Accountability statement of project owner

ACCOUNTABILITY STATEMENT OF THE PROJECT OWNER

This is to certify that to our knowledge all the information in the enclosed Initial Environmental Impact Assessment (IEIA) for Prek Changkran (Prey Veng Province) is true, accurate, and complete. Should we learn of any information which would make the enclosed IEIA inaccurate, we shall bring said information to the attention of the Ministry of Environment.

We hereby bind ourselves jointly and solidarity with the preparers for any penalties that may be imposed arising from any misrepresentations or failure to state material information in the enclosed IEIA.

Ministry of Industry, Mines and Energy

Title/Designation