# The Study on Groundwater Development in Central Cambodia
# Final Report

## Summary Report

LOCATION MAP
EXCHANGE RATE AND LIST OF ABBREVIATION
EXECUTIVE SUMMARY

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## 4.4 Groundwater Resource Evaluation

### 4.4.1 Hydrogeological Map

A hydrogeological map was prepared for presentation of groundwater conditions of the Study area (Figure 4.4.1). The map presents information on the topography, geology, depth of the basement rocks, groundwater levels and aquifer parameters etc.

### 4.4.2 Quantitative Evaluation

The Study area was divided into several districts according to hydrgeological conditions. Main aquifer, specific capacity, water quality and groundwater potential of each district are summerized in Table 4.4.1. Groundwater potential is high in the eastern section of the Study area (Eastern Kg. Cham Province) and low in Kg. Chhnang Province.

Productivity of the alluvial aquifer is poor in Kg. Cham Province as same as in Kg. Chhnang. Plio-Pleistocen sand and gravel layers form excellent aquifers as well as basalt in Kg.Cham Province. According to the pumping test, the pumping rate ranged from several ten m3/day〜 to several hundred m3/day. Yield of the basement rock aquifer which is lying beneath the basalt is also high in Memot district. From the points of the specific capacity, a large amount of groundwater can be pumped from these aquifers by using motorized pump.

### 4.4.3 Qualitative Evaluation

Based on the field measurement and laboratory analysis of groundwater, water quality by district and by aquifer can be summarized as follows:

#### (1) Basement rock area in Kg. Chhnang

Iron and manganese are higher than the WHO guideline value in many test wells. This tendency could be seen in the existing tube wells. Fluoride was detected in 3 test wells. However, the concentration is higher than the WHO guide line value only 0.3mg/l . It is judged that this does not affect the human's health directly.

#### (2) Alluvial lowland in Kg. Chhnang and Kg. Cham

Iron and manganese are high in the hand dug well and tube well drilled in the alluvial and

Pleistocene aquifers. Arsenic was also detected at the test well and the existing tube wells in the area along the Tonle Sap River and the Mekong River. Groundwater potential in the alluvial aquifer is low from the points of water quality as chloride, nitrate and ammonia are high.

### (3) Plio-Pleistocene Sediments in Kg.Cham

High nitrate concentration was detected at existing dug wells in some areas. Iron and manganese are high in the existing dug wells and tube wells in the area along the Mekong River. However, arsenic and fluoride are not detected. Water quality is generally good as the salinity is also low.

## 4.5 Water Balance Analysis

The groundwater recharge from the rainfall was estimated based on the water balance computation using the meteorological data collected in and around the study area. It is necessary to obtain daily data of rainfall, temperature, etc. for the estimation of groundwater recharge. However, the daily data at two (2) meteorological stations in Kg. Chhnang and Kg. Cham are not available. Therefore, the groundwater recharge was estimated using the long-term daily data recorded at Pochenton airport in Phnom Penh.

### (1) Methodology of Water Balance Computation

There are several methods to estimate the groundwater recharge such as tank model method and water balance equation analysis considering soil moisture capacity, etc. In the study, the SCS method was employed to estimate groundwater recharge because the tank model method cannot be applied without a long-term daily record of unconfined groundwater level. The SCS method can be applied easily with consideration of land use and geomorphological conditions. The input data are daily rainfall data for a period from January 1986 to December 1995 and long-term average of monthly pan-evaporation values. It was assumed in the SCS method for selecting the suitable type curves that the typical soil in the study area is sandy loam.

### (2) Results of Water Balance Computation

Based on the daily water balance computation for the period of 10 years, the average annual groundwater recharge is estimated as 448 mm, which occupies 34% of the average annual

rainfall. The average monthly recharge values show that there is no groundwater recharge from December to February in the dry season. On the other hand, the maximum monthly recharge of 137 mm occurs in September. The result of daily recharge estimate shows that the occurrence of daily groundwater recharge depends on the daily rainfall pattern and rainfall intensity. Therefore, the percentages of average monthly recharge to the monthly average rainfall are about 10% in March and April, about 35% in May, 20 to 30% in June to August, and 42 to 47% in September to November.

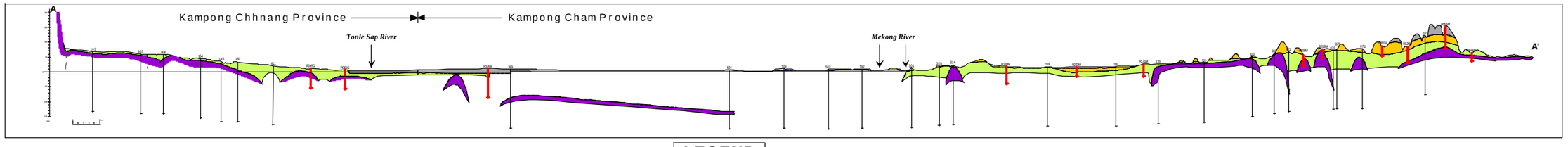
The estimated annual average amounts of other water balance components with the percentages to the average annual rainfall (=1,316 mm) are 511 mm (38.8%) of actual transpiration, 231 mm (17.6%) of actual evaporation, 102 mm (7.7%) of surface runoff, and 22 mm (1.7%) of interception loss by vegetation cover.

# Figure 4.4.1 HYDROGEOLOGICAL MAP OF CENTRAL CAMBODIA (Kampong Chhnang Province and Kampong Cham Province)

**Evaluation of Groundwater Potential**

| Province | District | Hydrogeologic Feature | Main Aquifer | Specific Capacity | Water Quality | Groundwater Potential |
|---|---|---|---|---|---|---|
| Kampong Chhnang | Kampong Leaeng<br>Choi Kiri<br>Kampong Tralach<br>Rolea Bier<br>Tuek Phos<br>Sameakki Mean Chey | Located along the Tonle Sap river. Covered by thin Alluvial sediments forming a shallow aquifer of poor quantity and quality. Fissure and weathered basement rocks become<br>Covered by thin Pleistocene sandy and clayey sediments. Basement rocks is located at shallow depth. | Fissure and weathered basement rocks (sandstone, rhyolite) | Specific capacity of the basement rocks ranges from less than 0.2 to 20m³/day/m depending on the fracture zone. | Shallow alluvial aquifer locally contains iron and arsenic higher than WHO guideline. Basement rocks aquifer locally contains high Fluoride. | (1)Alluvial shallow aquifer (depth:10-20m) is poor in quantity and locally high iron with arsenic. Low potential.<br>(2) Basement rock is generally unpromisable (depth: more than 20m). Fissured and weathered parts of the rocks become excellent aquifer of high potential. Pumping rate: 3.7 to 65.4m³/day |
| Kampong Cham | Batheay<br>Cheung Prey<br>Kang Meas<br>Krouch Chhmar<br>Srei Santhor<br>Kaoh Soutin | Located along the Tonle Sap river and Mekong river. Alluvial and Plio-Pleistocene Formation consist of thick clayey sediments. Shallow thin sandy layer forms aquifer of yellow or iron rich groundwater. | Alluvial and Plio-Pleistocene sediments. | Specific capacity of alluvial aquifer is 15.6m³/day at the test well in Cheng Prey | Generally high iron. Locally accompanied by high arsenic. High chloride (350mg/l) and TDS(1387mg/l) at the test well. | Groundwater potential is low in terms of quality. High iron and arsenic contents in shallow aquifer (Depth:20m). Locally groundwater is salinized.<br>Pumping rate:69.0m³/day at the test well. |
| | Stueng Trang<br>Chamkar Leu<br>Prey Chhor<br>Kampong Siem<br>Kampong Cham (PT) | Plio-Pleistocene sandy layer and basalt forms good aquifers. In Stueng Trang, Pleistocene sandy aquifer is locally in artesian condition. | Plio-Pleistocene basalt and sediments | Specific capacity of basalt is 40.9 m³/day in Chamkar Leu. | Generally good quality of water. Basalt aquifer is less iron. Plio-Pleistocene aquifer has slightly high iron groundwater. | Groundwater potential is high. Well depth: 50-80m. Flowing well (30-40l/min. Pumping rate in the test well: 18m³/day. |
| | Tboung Khmum<br>Ou Reang Ov<br>Memot<br>Ponhea Kraek | Plio-Pleistocene sand or gravel layer and basalt form good aquifers. In Ponhea Kraek , Plio-Pleistocene aquifer is locally in artesian condition. | Quaternary basalt and Plio-Pleistocene sediments | Plio-Pleistocene aquifer: 115-670 m³/day Basalt: 5.5-77.5m³/day | same as the above | Groundwater potential is excellent and productive(Depth 40-100m) Pumping rate of basalt: 60-90m³/day, Plio-Pleistocene: 100-150m³/day Flowing well: 40-72l/s |
| | Memot | Located on the gently undulated hill(remnant of basalt and Plio-Pleistocene sediments forming good aquifers. Basement rock locally found at depth of 15m | Basalt, Plio-Pleistocene sediments, Basement rocks (sandstone) | Sandstone:0.7-114.6m³/day Basalt: 2.9-92m³/day Plio-Pleistocene:28.7m³/day | Good quality. Iron and ferrosis free. No Fluoride in basement rock aquifer. | Groundwater potential is high. Well depth: 25-50m. Pumping rate:4-10l e³/day. |

## GEOLOGICAL CROSS SECTION ALONG A-A' LINE




**LEGEND**

- Water area
- Alluvial sand
- Alluvial clay (Lake or swamp deposits)
- Residual sand (Eluvial sand)
- Laterite (Basalt origin autochthonous red soil)
- Basalt (Pleistocene volcanics)
- Pliocene/Pleistocene (Unconsolidated fresh water sediments)
- Basement rocks (Pre-Tertiary igneous and sedimentary rocks)
- Main contour line (10, 30, 50, 100, 200m)
- Sub contour line (20m and others)
- Stratigraphic boundary
- Fault
- Elevation of basement rock surface (m above sea level)
- Test drilling point (above: Test Well No., below: Village No.)
- Electric sounding point (with No.)
- Geological cross sction line
- Basin Boundary
- Basin No.
- Observed Dug Well (with Village No.)
- Unconfined groundwater level (m below GL in Feb. 2001)
- Province boundary
- District boundary
- Main Road
- Railway
- Test drilling
- Electric sounding

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| THE STUDY ON GROUNDWATER DEVELOPMENT IN CENTRAL CAMBODIA |
| MAY 2002 |
| JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)<br>MINISTRY OF RURAL DEVELOPMENT, CAMBODIA |
| KOKUSAI KOGYO CO., LTD. |

## Table 4.4.1 Evaluation of Groundwater Potential

| Province | District | Hydrogeologic Feature | Main Aquifer | Specific Capacity | Water Quality | Groundwater Potential |
|---|---|---|---|---|---|---|
| Kampong Chhnang | Kampong Leng<br>Chul Kiri<br>Baribo<br>Kg.Chhnang (PT)<br>Rolea Phier<br>Kampong Tralach | Located along the Tonle Sap river. Covered by thin alluvial sediments forming a shallow aquifer of poor quantity and quality. Fissure and weathered basement rocks become an aquifer. | Fissure and wethered basement rocks (sandstone, rhyolite) | Specific capacity of the basement rocks ranges from less than 0.2 to 200$m^2$/day depending on the fracture zone. | Shallow alluvial aquifer locally contains iron and arsenic higher than WHO guideline. Basement rocks aquifer locally contains high fluoride. | (1)Alluvial shallow aquifer (depth:10-20m) is poor in quantity and locally high iron with arsenic. Low potential.<br><br>(2) Basement rock is generally impermeable (depth: more than 10m). Fissured and weathered parts of the rocks become excellent aquifer of high potential. Pumping rate: 3.7 to 63.4$m^3$/day |
| | Tuk Phos<br>Samaki Meanchey | Covered by thin Pleistocene sandy and clayey sediments. Basement rocks is located at shallow depth. | | | | |
| Kampong Cham | Bateay<br>Cheng Prey<br>Kang Meas<br>Kroch Chma<br>Srei Santhor<br>Kok Sotin | Located along the Tonle Sap river and Mekong river. Alluvial and Plio-Pleistocene formation consist of thick clayey sediments. Shallow thin sandy layer forms aquifer of saline or iron rich groundwater. | Alluvial and Plio-Pleistocene sediments. | Specific capacity of alluvial aquifer is 15.6$m^2$/day at the test well in Cheng Prey | Generally high iron. Locally accompanied by high arsenic. High chloride (386mg/l) and TDS(1507mg/l) at the test well. | Groundwater potential is low in terms of quality. High iron and arsenic contents in shallow aquifer (Depth:20m). Locally groundwater is salinized. Pumping rate 68.9$m^3$/day at the test well. |
| | Stung Trang<br>Chamkar Leu<br>Prey Chhor<br>Kampong Siem<br>Kampong Cham (PT) | Plio-Pleistocene sandy layer and basalt forms good aquifers. In Stung Trang, Pleistocene sandy aquifer is locally in artesian condition. | Plio-Pleistocene basalt and sediments | Specific capacity of basalt is 49.9 $m^2$/day in Chamkar Leu. | Generally good quality of water. Basalt aquifer is less iron. Plio-Pleistonce aquifer has slightly high iron groundwater. | Groundwater potential is high. Well depth: 50-80m. Flowing well :30-40l/min. Pumping rate in the test well: 180$m^3$/day. |
| | Tbong Khmum<br>O Reang Ov<br>Dambe<br>Ponhea Krek | Plio-Pleistocene sand or gravel layer and basalt form good aquifers. In Ponhea Krek , Plio-Pleistocene aquifer is locally in artesian condition. | Quaternary basalt and Plio-Pleistocene sediments | Plio-Pleistocene aquifer: 115-670 $m^2$/day Basalt: 5.5-27.9$m^2$/day | same as the above | Groundwater potential is excellent and productive(Depth 40-100m) Pumping rate of basalt: 60-90$m^3$/day, Plio-Pleistocene: 185-230$m^3$/day Flowing well: 60 l/min |
| | Memot | Located on the gently undulated hill composed of basalt and Plio-Pleistocene sediments forming good aquifers. Basement rock locally found at depth of 15m | Basalt, Plio-Pleistocene sediments, Basement rocks (sandstone) | Sandstone:6.7-114.6$m^2$/day Basalt: 2.9-52$m^2$/day Plio-Pleistocene:20.7$m^2$/day | Good quality. Iron and arsenic free. No fluoride in basement rock aquifer. | Groundwater potential is high. Well depth: 25-50m. Pumping rate:14.4-192 $m^3$/day. |