Figure 1-3 Locations of Weather Station (left) and Annual Rainfall Distribution (right)

Table 1-2 Observation Periods of Collected Data of Each Weather Station

| Name of the Weather Stations | Elevations (m) | Annual Rainfall (mm) | Period |
|---|---|---|---|
| Katimok | 2,286 | 1415 | 1983-2009 |
| Kabarnet | 2,042 | 1340 | 1995-2005 |
| Nakuru | 1,901 | 967 | 1995-2010 |
| Barwasa | 1,676 | 884 | 1983-2010 |
| Snake farm | 975 | 755 | 1984-2010 |
| Nginyang | 914 | 541 | 1983-1996 |
| Kapedo | 762 | 497 | 1983-2000 |

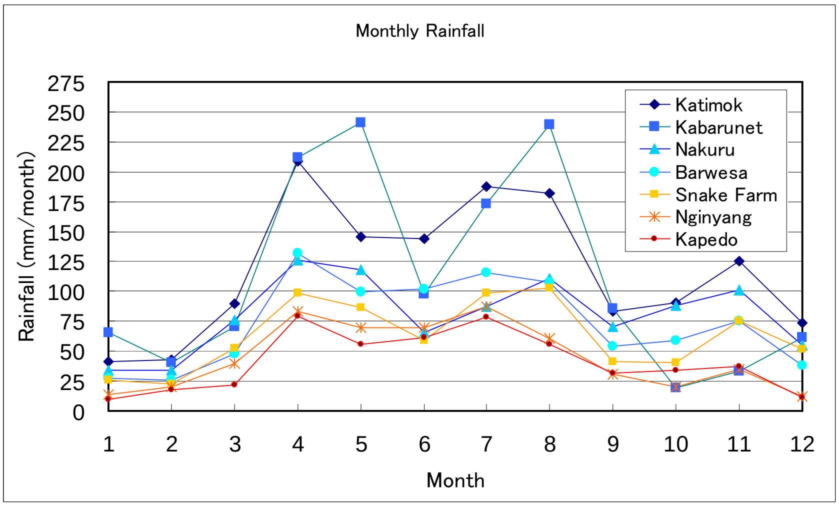



Figure 1-4 Monthly Rainfall Variation in the Project Area

These Figures and Table show the following tendencies:

- Monthly rainfall is larger from April to August, and smaller from December to February.
- Rainy season starts in March.
- November has a little bit larger rainfall than October.
- Annual rainfall in the highland area is larger than in the lowland area, which means that annual rainfall in Tugen Hills is larger than those in lowland areas such as Marigat and Chemolingot.
- Southern sub-basins have larger annual rainfall than the northern sub-basins in the project area.

b. Air Temperature

Monthly averages of daily maximum and minimum air temperature at Nakuru Weather Station are as shown in Figure 1-5. The observation period of collected data is from 1996 to 2009. The data shows that annual average of daily maximum air temperature is 26°C, and annual average of daily minimum air temperature is 12°C. Monthly change of daily maximum air temperature is higher in January to March and lower in July, and monthly change of daily minimum temperature is higher in April to May and lower in December to February. However, the difference among the air temperatures is small.

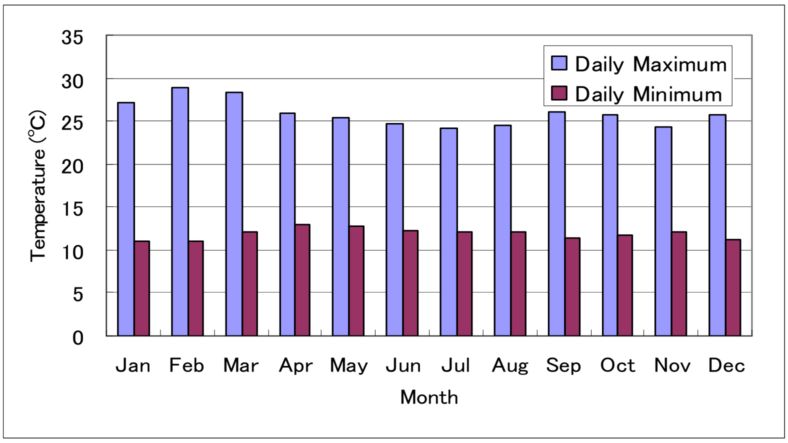



Figure 1-5 Monthly Change of Daily Maximum and Minimum Air Temperature

c. Sunshine Hours

Monthly averages of daily sunshine hours at Nakuru Weather Station are as shown in Figure 1-6. The observation period of collected data is from 1996 to 2009. The data shows that annual average of daily sunshine hours is about 7.5 hours, and the months from December to March and May to September have longer sunshine hours (more than 7 hours). On the other hand, sunshine hours are less than 6 hours in November. It should be noted that there are many months with no observation data.

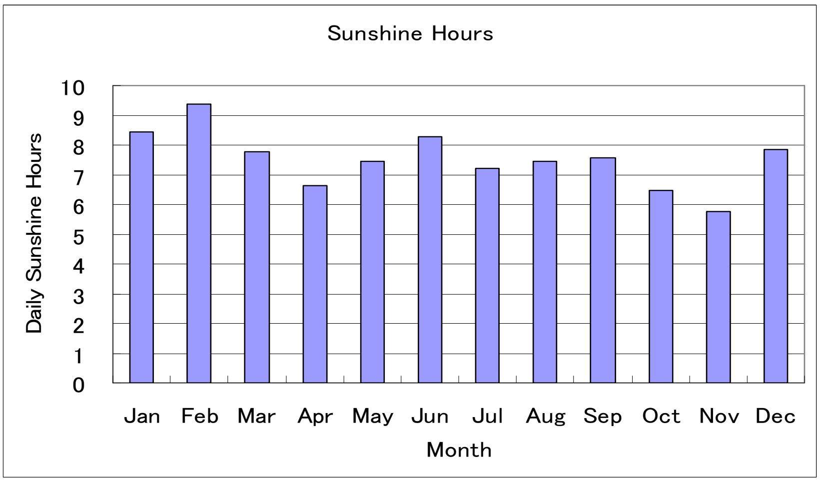



Figure 1-6 Monthly Change of Sunshine Hours

d. Wind Speed

Monthly averages of daily wind speed at Nakuru Weather Station are as shown in Figure 1-7. The observation period of collected data is from 1996 to 2009. The data shows that annual average of wind speed is about 3.1 m/sec. Wind speed is higher from December to May; however, the difference is small and wind speed is slow throughout the year.

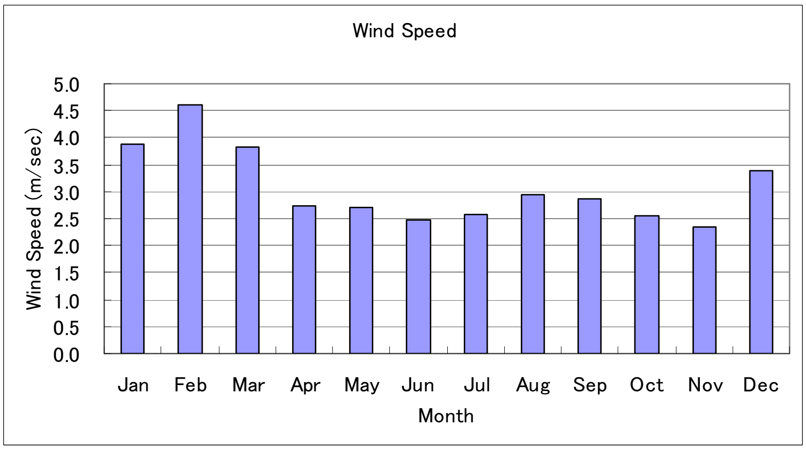



Figure 1-7 Monthly Change of Wind Speed

## 1-2-2 Topography

Kenya is located at the east coast of the African Continent and the equator crosses the country. It has a variety in topographical features such as glaciated high mountains, the Great Rift Valley abundant in faults and volcanoes, hilly highland, plain dessert and coastal landform. The project area is located in the Great Rift Valley.

Figure 1-8 shows the boundary and topography of the project area. The topographical characteristics of the area are governed by the Great Rift Valley System which extends to the north–south direction, and the distinctive features are classified to highland areas and low-lying areas. The highlands are the Mochongai (Laikipia) escarpments, the Tugen hills (Kamasia block), the Elgeyo escarpments and the Uasin Gishu highland from east to west of the project area.

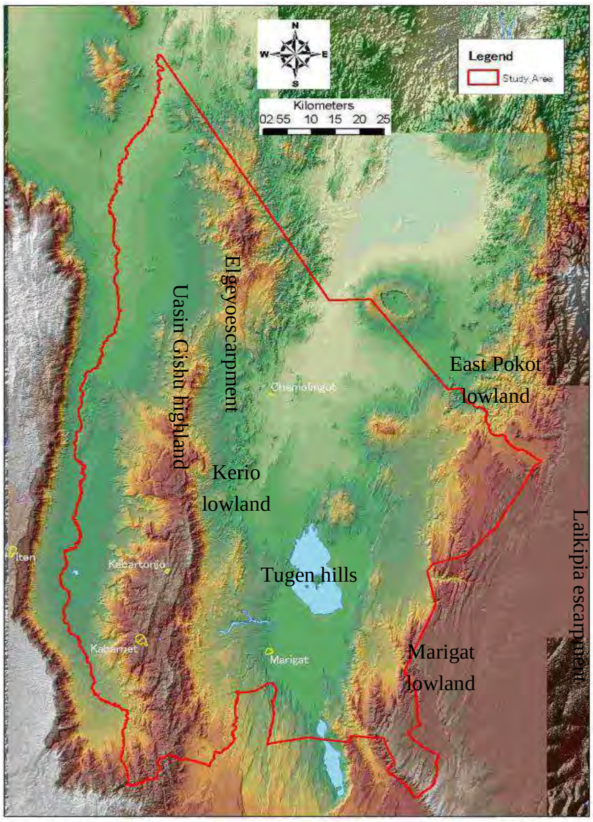



Figure 1-8 Topography of the Project Area

Low-lying areas such as Marigat lowland, East Pokot lowland and Kerio lowland lie among them.

One of the other characteristics is the existence of lakes: Lake Bogoria is located at south of Marigat lowland, and Lake Baringo is in the Marigat lowland. Both lakes are located at the lowest part of each internal drainage basin. Another characteristic is the existence of newly formed volcanoes such as Korosi, Paka and Silali in the East Pokot lowland. These three volcanoes were formed in Quaternary Era, and are expected for geothermal exploitation.

### 1-2-3 Geology

(1) Geology of Kenya

The geology of Kenya consists of Pre-Cambrian, Paleozoic, Mesozoic and Cenozoic rocks and sediments. The geology of Pre-Cambrian belongs to the Mozambique belt. It covers large parts of central and west Kenya, and some of northeast Kenya. The Mozambique belt falls generally into three systems called as the Nyanzian-Kavirondian system, Basement system and Bukoban system from the old system in order. Among these, the Basement system occupies a large portion of Pre-Cambrian in Kenya. The Basement system was thought as base rock in Kenya in the past; however, in the second half of 1966, it became apparent that the Basement system was formed in a newer period than the Nyanzian and Kavirondian systems.

Paleozoic and Mesozoic sedimentary rocks are distributed in northeast and southeast areas of Kenya. These consist of two kinds of rock: one is a peculiar terrestrial deposit correlated with the Karoo system formed from late Paleozoic to early Mesozoic, the other is a marine deposit such as limestone and sandstone formed from Jurassic to Cretaceous.

The geology of Cenozoic consists of volcanic rocks (mainly distributed in the Great Rift Valley) and sedimentary rocks (distributed in a belt continuing to the coast at the east side and around Lake Turkana). Lithological character of intrusive rocks widely changes from acidic to ultra-basic rocks. Intrusive rocks were main products by igneous activities during pre-synorogenic and synorogenic stages, and the rocks are more or less metamorphosed.

On the other hand, there are non-metamorphosed intrusive rocks which formation might be during late synorogenic stage to post synorogenic stage. These intrusive rocks exist as forms of rock sheets, stocks, and dikes. Large scale rock bodies such as batholith were not recognized.

Volcanic rocks were formed with movements of the Great Rift Valley, and it began from activities of basalt during Miocene, and it accompanied eruptive activities of nephelinite and carbonatite in Kenya. In addition, at late Miocene, fissure eruptions formed lava plateaus of phonolites, and also formed trachy-welded tuff. Caldera formation with volcanic activities continued even in Quaternary era.

Sedimentary rocks consist of marine sand of Tertiary era and sand/coral reef of Quaternary era at eastside, and lacustrine sediment during late Miocene to Pliocene around Lake Turkana. (Source: METAL MINING AGENCY OF JAPAN, 1984)

(2) Geology of the Project Area

The geology of the project area consists of: the basement system of Pre-Cambrian; phonolites, trachytes, basalts of Miocene and Pliocene; trachytes, basalts, pyroclastics of Pleistocene; colluvial and flood deposits of Holocene.

Figure 1-10 shows the outline of geology of the project area. The project area is almost located in the Great Rift Valley, and the movement formed many faults in north-south and east-west directions.

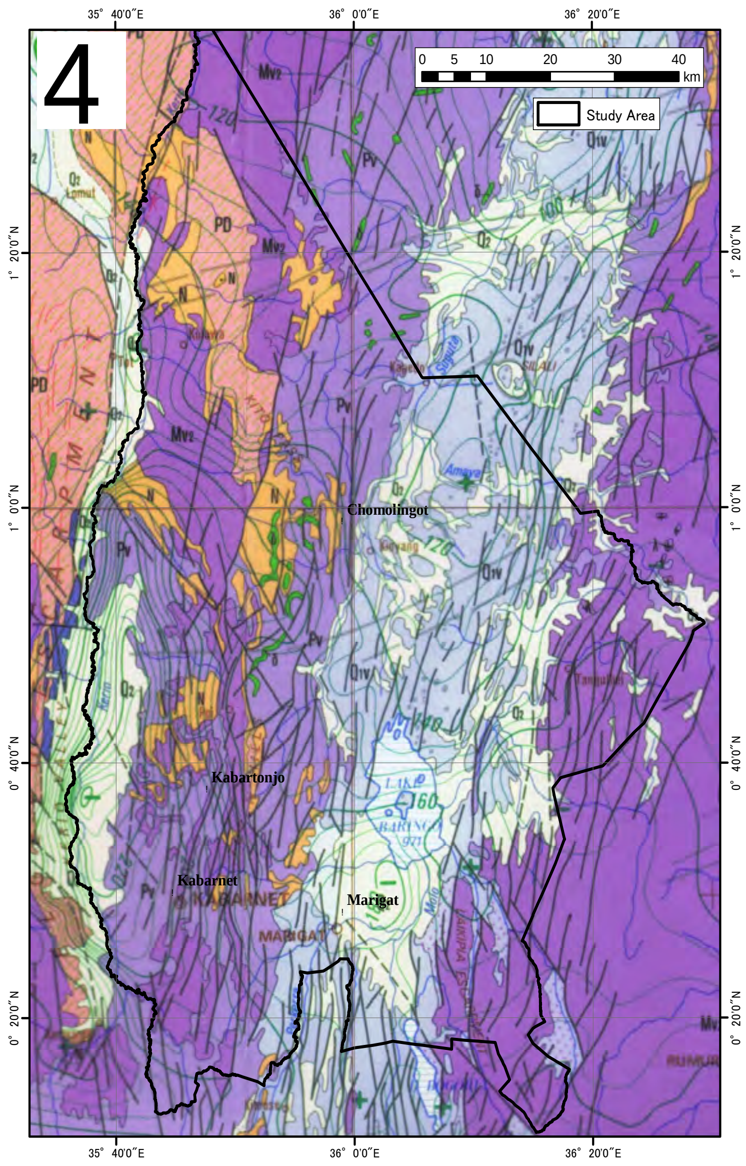



Figure 1-9 Geology of the Project Area

Table 1-3 Stratigraphic Classification of the Project Area

| Geological age | | | Symbol of Geology | Rocks and Sediments facies |
|---|---|---|---|---|
| Cenozoic | Quaternary | Holocene | $Q_2$ | Colluvial deposits、red soils、lacustrine deposits、and flood deposits; these deposits are distributed in lowland. Red sols along Kerio river, lacustrine deposits in lowland. Colluvial deposits at the end of hilly area, food deposits along rivers. |
| | | Pleistocene | $Q_{1v}$ | Trachytes, basalts, pyroclastics. Representative rocks are Baringo trachytes and Baringo basalts, and these geologies can be seen at west side of Lake Baringo. |
| | Neogine | | δ | Intrusive rocks. |
| | | Pliocene | N Pv N | Trachytes, phonolites, basalts, and sedimentary rocks interleaved in igneous rocks. Representative geology is Kabarnet trachytes, which can be seen around Kabarnet. |
| | | Miocene | N Mv N | Trachytes, phonolites, basalts, and sedimentary rocks interleaved in igneous rocks. Representative geology is Samburu Basalt, which is widely distributed around Laikipia and Tugen hills. . . |
| Pre Cambrian | | | PD | Mozambique belt (Basement system). The source rocks were sand, clay and limestone, and those were metamorphosed to gneiss, schist and marble stone. |

## 1-2-4 Hydrogeology

(1) Distribution of Springs

Existing spring data are provided from the counterpart team, and the locations are as described in the following figures with topological map and rainfall distribution maps.

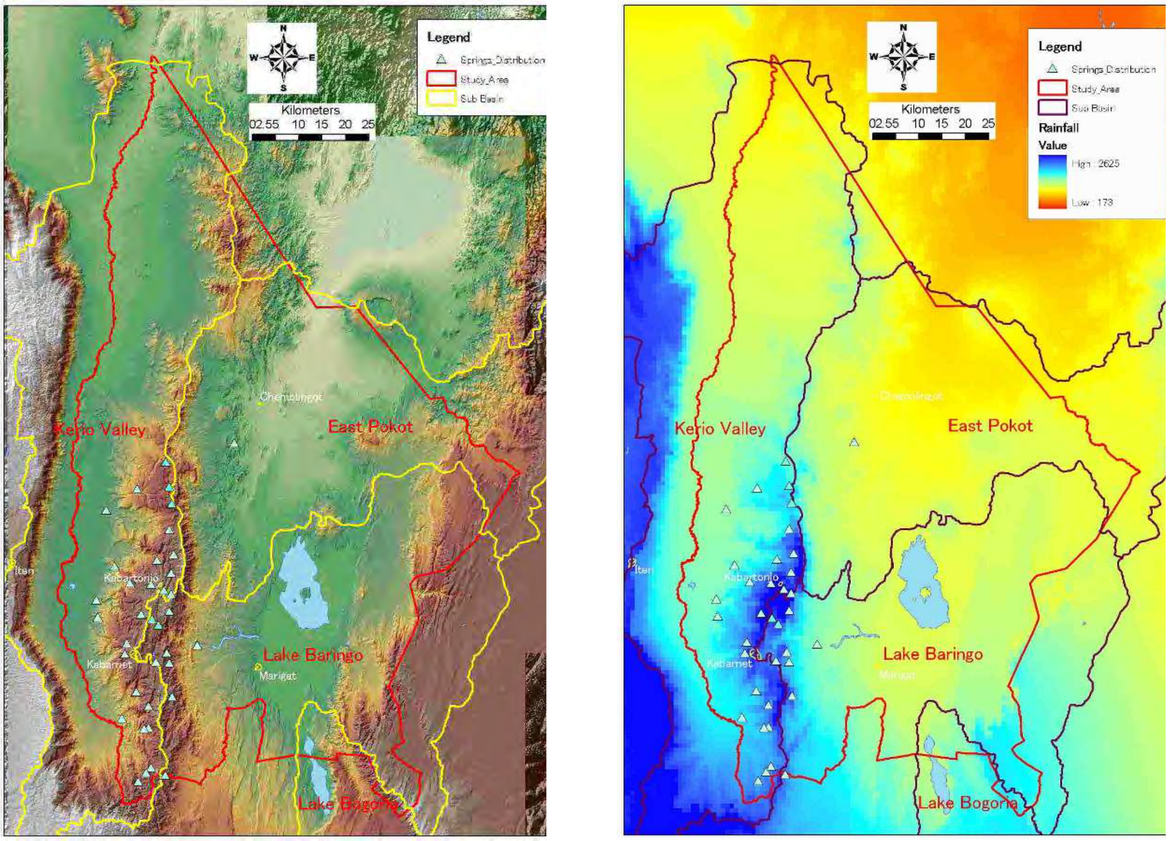



Figure 1-9 Distribution of Existing Springs

The figures show that springs are distributed around Tugen Hills which have a large amount of annual rainfall, and most of the springs are on the west slope of Tugen Hills. The reason is supposed to be that geological layers in Tugen Hills incline westward so that infiltrated rainfall reaching the aquifers flow westward along declined layers.

(2) Yields and Depths of Existing Wells ant Relation with Topography

Yields and depths of the existing wells are shown on the Topographic Map in the following figures.

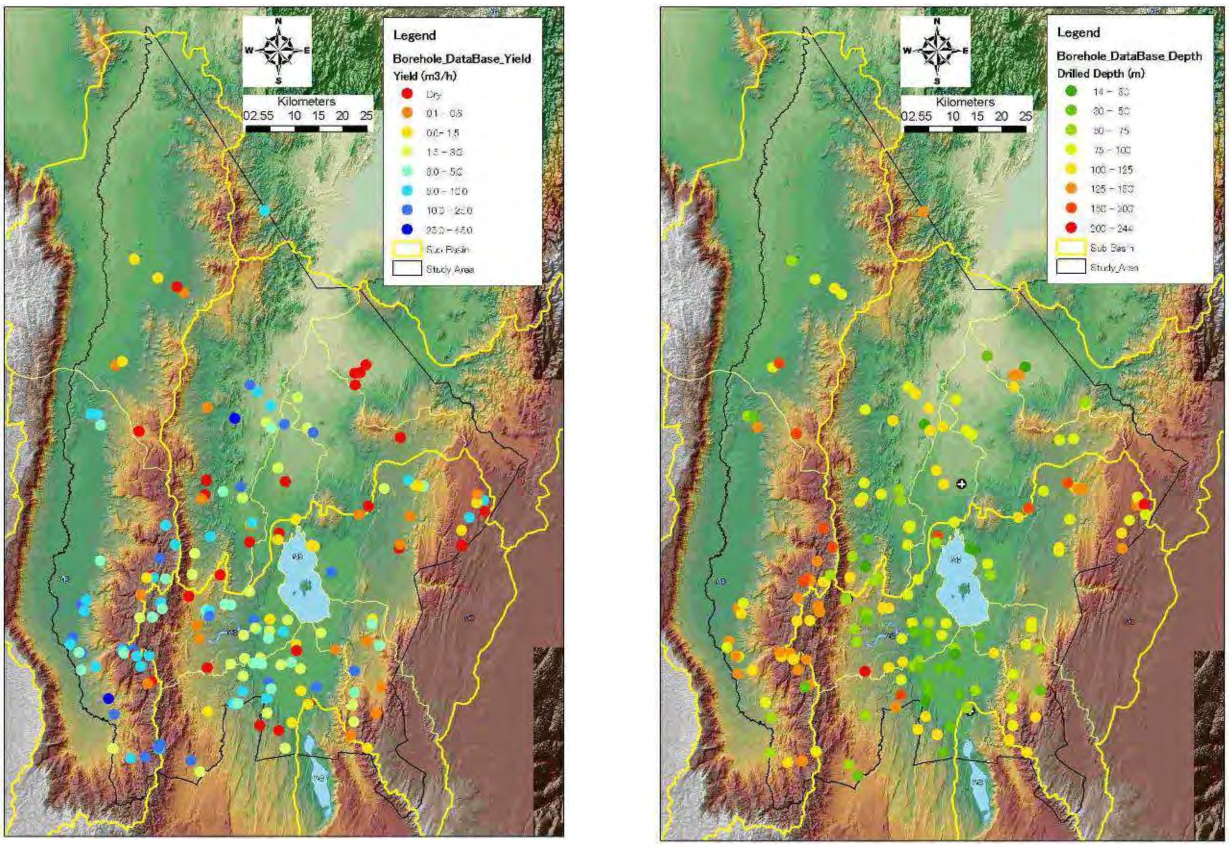



Figure 1-10 Yields (Left Fig.) and Depths (Right Fig.) of the Existing Wells on the Topographic Map

These figures indicate that:

- Southern Part of Kerio valley lowland: More than 3 $m^3$/hour of yield is generally expected. There are some wells with above 15 $m^3$/hour of yield due to blessed topographic condition where the water is easy to get together. The well depths are from 100m to 150m. Groundwater development in this area is relatively easy in the project area.

- Northern Part of Kerio valley lowland: Less than 1.5 $m^3$/hour of yield is expected. The well depths are from 75m to 150m.

- Ridge and Western Slope of Tugen Hills: 2.5 to 20 $m^3$/hour of yield is expected. The dispersion of yield by wells is very large. The well depths are from 100m to 200m. Dry wells are also distributed. Therefore it needs for groundwater development to carefully select well drilling points. The possibility of groundwater development in this area are middle, however, finding suitable points for new wells in the requested sites are not always possible.

- Eastern Slope of Tugen Hills: The slope is very steep so that few existing wells are distributed.

- Southern Part (Hilly area, Plateau and Fan deposit area) of the East side of the Tugen Hills (South of the sub-basin): Dry wells or wells with less 0.6$m^3$/hour of yield are distributed in the area which is close to the east side of steep slope of Tugen hills. The well depths are from 56m to 200m. On the other hand, wells in hilly and fan deposit area close to Marigat lowland generally have yield of 1 - 3m$^3$/hour and the well depth are 35m to 120m. In addition, wells located in suitable condition sometimes have yield of 5 to 15m$^3$/hour and the depths are 40m to 155m. Depth of wells at the plateau area is getting deep.

- Hilly Area of the East side of the Tugen Hills (North of the sub-basin): Wells with 0.6 to 2..7m$^3$/hour of yield and dry wells are distributed in the area which is close to the east side of steep slope of Tugen hills. The well depths are from 50m to 110m. Rain runoff is very rapid so that it may have few recharges to groundwater. On the other hand, the runoff from Tugen hills concentrate to lowland which is stretched to north-south direction and close to East Pokot lowland. The wells in the lowland have yield of 5 to 10m$^3$/hour, and the well depths are around 80m to 120m.

- Marigat Lowland (Sedimentary deposit area: lowland): Marigat lowland is a sedimentary deposit areas between Lake Baringo and Lake Bogoria, and of east of Lake Baringo. The wells in the lowland have yield of 0.7 to 4m$^3$/hour, and the well depths are around 20m to 60m. The wells distributed in the area where the groundwater being easy to concentrate, have yield of 9m$^3$/hour or more, and the well depths are 40m to 70m.

- Plateaus around Marigat Lowland: Volcanic rocks formed in Quaternary era are predominantly distributed in this area. The well yields are almost zero, or 0.5m$^3$/hour or less. The well depths are 90 to 120m.

- East Pokot Lowland: Volcanoes (Korosi, Paka and Silali) formed in Quaternary era are distributed in this area. The depths of existing wells are 100m to 145m; however large numbers of the wells are dry. Some wells which fortunately met localized groundwater have yield of about 2m$^3$/hour, and the depths are around 90m to 120m.

- Mochongai Hills and Mochongai Escarpment: The yields of existing wells distributed in this area are around zero to 0.95m$^3$/hour; and the well depths are 75m to 150m. Finding groundwater is very difficult in the area because the watershed of the area is very small along the escarpment and groundwater resource is small, however some wells fortunately have yields of 2.5 to 6m3/hour and the depths are 45m to 85m.

(3) Yield and Depth of Existing Wells (Relation with Geology)

Yields and depths of collected existing wells are summarized in the following figures.

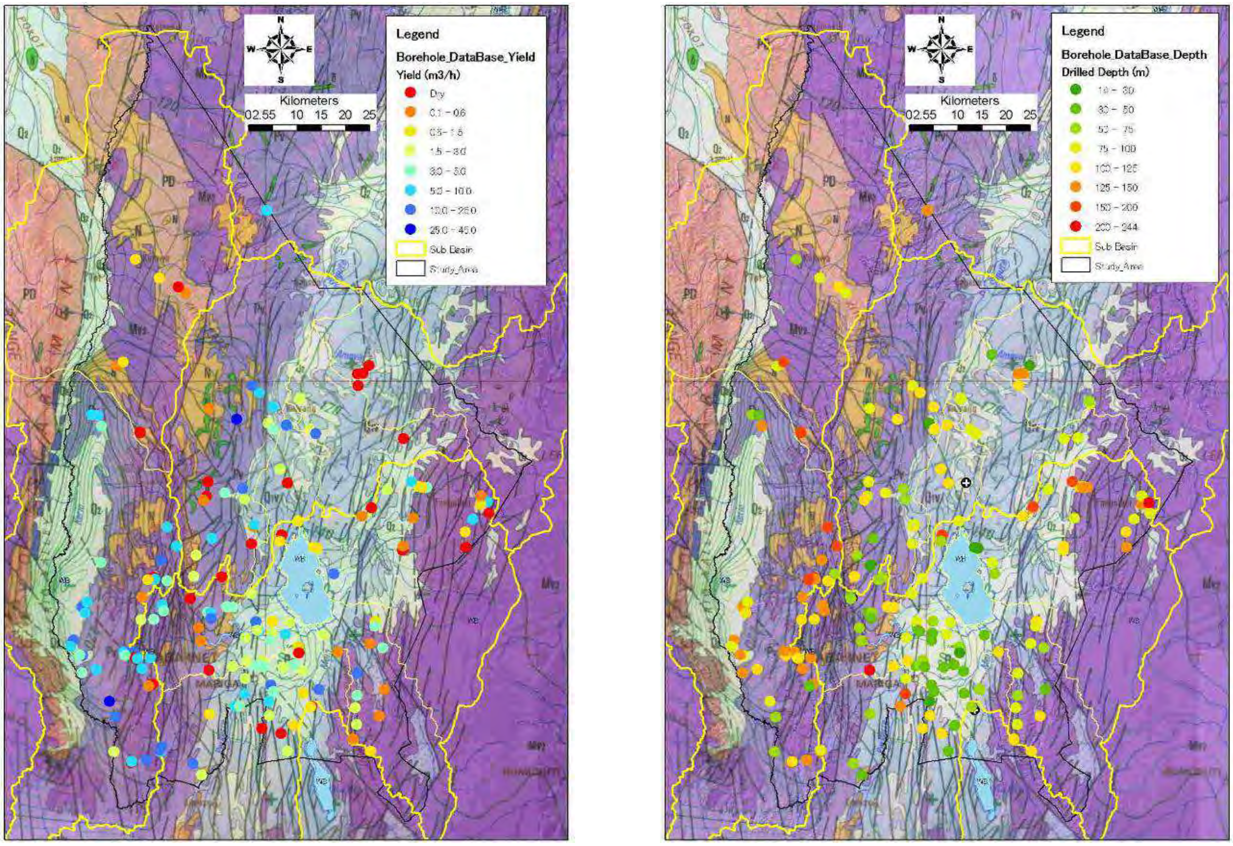



Figure 1-11 Yield (Left Figure) and Depth (Right Figure) of Existing Wells on the Geological Map

At rock distributed areas, groundwater aquifers to be developed are those in fault fracture zone, void in pyroclastics and cracks developed around boundaries of geological layers. At unconsolidated sediment layer distributed areas, groundwater aquifers are sand layers, gravel layers and cracks of rocks below the sediment layers.

As for the difference of well yield, the figures roughly show that the topography (about rainfall distribution) has stronger relation than the geological features. In addition, wells in lowlands consisting of volcanic rocks formed at Quaternary era have smaller yield than the others.

The target aquifers in each area are the following:

- Kerio Valley Lowland: Sediment layer, fractured zone and crack zones in rocks below sediment layers.
- Ridge and Western Slope of Tugen Hills: Fault fracture zone, crack zones in rocks (especially developed around boundaries of geological layers), and pyroclastics.
- Eastern Slope of Tugen Hills: Fault fracture zone, crack zones in rocks (especially developed around boundaries of geological layers), and pyroclastics.

- Southern Part (Hilly area, Plateau and Fan deposit area) of the East side of the Tugen Hills (South of the sub-basin): Colluvial deposits, fan deposits, fault fracture zone, crack zones in rocks (especially developed around boundaries of geological layers), and pyroclastics.

- Hilly Area of the East side of the Tugen Hills (North of the sub-basin): Fault fracture zone, crack zones in rocks (especially developed around boundaries of geological layers), and void in pyroclastics at hilly area near steep slope of Tugen hills; sediment layers is added to the target aquifers in low land which stretched to north-south direction located at eastern part of the hilly area above mentioned.

- Marigat lowland (Sedimentary deposit area: lowland): Sediment layers, colluvial deposits, crack zones of rocks below the sediment layers, and pyroclastics.

- Plateaus around Marigat Lowland: Fault fracture zone, crack zones in rocks, and pyroclastics.

- East Pokot Lowland: Fault fracture zone, crack zones in rocks, pyroclastics, and sediment layers (at particular area).

- Mochongai hills and Mochongai escarpment: Fault fracture zone, crack zones in rocks (especially developed around bed boundaries), and pyroclastics.

### 1-2-5 Groundwater Table

Groundwater tables of the existing wells are summarized and shown on the Topographic Map (left Figure) and Geological Map (right Figure) shown below.

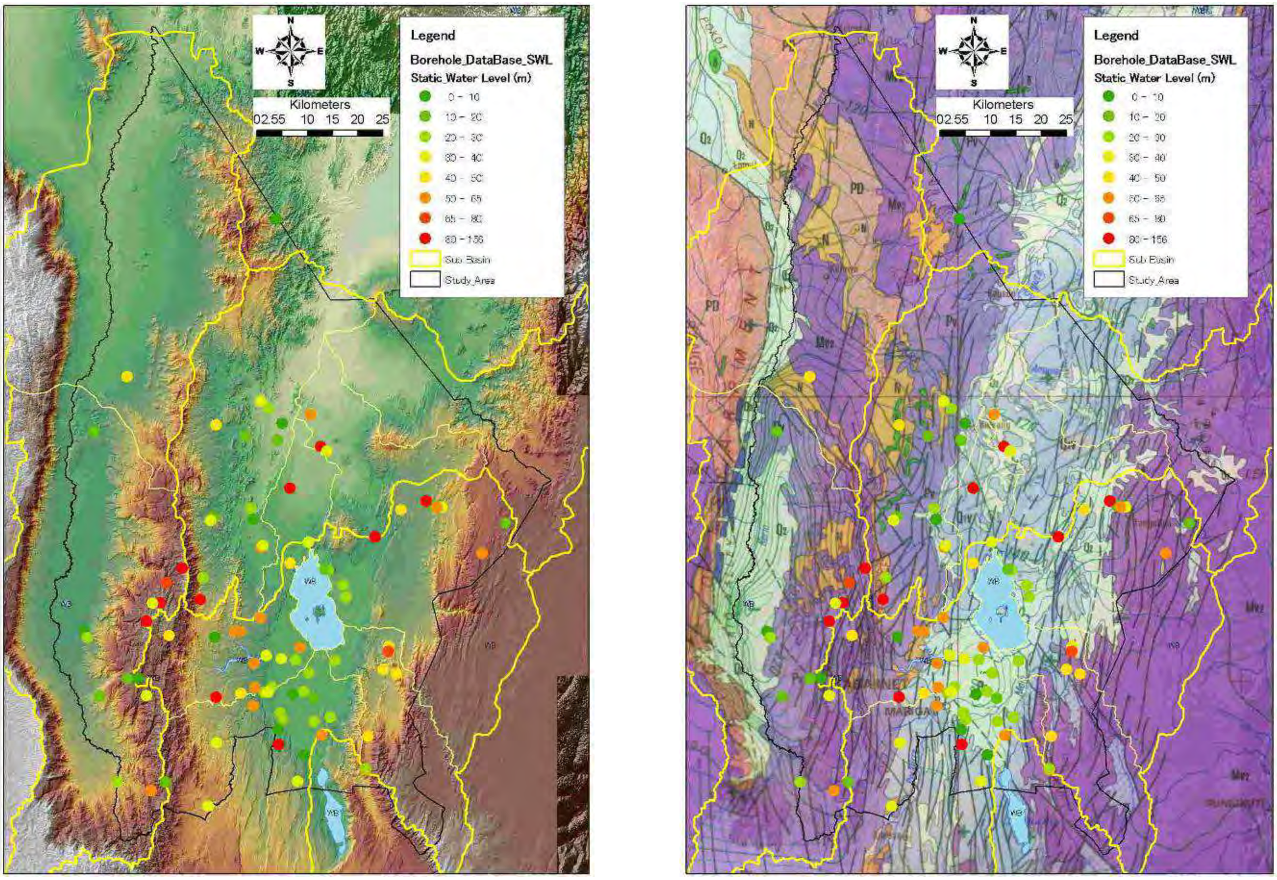



Figure 1-12 Depth Distribution of Groundwater Table of the Existing Wells

Groundwater tables in each area are summarized below based on the above figures.

- Kerio Valley Lowland: around 30m to 40m.
- Ridge and Western Slope of Tugen Hills: Around 30m to 125m. The depths of the groundwater tables vary widely in this area.
- Eastern Slope of Tugen Hills: Almost no existing wells are distributed in this area so that the groundwater tables are not known.
- Southern Part (Hilly area, Plateau and Fan deposit area) of the East side of the Tugen Hills (South of the sub-basin): Around 50m to 60m.
- Hilly Area of the East side of the Tugen Hills (North of the sub-basin): Around 20m to 80m. The depths of the groundwater tables vary widely in this area.
- Marigat Lowland (Sedimentary deposit area: lowland): Around 20m to 35m.
- Plateaus around Marigat Lowland: Around 35m to 95m. The depths of the groundwater tables vary widely in this area.

- East Pokot Lowland: Around 60m to 110m. The groundwater table is deep despite the wells are distributed in lowland area.
- Mochongai Hills and Mochongai Escarpment: Only one existing data is obtained, and the groundwater table is around 55m.

## 1-2-6 Water Quality

(1) Water Quality Standards

Kenya has two kinds of drinking water standards. One is written in “DRINKING WATER QUALTY AND EFFLUENT MONITORING GUIDELINE (Water Service Regulatory Board)”. The other is in “PRACTICE MANUAL FOR WATER SUPPLY SERVICES IN KENYA.” The items and regulation values are summarized in the tables below with the guideline values of corresponding water quality items of WHO Guideline 2004. It should be noted that some items in both Kenyan Standards have desirable and permissible values.

Table 1-4 Drinking Water Quality Regulation Values among Kenyan Standards and WHO Guideline

| | Water Quality Analysis Items | Unit | Kenyan Standard | | | WHO (2004) |
|---|---|---|---|---|---|---|
| | | | Guideline | Manual | | |
| | | | | Desirable | Permissible | |
| 1 | Colour | TCU | 15 | | 50 | --- |
| 2 | Taste and odour | --- | Shall not be offensive to consumers | | | --- |
| 3 | Suspended matter | --- | Nil | | | --- |
| 4 | Turbidity | NTU | 5 | | 25 | --- |
| 5 | TDS | mg/L | 1500 | | | 1000 (1984) |
| 6 | Hardness as CaCO3 | | 500 | | | --- |
| 7 | Aluminum as A1 | | 0.1 | | | 0.2 (1984) |
| 8 | Chloride as Cl- | | 250 | | 600 | 250 (1984) |
| 9 | Copper as Cu | | 0.1 | | 1.5 | 2 |
| 10 | Iron | mg/L | 0.3 | | 1.0 | 0.3 (1984) |
| 11 | Manganese | mg/L | 0.1 | | 0.5 | 0.4 |
| 12 | Sodium as Na | mg/L | 200 | | | 200 (1984) |
| 13 | Sulphate as SO4 | mg/L | 400 | | | 500(recommended) |
| 14 | Zinc as Zn | mg/L | 5 | | 15 | 5 (1984) |
| 15 | PH | | 6.5 – 8.5 | | 6.5 – 9.2 | --- |
| 16 | Magnesium as Mg | mg/L | 100 | | | --- |
| 17 | Chlorine concentration | mg/L | 0.2 - 0.5 | | | 5 |
| 18 | Calcium as Ca | mg/L | 250 | | | --- |
| 19 | Ammonia (N) | mg/L | 0.5 | | | --- |
| 20 | Fluoride | mg/L | 3.0 (1.5) | 1.5 | | 1.5 |
| 21 | Arsenic | mg/L | 0.05 | | | 0.01 |
| 22 | Cadmium as Cd | mg/L | 0.005 | | | 0.003 |
| 23 | Lead as Pb | mg/L | 0.05 | | | 0.01 |
| 24 | Mercury (total Hg) | mg/L | 0.001 | | | 0.006 |
| 25 | Selenium as Se | mg/L | 0.01 | | | 0.01 |
| 26 | Chromium as Cr | mg/L | 0.05 | | | 0.05 |
| 27 | Cyanide as CN | mg/L | 0.01 | | | 0.07 |
| 28 | Phenolic substances | mg/L | 0.002 | | | --- |
| 29 | Barium as Ba | mg/L | 1.0 | | | 0.7 |
| 30 | Nitrate as NO3 | mg/L | 10 | | | 50 |

Note) The values in the Table with "(1984)" means that guideline values did not established in the WHO Guideline after 1984 due to small effects of the items to human health. As for Fluoride, "DRINKING WATER QUALTY AND EFFLUENT MONITORING GUIDELINE" has explanatory note, and it says "the local and climatic conditions necessitate adaptation of Fluoride concentration in excess of 1.5 mg/L. In exceptional cases, a Fluoride content of 3mg/L can be acceptable in Kenya."

(Yellow) Items in Kenyan standards have lax regulation values than the one in WHO Guideline.

(Blue) Adopted regulation values in this project

The project is one of rural drinking water supply projects. The local and climatic conditions of the project area are very severe so that the development of groundwater is very difficult to keep with regular Kenyan standards of drinking water. Therefore, permissible values are adopted for the project in case the Kenyan standards have the corresponding values. Blue colored cells in the table show the adopted permissible values in the project.

(2) Total Dissolved Solid (TDS)

TDS data of existing wells were collected as summarized in the figures below. The figures show that there are some wells in which TDS values of groundwater exceed the regulation value (1500 mg/L). They are the 2 wells around Lake Baringo, 6 wells in Marigat lowland, 1 well at southern plateau of Marigat lowland, and 2 wells in East Pokot.

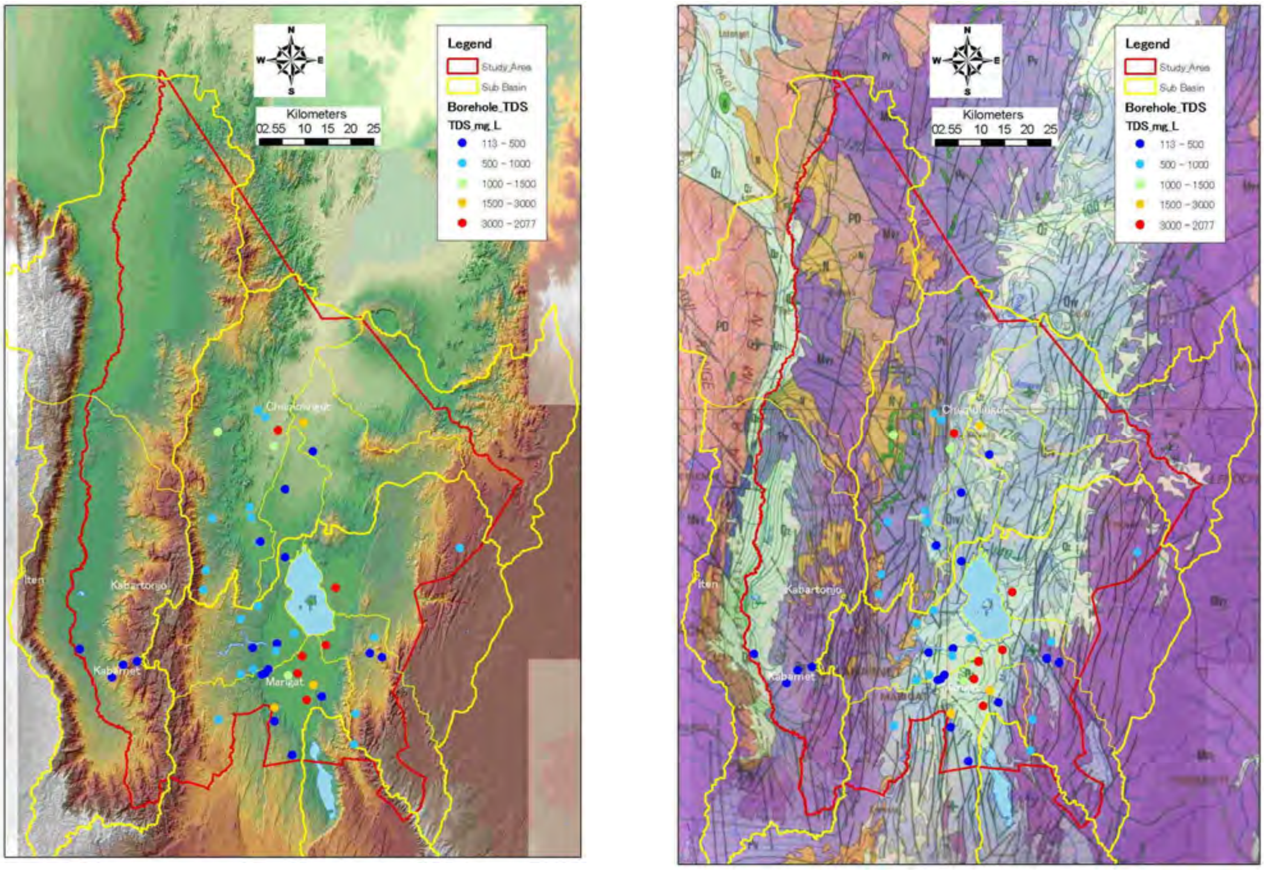



Figure 1-13 TDS Concentration of Groundwater in Existing Wells

The area around Lake Baringo and Marigat lowland is in the depression zone, and they are also located at the lowest reach of the sub-basin which has the hydrological structure of an internal drainage basin, so that the main deposits of sedimentary layers are lacustrine deposits. The areas under semi-arid climate have the general tendency of high evaporation, so that the groundwater in such areas may be rich in minerals. Therefore, the groundwater in the lacustrine deposits of the area around Lake Baringo and Marigat lowland is assumed to be rich in minerals and cause high TDS in the groundwater.

TDS values in groundwater satisfy the regulation values at a part of Marigat lowland near the southern plateau. The reason may be the rapid groundwater recharge from Tugen hills, especially from the highland area of the hills.

On the other hand, the causes mentioned above do not apply to the groundwater of the wells in the plateaus located at the south of Marigat lowland and East Pokot where TDS exceed the regulation value. One of the possible causes is the effect of volcanic activities of volcanoes during the Quaternary era such as Volcano Korosi, Paka and Silali.

Lake Baring is expected to be a salt lake from this standpoint; however, it actually is a freshwater lake with a high concentration of fluoride. The causes may be that the formation age of the lake is new, and/or the lake water leaks to the downstream basin with minerals.

(3) Fluoride

Fluoride data of existing wells are collected and summarized in the following figures. When the permissible value of fluoride in Kenyan standard applies to the project, it is 3mg/L. In this case, the figures show that there are some wells where fluoride values of groundwater exceed the permissible value. Those are distributed around Lake Baring, some parts of Marigat lowland, and the hilly area and lowland of East Pokot.

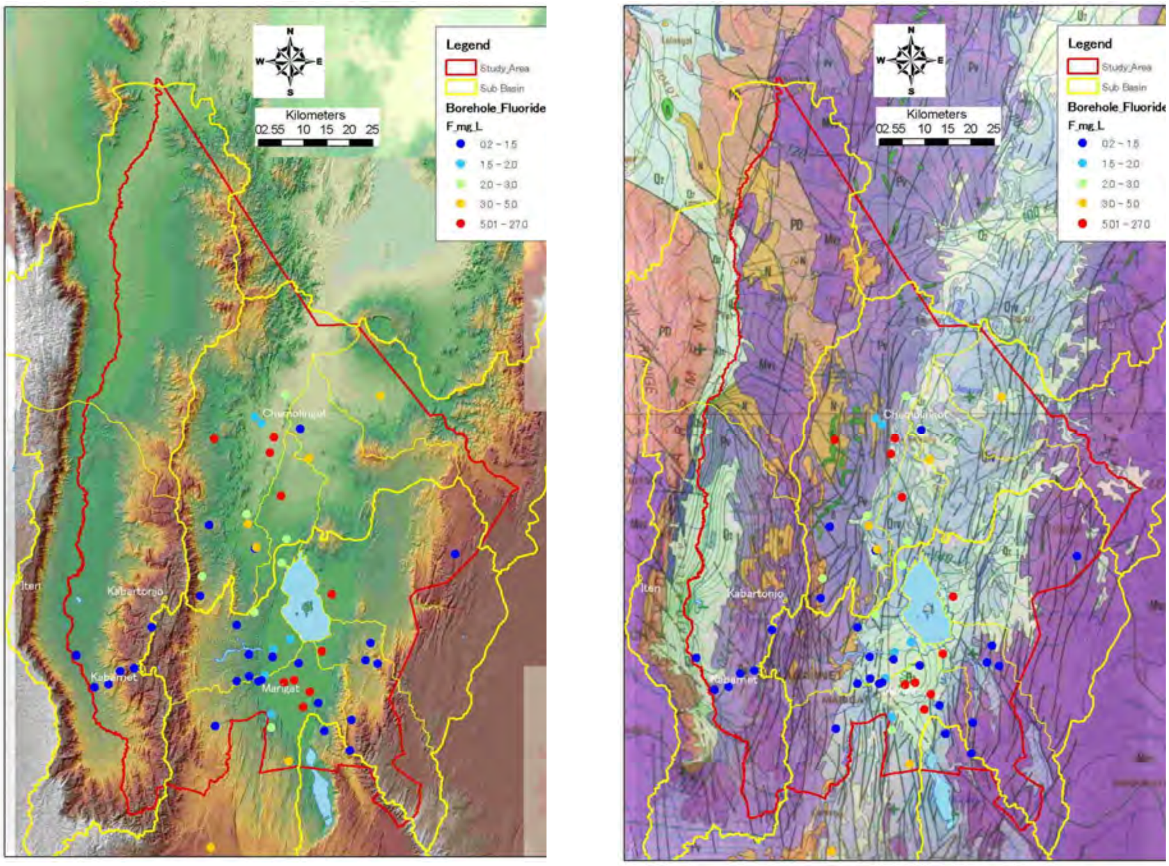



Figure 1-14 Fluoride Concentration of Groundwater in Existing Wells

As stated in the previous section (TDS), the area around Lake Baringo and Marigat lowland are under the condition that minerals easily accumulate. Consequently, it is possible that fluoride concentration of groundwater in the lacustrine deposits is high. However, considering that water of Lake Baringo is fresh, the condition may be another cause resulting from volcanic geology. Including East Pokot, wells with high fluoride concentration in fact are distributed on rocks such as trachyte, trachy-phonolite and basalt. Those rocks were formed under volcanic activities in Quaternary era. However, one exception is fluoride seems to come from intrusive rock. Kukwa Island also consists of volcanic rocks. Therefore, those areas may have groundwater with high concentration of fluoride.

(4) Iron

Iron data of existing wells are collected and summarized in the following figures. The figures show that there are some wells in which iron concentration of groundwater exceed the permissible value (1.0 mg/L). Those are the 7 wells at the hills and lowland around Lake Baringo, 1 well in East Pokot lowland, 2 wells at the southern hilly area of Tugen hills, and 2 wells in the Mochongai escarpment. Iron widely exists in earth crust and groundwater, so that it is difficult to find relation with geology.

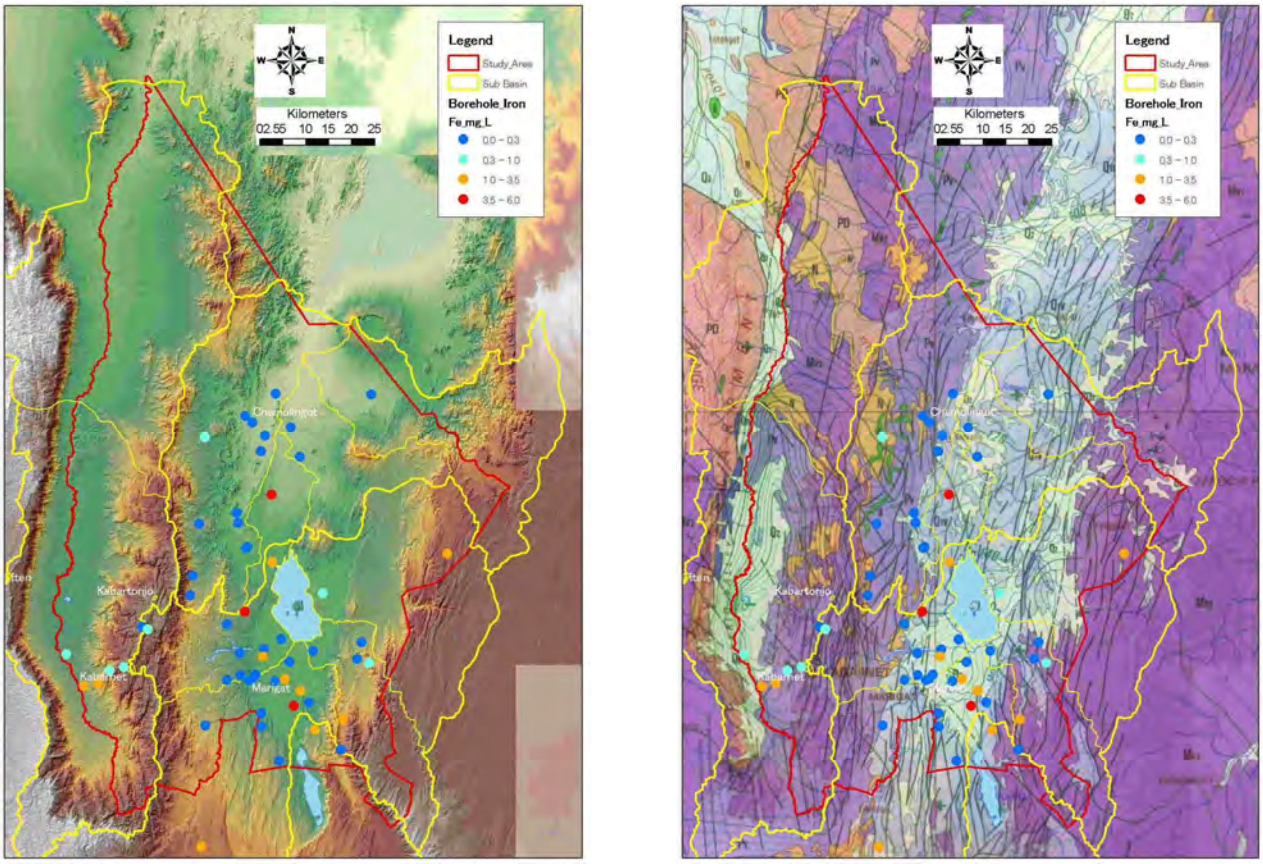



Figure 1-15 Iron Concentration of Groundwater in Existing Wells

(5) Manganese

Manganese data of existing wells have been collected and summarized in the following figures. The figures show that there are some wells in which iron concentration of groundwater exceed the permissible value (0.5 mg/L). Those are the 3 wells at the southern lowland around Lake Baringo. The result does not change when the WHO guideline value (0.4 mg/L) is applied.

Manganese as well as iron also widely exists in earth crust and groundwater. Iron and manganese are transition elements which are adjacent in the periodical table of chemical elements, so that these two elements often coexist. Therefore, the distribution of manganese exceed the permissible concentration seemingly limited to Marigat lowland, but it is natural to see that no relation exists between geology and concentration of manganese as well as iron.

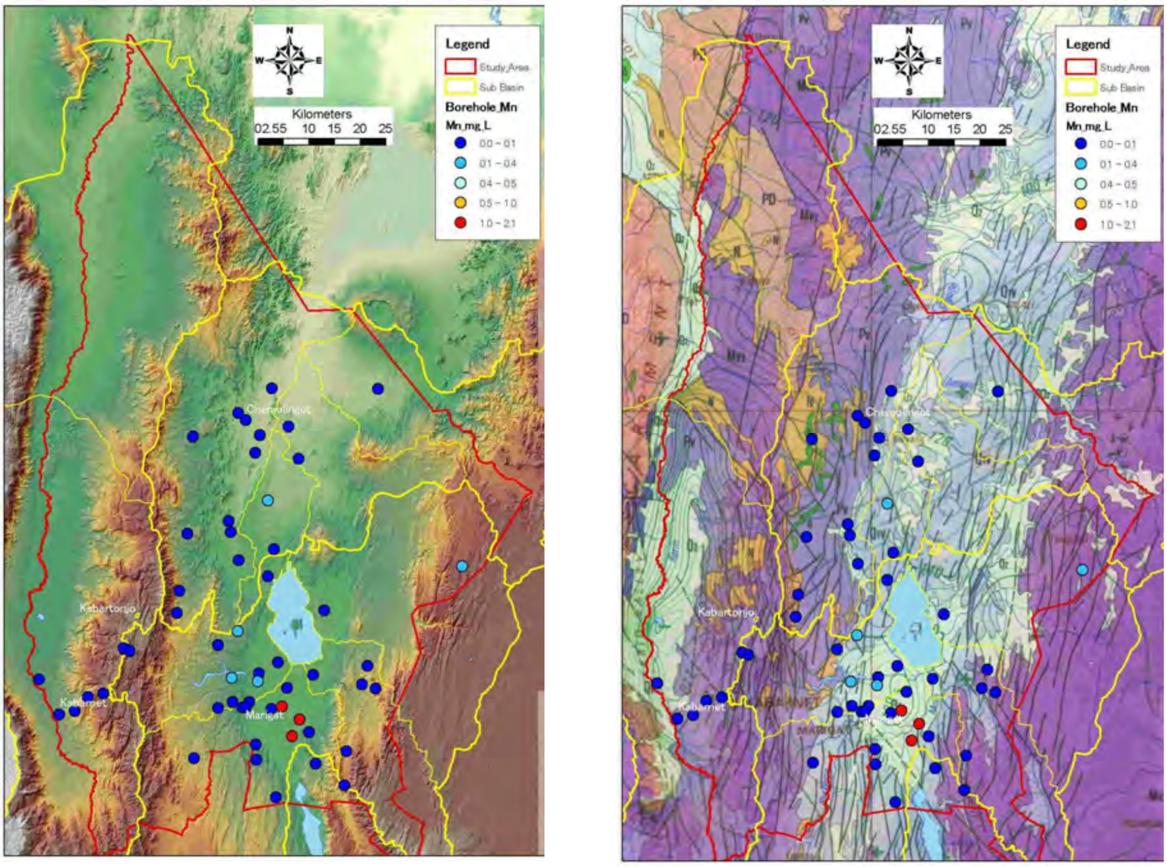



Figure 1-16 Manganese Concentration of Groundwater in Existing Wells

## 1-2-7 Geophysical Survey

The geophysical survey was carried out to obtain the following information:

Geological and hydrogeological condition to select the 10 test drilling survey points

Geological and hydrogeological condition of the Project Area

Conditions to design the production well structures at selected communities

(1) Geophysical Survey for determining 10 Test Drilling Survey Points

The survey team collected and summarized existing topological and geological data, information of existing wells, and the location and population of each requested communities. Then, it selected 10 communities from the communities in which the information on existing wells are short. Communities with larger population were given high priority for the selection, and geophysical survey was conducted for determining one test drilling point in each selected village. As an exception, one village with low population was selected in Marigat lowland, because there are no communities with higher population but whose grounds may have sedimentary aquifers with different fluoride concentrations.

There seems to be two kinds of aquifers in the project area: one is the fault fracture zone, and the other is sedimentary layers, so that the application of number of HEP and VES were changed for the aquifer types. In either case, firstly, site reconnaissance was conducted and, secondly, points with high groundwater development potential were chosen from the hydrogeological point of view, and then geophysical survey was conducted for the points.

[The Geophysical Survey for the Aquifer of Fault Fracture Zone]

As a rule, firstly, two HEPs were conducted at probable sites to know the exact location of faults. Secondly, three VESs were conducted at each promising point to obtain geological profiling data in depth.

[The Geophysical Survey for the Aquifer of Sedimentary Layers]

Basically, three VESs were conducted at a promising site in the selected site.

[Exploration Methods]

Horizontal Electrical Profiling (HEP)

Electrode configuration: Wenner array

Number of exploration points: Two lines in each village.

Exploration depth: 30m

Length of survey line: around 200m

Vertical Electrical Sounding (VES)

Electrode configuration: Shlumberger array

Number of exploration points: 3 points in each selected village

Exploration depth: 200m

[The Result of Geophysical Survey]

The locations of the 10 communities selected are shown in the following figure. The number of conducted geophysical surveys is shown in the following table.


Figure 1-17 Location of Ten Sites Selected

Table 1-5 Number of Explored Sites of Each Selected Village for the Test Drilling Survey

| Code | Selected Sites | Location | Division | No. of HEP | No. of VES |
|---|---|---|---|---|---|
| 24 | Toboroi | Kinyach | Bartabwa | 2 | 3 |
| 110 | Kapsikoryan | Kiboino | Salawa | 2 | 2 |
| 131 | Kabasis | Kabasis | Sacho | 2 | 3 |
| 137 | Kapkawa | Ewalel | Kabarnet | 2 | 3 |
| 67 | Lesuuwa | Ng'ambo | Marigat | 0 | 3 |
| 86 | Samuran | Sandai | Marigat | 0 | 3 |
| 103 | Kakwane | Lelmen | Salawa | 0 | 3 |
| 153 | Chebilat | Loruk | Mondi | 1 | 3 |
| 185 | Chesakam | Ribko | Nginyang | 0 | 3 |
| 155 | Naudo | Naudo | Mondi | 0 | 1 |
| Total | | | | 9 | 27 |

The estimated aquifer profile for selected test drilling points in each village selected is shown in the following table using VESs. The detailed data of each VES are shown in the Appendix.

Table 1-6 Estimated Aquifer Profile at Selected Test Drilling Points by Geophysical Survey

| Code | Selected Communities | Estimated Aquifer | Resistivity (Ohm-m) | Depth of Aquifer (m) | |
|---|---|---|---|---|---|
| | | | | Top | Bottom |
| 24 | Toboroi | Trachyphonolites, Basalts | 20 | 46 | --- |
| 110 | Kapsikoryan | Trachyphonolites | 120 | 8.3 | 130 |
| 131 | Kabasis | Trachyphonolites, Basalts | 38 | 15 | 200 |
| 137 | Kapkawa | Trachyphonolites, Basalts | 26 | 54 | --- |
| 67 | Lesuuwa | Basalts | 12 | 11 | 45 - 70 |
| 86 | Samuran | Sediments, Basalts | 40 | 65 | --- |
| 103 | Kakwane | Sediments, Basalts | 22 | 16 | 231 |
| 153 | Chebilat | Pyroclastic rocks | 18 | 140 | --- |
| 185 | Chesakam | Pyroclastics, basalts | 20 | 61 | --- |
| 155 | Naudo | Basalts | 50 | 94 | --- |

(2) Geophysical Survey for Design of Production Well and Obtaining Hydrogeological Data at Selected Communities

Selecting 112 communities from 140 candidate communities, geophysical surveys were conducted to get hydrogeological information and for design of production wells. When communities close to each other were considered to have same hydrogeological condition, one VES was conducted at representative point in the area. Selected 10 communities for test drilling survey were not included in 140 communities. The geophysical survey for test drilling survey also can contribute to the purpose of this section.

[Exploration Methods]

Vertical Electrical Sounding (VES)

Electrode configuration: Shlumberger array

Number of exploration points: 1 point in each selected village

Exploration depth: 200m

As an exception, for Lomyek Village, one HEP and two VES were implemented because the village was one of candidate site for test drilling survey.

[Result of Geophysical Survey]

The locations of 112 VESs are shown in the following table. The results are shown in the Appendix.

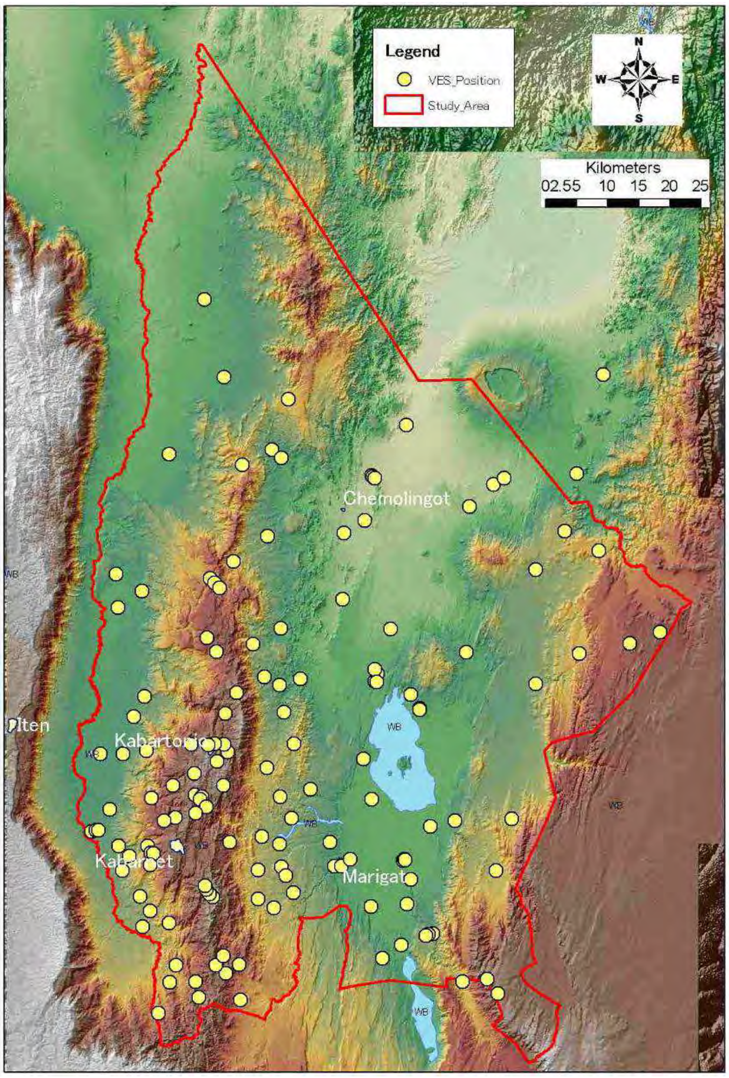



Figure 1-18 Locations of VES for Design of Production Well and Hydrogeological Data obtained at Selected Communities

## 1-2-8 Test Drilling Survey

The survey team collected and summarized existing topological and geological data, information on existing wells, and the location and population of each requested community, Then, it selected 10 communities in which information on existing wells is short. Communities with larger population were given high priority for the selection, and geophysical survey was conducted for determining one test drilling point in each selected village. As an exception, one village with low population was selected in Marigat lowland, because there are no communities with higher population but whose grounds may have sedimentary aquifers for surveying the difference of fluoride concentration in each aquifer.

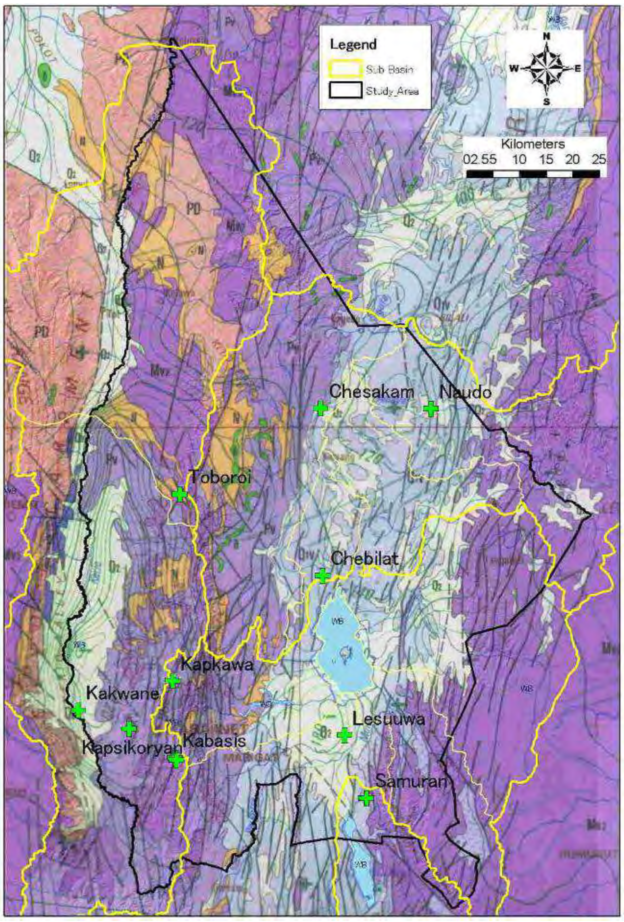



Figure 1-19 Location of Ten Test Drilling Communities

The results of test drilling surveys are summarized in Table 1-7.

Table 1-7 Results of Ten Test Drilling Surveys

| Code | Village | Zone | Provisional Depth(m) | Drilled Depth (m) | Safe Yield ($m^3/h$) | Static Water Level (m) | TDS (mg/L) | F (mg/L) | Fe (mg/L) | Mn (mg/L) | As (mg/L) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24 | Toboroi | Highland | 200 | 204 | | | | | | | | Dry |
| 110 | Kapsikoryan | Highland | 150 | 132 | 4.16 | 56.80 | 130 | 0.47 | 0.42 | <0.1 | Nil | |
| 131 | Kabasis | Highland | 200 | 230 | | | | | | | | Dry |
| 137 | Kapkawa | Highland | 200 | 204 | 19.39 | 47.90 | 100 | 0.0 | 0.74 | 0.0 | Nil | |
| 67 | Lesuuwa | Lowland | 70 | 100 | 3.00 | 18.30 | 2730 | 17.1 | 0.28 | <0.1 | 0.04 | Blackish |
| 86 | Samuran | Lowland | 100 | 100 | | | | 0.67 | 1.9 | <0.1 | | Little |
| 103 | Kakwane | Lowland | 100 | 86 | 5.60 | 39.55 | 270 | 0.72 | 0.6 | 0.1 | Nil | |
| 153 | Chebilat | Lowland | 160 | 180 | | | | 2.69 | 7.5 | <0.1 | | Little |
| 185 | Chesakam | Lowland | 90 | 86 | 23.80 | 10.55 | 360 | 2.2 | 0.06 | 0.2 | Nil | |
| 155 | Naudo | Lowland | 130 | 154 | 7.06 | 112.3 | 780 | 2.13 | 0.12 | 0.1 | 0.04 | Hot: 45℃ |
| Total | | | 1400 | 1476 | | | | | | | | |

In addition, groundwater sampling in different depths and their water quality tests were conducted to know if there is a difference in water quality in the different sedimentary layers using test drilling wells in the lowland. The results are summarized in Table 1-8.

Table 1-8 Results of Water Quality Tests of Different Aquifers in Test Drilling Wells at Lowland

| Test Drilling Village | Depth (m) | Fluoride (mg/L) | Iron (mg/L) | Manganese (mg/L) | EC (μS/cm) | pH |
|---|---|---|---|---|---|---|
| Chesakam | 30 | 2.4 | 0.1 | Below 0.1 | 760 | 7.9 |
| | 45 | 2.4 | 0.1 | Below 0.1 | 750 | 7.9 |
| | 58 | 2.4 | 0.1 | Below 0.1 | 750 | 7.9 |
| Naudo | 120 | 4.3 | 0.1 | Below 0.1 | 1540 | 7.9 |
| | 140 | 4.3 | 0.1 | Below 0.1 | 1530 | 7.8 |
| Kakuwane | 65 | 0.8 | 0.6 | Below 0.1 | 560 | 7.5 |
| | 75 | 0.8 | 0.6 | Below 0.1 | 560 | 7.4 |
| Lessuwa | 50 | 27.0 | 3.7 | Below 0.1 | 5660 | 8.0 |
| | 78 | 21.6 | 2.4 | Below 0.1 | 5410 | 7.8 |
| | 88 | 18.1 | 2.0 | Below 0.1 | 5170 | 7.5 |

Only one test drilling point in Lessuwa Village located in Marigat lowland showed difference of groundwater quality in depth. The groundwater quality at Lessuwa gets better as the well depth becomes deeper. However, the concentrations of fluoride and iron exceed the permissible values of Kenyan standards to a large extent. In addition, the electric conductivity shows more than 5,000μS/cm. This means that the groundwater is highly salty.

For these facts, efforts of developing groundwater in a lowland where the groundwater quality of existing wells did not meet the Kenyan standards seem to be very difficult.

## 1-3 Consideration for Social and Environmental Conditions

### 1-3-1 Laws and Regulations related to Environment

In Kenya, there are various environmental regulations on forest conservation, wildlife protection, sea water conservation, public health, agriculture and fisheries conservation, water conservation and other areas. The basis of the environmental law is the Environmental Management and Coordination Act, 1999 (EMCA) and based on this, the Environmental Impact Assessment and Audit Regulations (EIAAR) was enacted in 2003.

(1) Environmental Management and Coordination Act (EMCA)

EMCA is the basis of the national environmental policy. The law consists of the following 14 chapters:

Table 1-9 Contents of Environmental Management and Coordination Act

| Chapters | Contents |
|---|---|
| Chapter 1 | Introduction |
| Chapter 2 | Common Principles |
| Chapter 3 | Environmental Mechanism |
| Chapter 4 | Environmental Planning |
| Chapter 5 | Environmental Preservation / Conservation |
| Chapter 6 | Environmental Impact Evaluation |
| Chapter 7 | Environmental Audit and Monitoring |
| Chapter 8 | Environmental Standards |
| Chapter 9 | Environmental Restoration Order, Preservation Order, the Environment Usufruct |
| Chapter 10 | Inspection on Environmental Protection, Analysis, and Data Storage |
| Chapter 11 | International treaties / Conventions / Agreement |
| Chapter 12 | Establishment of the National Environment Court |
| Chapter 13 | Penalties for Violations |
| Chapter 14 | Separate Regulations pertaining to this Act |
| Supplementary Provision 1 | Agencies and Constituent Members of the National Environment Council (Under Secretary) |
| Supplementary Provision 2 | Projects Subject to Environmental Impact Assessment Project |
| Supplementary Provision 3 | Constituent Members of the National Environment Action Plan Committee |

Source：Environmental Management and Coordination Act, 1999

In addition, according to EMCA Supplementary Provision 2, an environmental approval prior to implementation of the project (Environmental License) is required to be obtained for the businesses listed below. There is no categorization by size and degree of expected impact of the project (e g. JICA's Guidelines Category A, B, C).

① General Matters: projects which assume significantly different use of the structure, land and businesses from the current state of the area

② Urban development: new urban development, industrial parks, construction of new recreational community shopping centers, etc.

③ Transportation development: Main highway, roads in mountainous forest area, wetland scenic areas, railways, airports, oil and gas pipelines, water transport, etc.

④ Dams, river development, water resources development: dam reservoirs, river basin changes, transfers of water between catchments, flood control, groundwater development, etc.

⑤ Aerial spraying of pesticides

⑥ Various mines, quarries, etc.

⑦ Forestry Development: timber harvesting, reforestation, etc.

⑧ Agricultural development: large-scale farming, agricultural fertilizer use, introduction of a new breed of animal crops, irrigation, etc.

⑨ Industrial Development: ore smelting, casting, brick, cement, fertilizers, petroleum refining, chemical manufacturing, leather tanning, food processing, automobiles, machinery, other manufacturing

⑩ Power Development:

⑪ Natural gas, flammable or explosive gas management

⑫ Sewage effluent various gas, waste disposal, etc.

⑬ Protecting the natural environment in the development of conservation areas: national parks, hunting district, the development of Wildlife, forestry, catchment management, ecosystem management, etc.

⑭ Nuclear energy development

⑮ Biotechnological development: the introduction of technologies such as genetically modified organisms

⑯ Items related to this Project in the above listed 15 provisions are ④, ⑦ and ⑬.

(2) Environmental Impact Assessment and Audit Regulations (EIAAR)

With respect to environmental and social considerations based on the EMCA above, enacted was the EIAAR defining the licensing procedures for EIA related to the principal's role.

Table 1-10 Contents of Environmental Impact Assessment and Audit Regulations (EIAAR))

| Chapters | Contents |
|---|---|
| Chapter 1 | Preface |
| Chapter 2 | Project Report |
| Chapter 3 | Full-scale EIA study report |
| Chapter 4 | Environmental Impact Assessment (EIA full-scale) Research Report |
| Chapter 5 | Environmental Audit and Monitoring |
| Chapter 6 Bylaws | (Environment Impact Assessment, penalty) |
| Supplementary Provisions 1 | Various forms of documents (application forms, certification, etc.) |
| Supplementary provisions 2 | Parameters to be considered in Environmental Impact Assessment |
| Supplementary Provisions 3 | EIA study report contents |
| Supplementary Provisions 4 | EIA specialist certification standards |
| Supplementary Provisions 5 | Costs relating to Environmental License |

Source：Environmental (Impact Assessment and Audit) Regulations, 2003

In addition, the National Environmental Management Agency (NEMA) drafted the Environmental Impact Assessment Guideline and Administrative Procedure in 2002 in line with the EIAAR. Also, as to the water sector, the EIA manual and guidelines have been produced in Part D of the "DMWS" and the procedures are conducted in accordance with these regulations.

### 1-3-2 Environmental Licensing Procedure and Duration

Environmental license has the following 2 steps based on the EIAAR.

(1) Step -1 : Projects licensed with a simple project report

(a) Procedure: After submission of project reports, NEMA conducts an appraisal and if there is little or negligible environmental impact, an environmental permit (Environmental License) is issued.

(b) Examination period : Generally, within 45 days after a project report is submitted (including weekends and bank holidays)

(c) Others: After the target communities are selected project reports need to be expeditiously submitted. 'Licensed' or 'implementation of a full scale EIA' is decided upon appraisal.

(2) Step -2 : Projects that require a full-EIA study and EIA report

(a) Procedure: NEMA reviews the project report, and if significant or some effects are expected, a full scale EIA is requested. After a full EIA report is submitted, an appraisal is conducted.

(b) Examination period : Generally, within 3 months after a project report is submitted to NEMA (including weekends and bank holidays)

(c) Others: these steps include clarification of social and environmental parameters through screening, approval of environmental selected specialists after a public hearing and EIA and submission of the report. In case the projected received 'not licensed', the project needs to be re-planned

The following items are to be included in a project report.

(1) Name, PIN number, address, person in charge, telephone, fax and mailing address

(2) Title of the project

(3) Purpose and magnitude of the Project

(4) Contents of the Project

(5) Target Area

(6) Development environment parameters at the time of construction and servicing:

  (a) Design of the project

  (b) Materials used during construction, an overview of products and byproducts, and the method of disposal

  (c) Preventive measures to reduce problems at and after the project implementation

  (d) Accident prevention that could occur with the project and management action plan

  (e) Health and Safety Management Plan for the workers and residents in the vicinity

  (f) Economic impact on national and local communities levels

  (g) Project Cost

  (h) Public nature of the project

  (j) Environmental Management Plan for the entire project

In addition, the matters described in the EIA shall include the following items:

(1) Target Area
(2) Various business-related laws and regulations, and other information about the underlying data
(3) Purpose of the project
(4) Technology and processes that apply to the implementation of the project
(5) Materials to be used when implementing a project
(6) Products produced with the project, by-products and wastes
(7) The expected impact of the environment
(8) Environmental impact expected from the project implementation (social and cultural influence, direct or indirect effects, the accumulation effect, and long-term and short-term impact)
(9) Possible alternatives (technologies, processes, etc.) and their reasons for selection
(10) Avoidance the environmental impact of the project, the costs of environmental management, duration, responsibilities, etc.
(11) Prevention of accidents through the expected time in service during construction and presentation of Action Plan for the dangerous task management, etc.
(12) Emergency measures for management of health and safety of workers and employees
(13) Lack of information about the environment and recognition of the predicted gap
(14) Economic analysis of the project
(15) Environmental impact in other cases and mitigation measures to ensure a possible workaround
(16) In addition to the above, other parameters and issues requested by NEMA

It was confirmed that environmental licensing is conducted by the Government of Kenya. Basically, a project report is sufficient as long as the project stays off the protected area. The target communities are categorized by location and natural environment and reports are prepared following these categories. The project report is finalized after the selection of the target communities. RV-WSB hires consultants officially registered in NEMA to conduct the assessment.

# CHAPTER 2 CONTENTS OF THE PROJECT

## 2-1 Basic Concepts of the Project

The plan governing the rural water supply projects is "Vision 2030", the long term national development strategy of the Kenya until 2030, and the goal of water coverage proportion is set at 70% in rural areas.

The National Water Services Strategy for 2007-2015, which follows the Water Act of 2002, elaborates the new strategy in the water sector, aiming at water coverage of the national average of 80% in urban and 59% in rural area, which was 57% in 2005/2006 (60% in urban area, 40% in rural area). Access to safe water with a public tap is to be less than 2km. The project is guided by these superior plan and strategy, and is positioned to contribute to improve the rural water supply.

The safe water coverage rate, such as piped water and groundwater, is estimated at about 24% in the survey area, Baringo area, including Baring Central, North Baringo, Marigat and East Pokot districts. Majority of the people need to use dug wells on riverbed, reservoir and springs without sanitation. Therefore, it is an urgent challenge to secure safe and stable water sources.

The project targets 90 sites in Baringo County, and to construct water supply facilities independently in order to increase the water supply coverage rate from 24 % to 37%, with which an improvement of living conditions of the target area is aimed.

To achieve the above objective, the Project is to construct water supply facilities in the target sites. Higher priority is given to communities which have many problems to supply safe and stabile water. Further, the Project is to procure equipment for operation and maintenance of the water supply facilities. Assistance to the management of operation and maintenance is to be provided, such as the training of extension officers in the District Water Office and water users association of the communities, to support establishment of water users association, to train people related to the Project. A summary of the cooperation is outlined in Table 2-1.

Table 2-1 Scope of the Project

| Items | Contents | Outline |
|---|---|---|
| Facility Construction | Construction of Water Supply Facility | 90 sites (borehole, pumping facility, storage tank, public tap, distribution pipe, trough for domestic animal) |
| Procurement of Equipment | Procurement of Equipment for operation and maintenance | 1 double cabin pick-up (4WD), 2 motorbikes(175cc), 1 desktop computer, 1 printer |
| Assistance to Operation and Maintenance | Organizational capacity building training | • Training of extension workers in the District Water Office<br>• Establish Water Users Association, Training of the members of WUA |

## 2-2 Outline Design of the Japanese Assistance

### 2-2-1 Design Policy

#### 2-2-1-1 Basic Policy

(1) Scope of Cooperation

Based on the review of the request from the Kenyan side, the Project shall construct water supply facilities with boreholes, pumping equipment, storage tank, transmission pipes in sites selected from 190 communities in Baringo with high priority, including Baringo Central, North Baringo, Marigat and East Pokot districts.

Equipment for operation and maintenance is to be procured to strengthen technical capacity in the District Water Office. Assistance to management and guidance is planned for sustainable operation and maintenance in order to establish water users association, and training for members of WUA.

(2) Selection of Target Communities

Target communities are to be selected on the priority basis considering conditions of the existing water supply facilities, access to the target area, groundwater development potential, and operation and maintenance capacity of the communities.

Groundwater potential is to be evaluated by the characteristics of each zone categorized by geological and topographical conditions based on the analysis of geophysical prospecting survey, test drilling and hydro-geological data. Borehole conditions with depth, water level and success rate is to be estimated in all sites. Water quality is to be assessed of fluoride, saline and temperatures (vapour).

Operation and maintenance capacity is to be assessed with the results of social survey in order to evaluate community's capacity to operate and maintain a facility.

Based on above-mentioned evaluation, communities having difficulties to operate a facility sustainably are excluded. After priorities are given, types of pumping facility and other facilities are planned. Success rate of the borehole construction is to be estimated. Accordingly, the necessary number of reserved sites are to be selected.

(3) Fluoride Treatment

Fluoride concentration at lowland is expected to be beyond 3.0 mg/L of the Kenya standards. Fluoride treatment by bone-char has been introduced by an NGO in the target area, and this method may be technically acceptable. However, bone-char materials have to be replaced periodically. Some communities made replacement with the assistance of an NGO. In the case of fluoride, hazardous effect to human health is serious in case the concentration is high; however, it is difficult to check by colour and taste of elements such as iron and manganese.

Therefore, fluoride treatment is not included in the Project because the scheme of a Grant Aid Project does not follow a longer term support which is required for the treatment. If the water quality of borehole exceeds the standards of Kenya, borehole is sealed at the top of casing and transferred to Kenya with the condition that the water is not suitable for drinking.

(4) Target Communities and Water Supply Facility Level

The Project aims to secure safe and stable borehole water source with pumping facility, elevated water storage tank, water vending kiosk and a maintenance room.

A suitable power supply for pumping is to be selected according to the site condition. Electric power from the commercial grid, solar panel and generator are the options. Additionally, the following conditions are considered. If position of the borehole is selected at the hollow site far from the road on ridge, storage tank and kiosk house is to be constructed near the road for the benefit of people, and water is to be transmitted from borehole to the tank.

(5) Water Supply Facility

(a) Method of Facility Planning

Facilities are planned for 90 sites. The design criteria are based on the hydro-geological data surveyed in this study. The Project will design the level type of 1.5 (a point-source water supply with power pump); therefore, the facilities have to be carefully planned for each site taking different geological and social conditions into account. Particularly, success rate, yield, and water levels have to be carefully examined to select the types of facilities for each site.

Therefore, the Project will categorise the target sites by geological condition and population and apply standardized facility designs, so that the risk of design change is reduced.

(b) Borehole construction and unsuccessful case

In case the planned water supply volume is larger than assumed groundwater potential and community's population is very large, more than one borehole can be planned. In the implementation stage, if a borehole is unsuccessful, a second drilling is conducted at the site recommended by the detailed design survey. If the second drilling is unsuccessful, another site is to be selected from reserved sites. Unsuccessful boreholes are to be refilled or closed at the casing top and transferred to Kenya, according to the discussion with Kenyan Government.

(c) Selection of energy and type of facility

- Commercial Grid has priority on the energy selection when target site has energy line with 3 phase 415 V or distance from high voltage power line is less than 600m. When the site does not have such a condition, solar energy should be adopted as second alternative with confirmation that solar pump's capacity is available. If both commercial grid and solar energy are difficult to select, a generator can be applied when the community has capacity to pay its cost of operation and maintenance.

- Other water supply facilities are composed of a borehole pit, transmission pipes, a storage tank, a water kiosk, an animal water trough and protection fence. These facilities should be considered as to their endurance, function and cost performance.
- When the volume of borehole pit is the same as the transmit pipe, one design is applied if the transmission pipes have no significant difference.
- Material and installation method of the transmission pipe should be determined in consideration of condition of surface soil. Size of the pipe can be same, and length of pipe shall adopt the average of the estimated length of the target communities.
- Storage tank is the elevated type. However, tanks on the ground are used if a naturally elevated position is available.
- Water kiosk is designed with endurance. When generator is required, separate room for the generator is to be installed.
- The Contractor shall construct fences and drains.

### 2-2-1-2 Policy on Natural Conditions

(1) Climate Conditions

The target area receives a lot of rainfall during the rainy season between April and August of more than 200mm in mountainous areas like Kabarnet. This tendency occurs in Marigat and East Pokot, but maximum monthly rainfall is 120mm. No paved route is available except the national route from Nakul to Marigat, and Marigat to Kabarnet. Access conditions get worse during the rainy seasons to the many communities situated at mountainous and hilly areas with slip on muddy road, and low areas crossed tentatively with flowing river. Therefore, the condition is considered in the implementation plan, and vehicles for operation and maintenance are to be selected in accordance with the capability for travelling and endurance.

(2) Geographical and Geological Conditions

The target area is the eastern rift valley from south to north. This area is classified topographically, from the east as the highland like Mochongai (Laikipia), Tugen High Land (Kamasia) , Elgeyo, Uasin Gishu Highland, and the lowlands such as Marigat lowland, East Pokot lowland and Kerio lowland. Hilly areas and fault cliff formed by the activity of Rift Valley are crashed with many fracture zones.

From the results of the geological survey, geophysical prospecting and test drilling carried out in the natural conditions survey, groundwater development can be targeted at the following:

- Sedimentation zone in Kerio Lowland

- Fissure zone in Kerio Basalt near Kerio Lowland

- Sedimentation zone and Fissure water of the rock in western part of Marigat Lowland
- Fault and fissure zone of Tugen Highland
- Sedimentation zone, fracture zone and fissure water in the rock of Tugen Highland
- Fracture zone and fissure water of rock in Mochogai Highland
- Alluvium of East Pokot

The target area is one of the difficult zones for groundwater development in Kenya on the aspect of hydrogeological condition. Therefore, geophysical prospecting with electric exploration in the detailed design stage has to be conducted to increase success rates.

### 2-2-1-3 Policy on Social Conditions

Sufficient consideration shall be paid to select target communities on the population size, population structure, existing water sources and existing water supply facilities, living water requirements, water transportation distance, transportation time, access conditions, awareness of the communities on water supply water conditions, willingness to establish rural sanitation water committee and water supply points committee, willingness to participate in maintenance activities, and maintenance cost.

The baseline of service population adopts the survey population in 2011 and the population growth rate of approximately 1.6% is considered.

### 2-2-1-4 Construction/Procurement Conditions

Numerous construction companies including borehole drilling companies operate in Kenya; therefore, the Project shall utilize such local capacities. A total of 55 drilling companies are registered in MOWI. In the test drilling conducted in the Second Preparatory Survey, process control on preparation, test pumping and water quality were pointed out to be difficult. Therefore, enough technical staff should be arranged. Almost all construction equipment and materials are available in Kenya, but those not available are to be procured from a third country or Japan.

### 2-2-1-5 Capacity of Implementation Agency on Operation and Maintenance

The Project is to be conducted with the Rift Valley Water Service Board under the Ministry of Water and Irrigation, and the Ministry of Water Resources is the counterpart. As to the operation and maintenance of completed facilities, the District Water Office under RV-WSB will support the operation and maintenance to be conducted by communities. The training of 5 technical staff of the DWO are presently undergoing training, but capacity development for extension workers by OJT shall be conducted to establish a support system for the communities.

For the effective operation and maintenance of water supply facilities, training on the establishment and management of water committees has to be conducted in 3 stages, i.e., before, during and around the completion of construction works. Further training on operation, maintenance and repair of facilities have to be conducted for the water users association/s during the construction work.

#### 2-2-1-6 Facilities and Equipment Grade Setting

Water supply facilities that require minimum costs are designed. As community facilities, they are designed for easy operation and maintenance with high durability to enable sustainable use. The target area lags behind in infrastructure development, and even main trunk roads are unpaved. A 4x4 pick-up truck is to be procured because road conditions are very poor especially during the rainy seasons.

#### 2-2-1-7 Construction Method/Procurement and Construction Period

The Project shall adopt a construction method that the local companies can work with, considering the deployment of local construction companies. Construction materials that can be procured at the site or from neighbouring countries shall be selected to lower the cost.

Concrete apron and wastewater drainage facilities are to be primarily installed when the boreholes are drilled. The order of construction shall take priority according to the community's urgent requirement, but efficiency of the work plan shall be given the highest consideration.

### 2-2-2 Basic Plan (Construction Plan/Equipment Plan)

#### 2-2-2-1 Basic Design

(1) Target Year of the Project

The target year of the Project is set at 2015. The target population adds a population growth rate (about 1.6%) to the result of the population survey in 2011 as the baseline. The service population was estimated from the Social Survey and the interviews.

(2) Service area and Service Population

The National Water Service Strategy aims to make the distance from home to a water source within 2km in rural areas. Existing water sources are river water, dug well at riverbeds and spring water. People fetch water from the water sources at 0.2 to 1km in the rainy season. The distance varies in the dry season in East Pokot and Marigat which is up to 5 km. The distribution of houses in the target area was assessed through a satellite photo image. Most houses are located within 2 to 3km, around 2km on average from a water source. Service population of the Project is estimated basically from the results of the social survey. Water demands of day schools and bordering schools are also included in the Project.

(3) Water Consumption

Water consumption rates are shown in the Design Manual for Water Supply in Kenya based on the annual precipitation rate. Based on the rainfall information in the target area, water consumption units shown in Table 2-2 are applied.

Table 2-2 Water Supply Unit

| Average Precipitation/Year | Water Supply Unit | Area |
|---|---|---|
| 1000 mm and above | 20 L/person/day | Kabarnet<br>North Kabarnet |
| 500 mm and above, below 1000mm | 15 L/person/day | East Pokot<br>Marigat |
| Below 500 mm | 10 L/person/day | — |

According to the Manual, consumption is 5 L/p/d for day schools, and 50 L/p/d for boarding schools. However, for the Project the value shown in Table 2-3 is applied considering the level 1.5 (point water source) system and the difficulty of groundwater development in the area.

Table 2-3 Water Supply Unit at School

| School | Facility Standard | Project |
|---|---|---|
| Day School | 5 L/person/day | 2 L/person/day |
| Boarding School | 50 L/person/day | 15/20 L/person/day<br>(depending on district) |

(4) Evaluation of Groundwater Potential

In connection with the study mentioned above, the project area was divided into 12 zones and the possibility of groundwater development was studied.

The zoning of the project area was classified by considering the topography, geology, sub-basin, water quality and so on of each location Figure 2-1. The results are shown in Table 2-4.

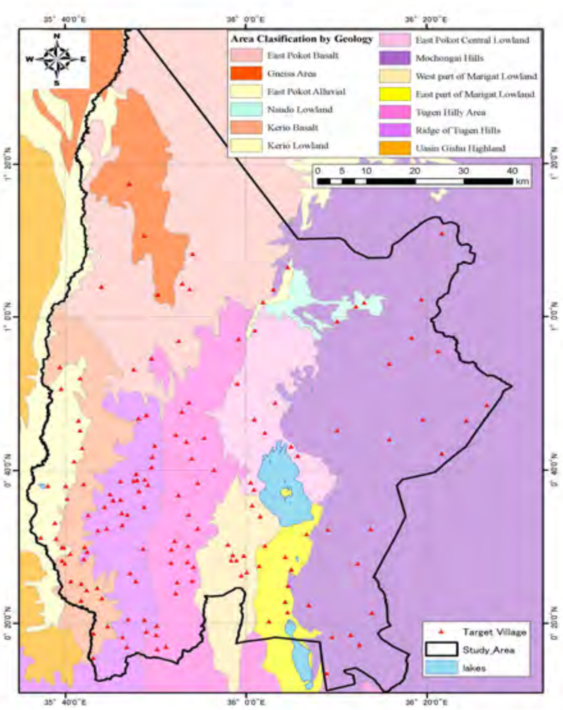



Figure 2-1 Area Classification for Groundwater Development

(5) Hydrogeological Condition and Success Rate of Borehole Construction

Table 2-4 Possibility of Groundwater Development of Every Target Area

| Target area | Hydro-geological Condition | | Possibility of Development |
|---|---|---|---|
| Kerio valley lowland | Groundwater recharge | The area is surrounded by hills of over 2000m ASL, and the catchment includes high rainfall area. The recharged water concentrates to the area. | High |
| | Aquifers | Sediments at lowland (sandy soil), faults fracture zone and cracks in rocks under sedimentary layers. | |
| | Water Quality | Detention time of groundwater seems to be short so that the water quality is generally good. However, it may sometimes contain iron excess the permissible concentration. | |
| Kerio Basalt | Groundwater recharge | Groundwater recharge from rainfall rich area of Tugen hills is expected. | Comparatively high |
| | Aquifers | Cracks and volume with a lot of void in basalt | |
| | Water Quality | Detention time of groundwater seems to be short so that the water quality is generally good. However, it may sometimes contain iron excess the permissible concentration. | |
| Ridge of Tugen hills | Groundwater recharge | Geological layers in Tugen hills generally slope down from east to west so that infiltrated rainwater at highland area tends to flow into Kerio valley. Tugen hills are most rainfall rich area in the project area, and then higher recharge is expected. | Medium |
| | Aquifers | Fault fracture zone, cracks in rocks (especially developed around geological boundaries of rocks), and pyroclastics. Some candidate communities are located on ridges which have deep valley at both sides. In such a case, the groundwater table may be very deep. | |
| | Water Quality | Detention time of groundwater seems to be short so that the water quality is generally good. However, it may sometimes contain iron excess the permissible concentration. | |
| Hilly area of east side of Tugen Hills | Groundwater recharge | Groundwater recharge from rainfall rich area of Tugen hills is expected at some places due to the geological structure. | Medium |
| | Aquifers | Colluvial deposit, fan deposit, fault fracture zone, cracks in rocks (especially developed around geological boundaries of rocks), pyroclastics. | |
| | Water Quality | Groundwater quality is not sensitive issue in this area. However, some existing wells at intrusive rocks and the downstream have high concentration of fluoride. | |
| Western part of Marigat Lowland | Groundwater recharge | Groundwater recharge from rainfall rich area of Tugen hills is expected. | Comparatively high |
| | Aquifers | Sedimentary layers (conglomerate, sand), colluvial deposit, cracks in rocks under sedimentary layers, and pyroclastics | |
| | Water Quality | Some existing wells have high concentration of fluoride depend on the places. | |
| Eastern part of Marigat Lowland | Groundwater recharge | Groundwater recharge is high due to the area located at the end of the catchment. | Comparatively low |
| | Aquifers | Sediment layers (conglomerate, sand) | |
| | Water Quality | Fluoride concentration is high. | |
| Central lowland of East Pokot | Groundwater recharge | Groundwater recharge from upper reach is spread wide and thin due to the flatness and shallow depth of rock distribution. | Low |
| | Aquifers | Fault fracture zone, cracks in rocks and pyroclastics | |
| | Water Quality | Here are many places with high concentration of fluoride. | |
| Alluvial deposit in East Pokot | Groundwater recharge | Groundwater recharge from Tugen hills is expected. | High |
| | Aquifers | Sediment layers (conglomerate, sand) | |
| | Water Quality | Here are some places with high concentration of fluoride. | |
| East Pokot Basalt | Groundwater recharge | This area is located in semi-arid area, and the groundwater recharge is scarce. | Low |
| | Aquifers | Fault fracture zone, cracks in rocks and pyroclastics. Sedimentary layers at some places. | |
| | Water Quality | There may be high concentration of fluoride due to volcanic mountains formed in Quaternary age. | |
| Naudo Lowland | Groundwater recharge | The area is very dry and depth to rocks is shallow so that the groundwater recharge is not expected. | Very low |
| | Aquifers | Fault fracture zone, and cracks in rocks | |
| | Water Quality | Groundwater temperature is high and fluoride concentration is high too. | |
| Gneiss Area | Groundwater recharge | Groundwater recharge is low due to small rainfall. | Very low |
| | Aquifers | Fault fracture zone and cracks in rocKshowever, there are very few continuous cracks in rocks. | |
| | Water Quality | Groundwater quality is not sensitive issue. | |
| Mochongai Hills | Groundwater recharge | There are some places where groundwater recharge from Mochongai (Laikipia) escarpment is expected. | Medium |
| | Aquifers | Fault fracture zone, cracks in rocks (especially developed around geological boundaries of rocks), and pyroclastics. | |
| | Water Quality | Existing data is very few so that the water quality is not unpredictable. It may be not sensible because the area is near upper stream of the catchment, but there may be left high concentration of iron. | |

A database was compiled using the data collected for the existing boreholes. The data are categorized by geographical conditions. The drilling depths, yields, and static water levels are statistically summarized. The data with drilling depth were 194, those with yield were 170 and those with static water level were 96. As to water quality, the number of data gets scarce that TDS was recorded with 52, fluoride with 56 and iron with 55 data sets. Other relevant information was “in use or abandoned.” The data sets were analysed by area. Table 2-5 shows the summary of average and distribution range of each parameter for existing boreholes. This table includes the data collected during the preparatory survey for the Project.

Table 2-5 Summarized Data of Existing Wells and Success Rate (Yield)

| | Number | Drilling Depth (m) | | | Pumping Yield ($m^3$/h) | | | Static Water Level (m) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | No. | Ave. | Distribution Range | No. | Ave. | Distribution Range | No | Ave. | Distribution Range |
| Kerio valley lowland | 5 | 5 | 110.0 | 80.0 ～ 150.0 | 5 | 9.4 | 3.6 ～ 18.0 | 1 | 39.6 | 39.6 ～ 39.6 |
| Kerio Basalt | 9 | 9 | 105.6 | 40.0 ～ 143.0 | 8 | 7.5 | 3.8 ～ 11.1 | 5 | 16.5 | 4.0 ～ 27.0 |
| Ridge of Tugen hills | 37 | 35 | 133.7 | 42.0 ～ 230.0 | 30 | 8.5 | 0.4 ～ 22.0 | 15 | 53.0 | 4.6 ～ 122.0 |
| Hilly area of East side of Tugen hills | 29 | 29 | 84.9 | 30.0 ～ 244.0 | 26 | 5.0 | 0.0 ～ 45.0 | 14 | 44.7 | 9.8 ～ 156.0 |
| West part of Marigat lowland | 23 | 23 | 78.1 | 14.0 ～ 155.0 | 22 | 4.8 | 0.0 ～ 18.0 | 14 | 40.2 | 8.9 ～ 81.9 |
| East part of Marigat lowland | 17 | 16 | 61.6 | 25.0 ～ 122.0 | 15 | 2.2 | 0.0 ～ 10.8 | 12 | 24.7 | 0.0 ～ 60.9 |
| Central lowland of East Pokot | 24 | 24 | 89.4 | 20.0 ～ 188.0 | 21 | 4.5 | 0.0 ～ 14.8 | 17 | 37.9 | 0.0 ～ 85.8 |
| Alluvial deposit in East Pokot | 1 | 1 | 84.0 | 84.0 ～ 84.0 | 1 | 23.8 | 23.8 ～ 23.8 | 1 | 10.6 | 10.6 ～ 10.6 |
| East Pokot Basalt | 6 | 6 | 140.5 | 75.0 ～ 204.0 | 3 | 0.7 | 0.3 ～ 1.0 | 1 | 50.0 | 50.0 ～ 50.0 |
| Naudo lowland | 6 | 6 | 103.2 | 22.0 ～ 154.0 | 5 | 1.5 | 0.0 ～ 7.4 | 1 | 112.3 | 112.3 ～ 112.3 |
| Gneiss area | 3 | 3 | 103.6 | 90.9 ～ 120.0 | 3 | 0.4 | 0.0 ～ 0.8 | 0 | - | - ～ - |
| Mochongoi hills | 37 | 37 | 107.0 | 40.1 ～ 225.0 | 31 | 2.3 | 0.0 ～ 12.0 | 15 | 52.2 | 18.6 ～ 110.0 |
| Total | 197 | 194 | 99.9 | 14.0 ～ 244.0 | 170 | 4.9 | 0.0 ～ 45.0 | 96 | 41.7 | 0.0 ～ 156.0 |

Table 2-6 Summarized Data of Existing Wells and the Success Rate (Water Quality)

| | Number | TDS | | | Fluoride (mg/L) | | | Iron (mg/L) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | No. | Ave. | Distribution Range | No. | Ave. | Distribution Range | No. | Ave. | Distribution Range |
| Kerio valley lowland | 5 | 1 | 270 | 270 ～ 270 | 1 | 0.7 | 0.7 ～ 0.7 | 1 | 0.6 | 0.6 ～ 0.6 |
| Kerio Basalt | 9 | 2 | 113 | 113 ～ 113 | 2 | 0.4 | 0.3 ～ 0.6 | 2 | 2.45 | 1.4 ～ 3.5 |
| Ridge of Tugen hills | 37 | 4 | 125 | 100 ～ 145 | 4 | 0.4 | 0.0 ～ 0.7 | 4 | 0.43 | 0.1 ～ 0.7 |
| Hilly area of East side of Tugen hills | 29 | 8 | 667 | 523 ～ 1,036 | 8 | 2.1 | 0.5 ～ 7.1 | 8 | 0.19 | 0 ～ 1 |
| West part of Marigat lowland | 23 | 11 | 573 | 176 ～ 1,699 | 11 | 1.4 | 0.5 ～ 2.4 | 11 | 0.67 | 0 ～ 4.2 |
| East part of Marigat lowland | 17 | 10 | 5,568 | 426 ～ 20,770 | 10 | 9.8 | 0.3 ～ 27.0 | 10 | 1.29 | 0 ～ 5 |
| Central lowland of East Pokot | 24 | 12 | 1,697 | 200 ～ 7,087 | 12 | 6.3 | 0.3 ～ 22.5 | 12 | 1.21 | 0 ～ 6 |
| Alluvial deposit in East Pokot | 1 | 1 | - | 0 ～ - | 1 | 2.4 | 2.4 ～ 2.4 | 0 | - | - ～ - |
| East Pokot Basalt | 6 | 0 | - | 0 ～ - | 0 | - | - ～ - | 0 | - | - ～ - |
| Naudo lowland | 6 | 1 | 780 | 780 ～ 780 | 1 | 2.1 | 2.1 ～ 2.1 | 1 | 0.12 | 0.1 ～ 0.1 |
| Gneiss area | 3 | 0 | - | - ～ - | 0 | - | - ～ - | 0 | - | - ～ - |
| Mochongoi hills | 37 | 6 | 587 | 354 ～ 728 | 6 | 0.7 | 0.4 ～ 1.0 | 6 | 0.94 | 0.1 ～ 3.1 |
| Total | 197 | 52 | 1,676 | 100 ～ 20,770 | 56 | 3.9 | 0.0 ～ 27.9 | 55 | 0.9 | 0 ～ 6 |

The existing boreholes success rates were estimated by the success rates of yield and water quality using the data in Table 2-6. The boreholes with yield of less than $1m^3$/hr were counted as failure, others were counted as success. In terms of water quality, when the parameters for TDS, fluoride and iron are higher than the permissible values of Kenya standards, the borehole was counted as a failure. The number of water quality data is not sufficiently large that the currently functioning boreholes are counted as success.

Table 2-7 Success Rate of Existing Boreholes by Area

| Zone | Drilling numbers | Water Volume Success Rate | | | Water Quality Success Rate | | | Total Success Rate |
|---|---|---|---|---|---|---|---|---|
| | | Drilling numbers | Success | Success Rate | Drilling numbers | Success | Success Rate | |
| Kerio valley lowland | 5 | 5 | 5 | 100.0 | 5 | 5 | 100.0 | 100.0 |
| Kerio Basalt | 9 | 8 | 8 | 100.0 | 2 | 0 | 0.0 | 0.0 |
| Ridge of Tugen hills | 37 | 37 | 29 | 78.4 | 33 | 26 | 78.8 | 61.8 |
| Hilly area of East side of Tugen hills | 29 | 29 | 18 | 62.1 | 20 | 18 | 90.0 | 55.9 |
| West part of Marigat lowland | 23 | 23 | 21 | 91.3 | 20 | 12 | 60.0 | 54.8 |
| East part of Marigat lowland | 17 | 16 | 10 | 62.5 | 10 | 1 | 10.0 | 6.3 |
| Central lowland of East Pokot | 24 | 24 | 16 | 66.7 | 19 | 6 | 31.6 | 21.1 |
| Alluvial deposit in East Pokot | 1 | 1 | 1 | 100.0 | 1 | 1 | 100.0 | 100.0 |
| East Pokot Basalt | 6 | 6 | 0 | 0.0 | - | - | - | 0.0 |
| Naudo lowland | 6 | 6 | 1 | 16.7 | 1 | 1 | 100.0 | 16.7 |
| Gneiss area | 3 | 3 | 0 | 0.0 | 3 | 3 | 100.0 | 0.0 |
| Mochongoi hills | 37 | 36 | 16 | 44.4 | 24 | 19 | 79.2 | 35.2 |
| Total | 197 | 194 | 125 | 64.4 | 138 | 92 | 66.7 | 43.0 |

The drilling depth, estimated yields, static water levels and success rates for the construction works were estimated by geophysical conditions, the data analysis of GIS, electric exploration and test drilling. As a result, the drilling depths are 100m, 150m, 200m, 250m with the static water levels of 10 to 110m. The success rates were evaluated both from the water volume and quality. Therefore, for all 118 sites of the target and reserve sites, the success rates were calculated. The average success rate of these 118 sites is 56%.

Table 2-8 Success Rate of Project Sites by Depth

| Drilling Depth (m) | Qt'y | Volume Success Rate (%) | Water Quality Success Rate (%) | Success Rate (%) |
|---|---|---|---|---|
| 250 | 6 | 6 | 0 | 0.0 |
| 200 | 6 | 6 | 1 | 16.7 |
| 150 | 3 | 3 | 0 | 0.0 |
| 100 | 37 | 36 | 16 | 44.4 |
| Total | 118 | 72 | 79 | 56 |

(6) Selection of Target and Reserved Community

The preparatory survey narrowed down and prioritized the planned target communities for the Project from necessity and construction possibility in the requested list of 190 communities.

As the first step, the 190 communities were narrowed down to 150 communities, and target communities and reserved sites were selected in the second step.

Step 1: The communities with the following three conditions were excluded in the selection of 150 from 190 sites through discussion with DWO.

a) Access to the site

Communities that have no available access for a drilling rig area.

b) Safety

Communities that have quarrels with other communities because of land or water problem are excluded.

c) Project/Plan of donors other than Japan

Communities that have a new project or plan with other donors are excluded.

Step 2: Hydrogeological survey, including test drilling and geophysical survey, social and field survey by the Study Team were conducted for selected 150 communities.

Target sites of the Project were selected by the criteria shown in Table 2-9.

Table 2-9 Selection Criteria for Communities

| Item | Criteria |
|---|---|
| Access to the site | Accessibility of the drilling machine to the site |
| Existing Water Supply Facility | Availability of the existing water supply facility |
| Project by other donor | Availability of the water supply project (confirmed by interview) |
| Potentiality of Groundwater | Evaluation of the groundwater potentiality<br>1) Borehole success rate is less than 40% |
| Capacity of operation and maintenance | 1) Population of the site is less than the minimum 350 to apply motor pump<br>2) Communities do not have sufficient capacity and willingness to establish water users association and pay water fees to maintain a water supply facility. |
| Water quality | Any water quality parameter is over the standard of Kenya, especially fluoride, salt and hot spring (temperature and vapor) |

Accessibility to the site by drilling machines was confirmed by the field survey. Some sites were excluded because of difficulty with access even by 4WD.

One community with existing water supply facilities was observed, 2 hand pumps have been used. Capacity of the hand pumps are enough for the community's population, therefore this community was excluded from the Project.

Projects by other donors in the surveyed communities were not found.

Concerning the groundwater potential, if success rate of the borehole construction is less than 40% on the aspects of water quantity and quality, the community was excluded and, if the community's population is less than 350, a hand pump is recommendable. However, maximum dynamic water level by hand pump is 45m; therefore, if static water level is predicted deeper than 40m, such a community is also excluded.

Concerning the capacity for operation and maintenance of water supply facilities, the basic idea is estimated by income of the community's residents. According to the Social Survey, monthly income is estimated at around 6,000 Ksh for people involved in agriculture, around 8,000 Ksh for people in agriculture/livestock and around 10,000 Ksh for people involved mainly in livestock. If 5% of monthly incomes can be spent for drinking water, the daily water fee of a family can be 10Ksh, 13.3Ksh and 16.7Ksh for agriculture, agriculture/livestock and livestock, respectively.

The main occupation in the target area is agriculture/livestock or livestock, therefore, around 3Ksh per 20L bucket is estimated as payable amount if one family has 5 members.

According to the field survey on the communities with existing water supply facilities, the monthly payment for water is around 150-500Ksh when the water source is surface water and distributed by gravity. Around 2-4Ksh per 20L bucket is charged when water is from groundwater, i.e., borehole with submergible motor pump by generator. Some communities having very severe conditions in the target area buy water from private water vendors at around 10-30 Ksh per 20L bucket.

Results of the social survey on the payable amount for water vary from 2 to 30Ksh per 20L bucket, with the average being 8.8Ksh. It is assumed that due to the above-mentioned situation of water from private water vendors, some people have dictated the existing buying values. Therefore, the sustainable water fee is estimated at around 3Ksh per 20L based on the calculation from monthly payment.

On the other hand, the required operation and maintenance cost is varied by the scale of the community and the type of energy for the pump used is 2-3Ksh per 20L. Since the results of the social survey indicate that all communities have the willingness to establish water users associations by themselves, basically, all of the 150 communities have the capacity to pay water fees and organize water supply systems. From these aspects, no community was excluded from the Project.

Since water quality is evaluated from geological categorization with analysis of collected water quality information, the communities in high fluoride, high TDS (Salinity) and hot spring zones were excluded and 103 communities were finally selected as target and reserve sites in the Project.

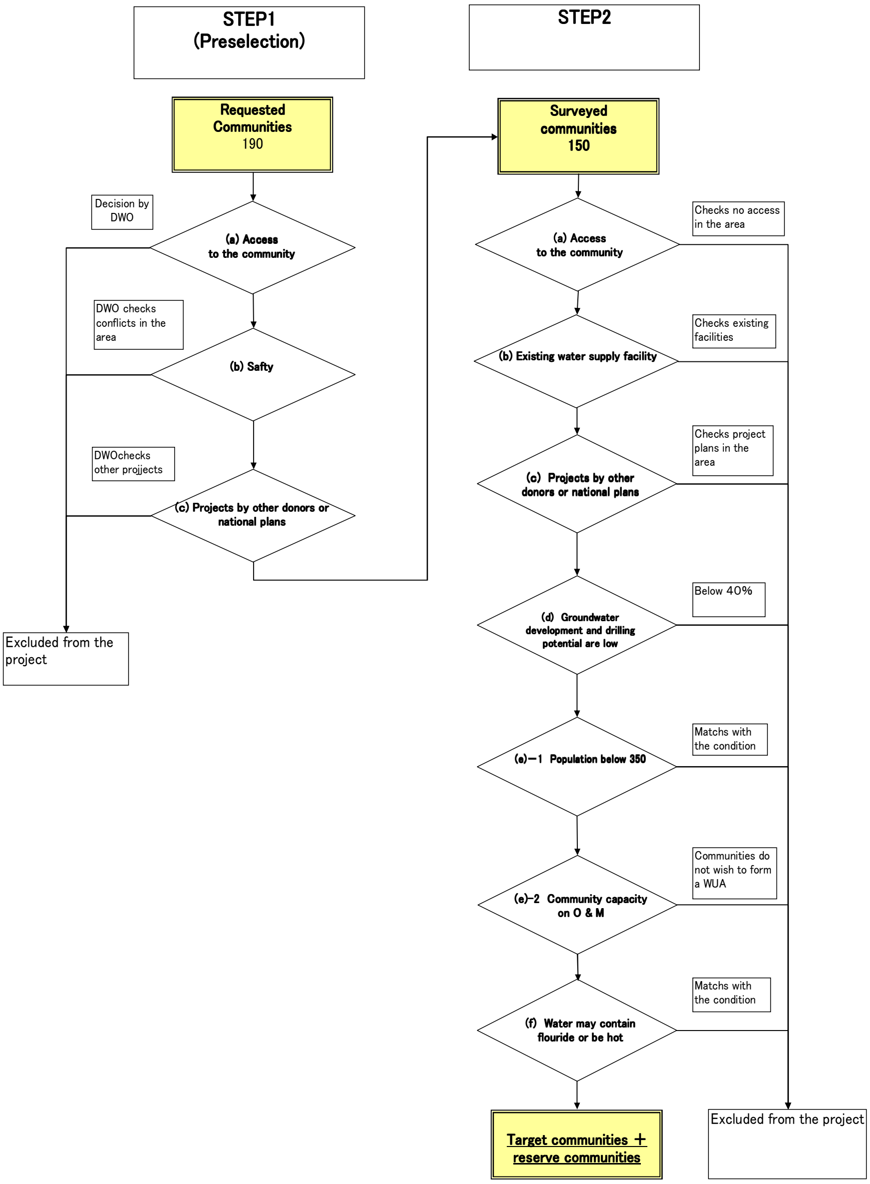



Figure 2-2 Selection Flow

Table 2-10 Number of Communities excluded from the Project

| District | Access | Existing Water Supply Facility | Project by other Donor | Check of house No. by Satellite data | Potentiality of groundwater | Population less than 350, water level is less than 40m | Operation and Maintenance Capacity | Total |
|---|---|---|---|---|---|---|---|---|
| North Baringo | 4 | 0 | 0 | 0 | 1 | 2 | 0 | 8 |
| Baringo Central | 1 | 0 | 0 | 0 | 1 | 3 | 0 | 5 |
| Marigat | 1 | 1 | 0 | 2 | 10 | 2 | 0 | 16 |
| East Pokot | 1 | 0 | 0 | 1 | 14 | 3 | 0 | 19 |
| Total | 7 | 1 | 0 | 3 | 27 | 10 | 0 | 48 |

(7) Plural Borehole Sites

The 103 communities finally selected with sites for 2 boreholes were planned under the following conditions:

- Planned water supply amount is bigger than the estimated pumping yield of the borehole
- In case the population of the community is large, 2 boreholes are drilled.

Two boreholes are to be drilled in the 15 communities shown in the table below.

Table 2-11 Communities to be drilled with Two Boreholes

| Distirct | Communities with 2 borehole sites |
|---|---|
| North Baringo | Barwesa (36), Kapchepkor (42), Kaptere (43), Ossen Forest Station (47) |
| Baringo Central | Kakwane (103), Salawa Primaly (105), Salawa Hospital (109), Mogorwa (120), Tabarin (124), Timboiywo (130), Kapkawa (137), Salawa Hospital (104), Gwalel (136) |
| Marigat | - |
| East Pockot | Donga (183), Katakmuwo (184) |

(8) Site Selection

Finally, 103 sites in 118 communities were selected as project target and reserved sites.

Of the 118 selected communities, 48 sites have the population 500 people, 42 sites have 750 17 sites have 1000 and 11 sites have 1500. Success rates of borehole construction are 40% to 75%, and the average is 56% including test drilling sites in the Second Preparatory Survey (5 boreholes among 10 were a success).

Japan’s Grant Aid scheme emphasizes cost-benefit effects to be high. Thus, beneficiary population and success rates of the borehole need to be large. Therefore, priorities of the communities for the Project’s implementation are decided by the conditions shown in the table below. If the orders are the same, priority is given to Marigat and East Pokot districts.

Table 2-12 Points to be given Weight for Prioritization

| Item | Condition |
|---|---|
| Population of the site | More than 1000: 3 points<br>500-999: 2 points<br>Less than 500: 1 point |
| Success rate of borehole construction | More than 70%: 4 points<br>60%: 3 points<br>50%: 2 points<br>40%: 1 point |

Sites with the following conditions will receive a lower priority:

- If the communities are close to each other, one of the overlapping communities is given lower priority.

- If the estimated pumping yield is smaller than the plan of water supply, it is given a lower priority

On the other hand, each reserved site should bear a certain number to make it easier to make a follow up if the borehole construction fails as to quantity limit or quality problems. Success rate is estimated at 56%, and drilling at a site is planned to be done twice; therefore, the number of reserved sites is as follows:

Success rate if drilling is conducted two times at one site = 1 – 0.44 x 0.44 = 0.80 (80%)

If the construction sites are 100, the number of reserved sites is as follows:

Construction sites: 100

Construction and reserve sites: 100/0.8 = 125

Reserved sites: 25

To construct 100 boreholes as requested, 125 sites need to be secured considering the success rate. However, only 118 sites were selected from the requested sites. Considering all the above conditions, 90 sites are targeted to have a construction number with the remaining 28 sites to be the reserve sites. Five (5) test boreholes drilled under the Second Preparatory Survey were a success, and were used for the construction of water supply facilities. Then, 85 boreholes were drilled in the implementation stage. Figure 3 shows the location of target sites while Table 2-13 shows a list of target and reserve sites.

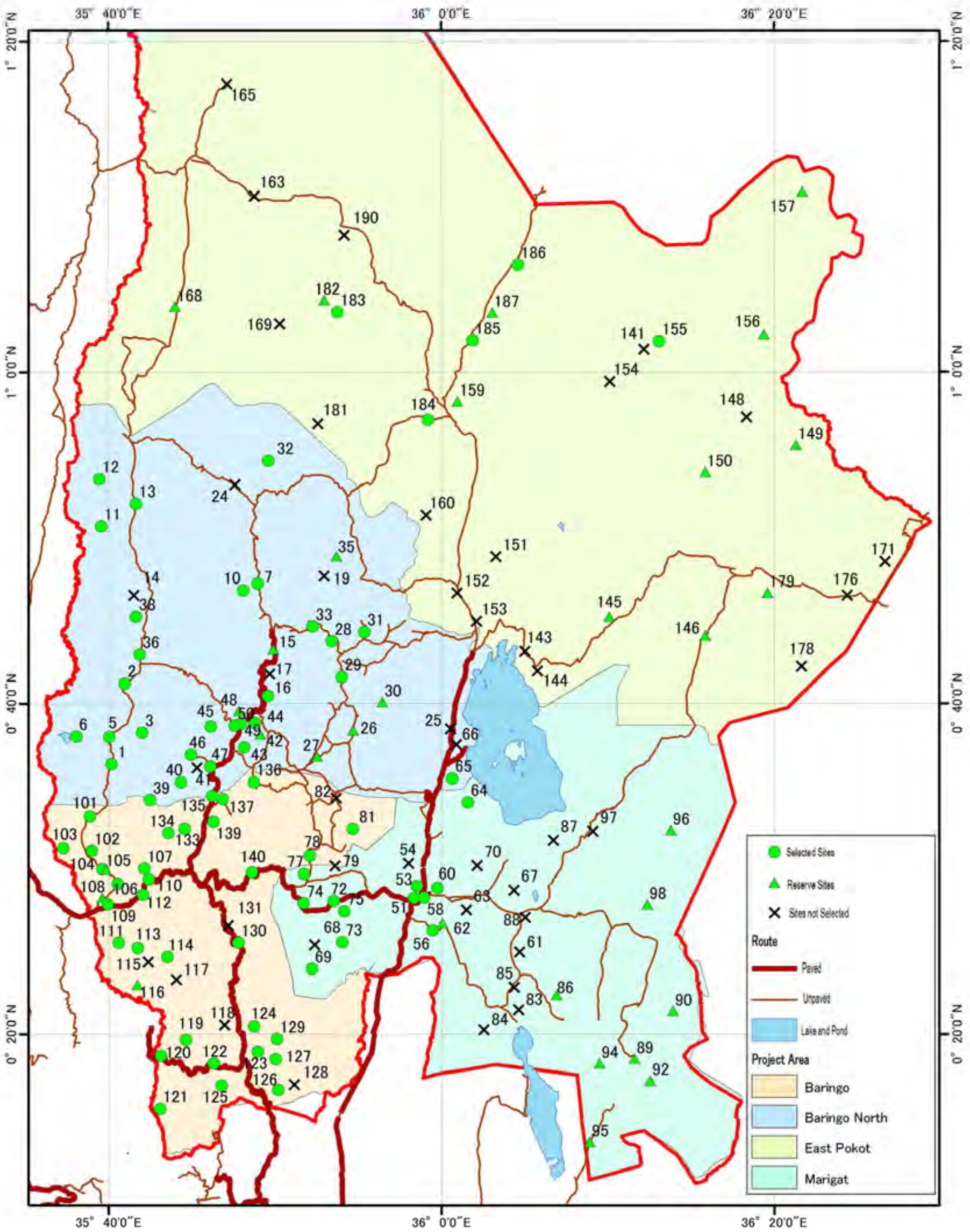



Figure 2-3 Project Site Location Map

# Table 2-13 List of Project and Reserve Sites

| | NO | Province | Division | Location | Site/Village Name | Planned water supply population (2015) | Water supply volume (m3/day) | Access | Existing facitilties | Polulation | Geological areas | Geology | Depth(m) | Estimated static water level(m) | Yield (m3/h) | Dynamic level (m) | Water quality | Water volume (%) | Water quality (%) | Success rate (%) | Population <350 & SWL>40 | Necessary nr. (Yield/(Planned volume/8)) | Judging 1:Selected 2:Reserve 3:Exclude 4:Exclude | Ranking | | | Rank | Remarks | Reason for reserve or excluded sites |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Condition ① | Condition ② | Condtion ③ | | | — | Condition ④ | Condition ⑤ | — | Condition ⑥ | Condition ⑦ | | | Condition ⑧ | Condition ⑨ | | Pop. | Succes | Evaluation | | | |
| Selected Sites | **137.1** | **Baringo** | **Kabarnet** | **Ewalel** | **Kapkawa-1** | ***1,290*** | **61.9** | | | | **Tugen Ridge** | **Sediment, Basalt** | **200** | **60** | **10** | **100** | | 85 | 85 | **100.0** | | **0.9** | **1** | **3** | **4** | **7** | **1** | **Successful BH** | |
| | 38 | Baringo North | Barwessa | Barwessa | Likwon | 640 | 12.8 | | | | Kerio Sediments | Sediment | 150 | 40 | 5 | 75 | | 87 | 85 | **74.0** | | 0.5 | 1 | 2 | 4 | 6 | 2 | | |
| | **103.1** | **Baringo** | **Salawa** | **Lelmen** | **Kakwane1** | **630** | **12.6** | | | | **Kerio Sediments** | **Sediments** | **150** | **40** | **5** | **75** | | 87 | 86 | **100.0** | | **0.5** | **1** | **2** | **4** | **6** | **3** | **Successful BH** | |
| | 103.2 | Baringo | Salawa | Lelmen | Kakwane2 | 800 | 16 | | | | Kerio Sediments | Sediments | 150 | 40 | 5 | 75 | | 87 | 86 | **74.8** | | 0.5 | 1 | 2 | 4 | 6 | 4 | | |
| | 106 | Baringo | Salawa | Kabarnet Soi | Eron Primary | 750 | 15 | | | | Kerio Sediments | Sediments, Basalt | 150 | 40 | 5 | 75 | | 87 | 86 | **74.8** | | 0.4 | 1 | 2 | 4 | 6 | 5 | | |
| | 109.1 | Baringo | Salawa | Kiboino | Oinobmoi centre1 | ***1,430*** | 28.6 | | | | Kerio Basalt | Basalt | 150 | 40 | 5 | 75 | | 85 | 75 | **63.8** | | 0.8 | 1 | 3 | 3 | 6 | 6 | **BH Drilling in DD** | |
| | **110** | **Baringo** | **Salawa** | **Kiboino** | **Kapsikoryan** | **960** | **19.2** | | | | **Tugen Ridge** | **Basalt** | **150** | **70** | **2** | **100** | | 82 | 85 | **100.0** | | **1.0** | **1** | **2** | **4** | **6** | **7** | **Successful BH** | |
| | 137.2 | Baringo | Kabarnet | Ewalel | Kapkawa-2 | 500 | 10 | | | | Tugen Ridge | Sediment, Basalt | 200 | 60 | 10 | 100 | | 85 | 85 | **72.3** | | 0.2 | 1 | 2 | 4 | 6 | 8 | | |
| | **155** | **East Pokot** | **Mondi** | **Naudo** | **Naudo** | **750** | **11.3** | | | | **Naudo Lowland** | **Sediment, Basalt** | **150** | **110** | **1** | **125** | | 40 | 50 | **100.0** | | **0.2** | **1** | **2** | **4** | **6** | **9** | **Successful BH** | |
| | **185** | **East Pokot** | **Nginyany** | **Ribko** | **Chesakam** | **560** | **8.4** | | | | **East Pokot Sediments** | **Sediments** | **150** | **30** | **6** | **50** | | **85** | **82** | **100.0** | | **0.3** | **1** | **2** | **4** | **6** | **10** | **Successful BH** | |
| | 6 | Baringo North | Barwessa | Kabutiei | Kapnarok | 400 | 8 | | | | Kerio Sediments | Sediments | 150 | 40 | 5 | 75 | | 87 | 86 | **74.8** | | 0.4 | 1 | 1 | 4 | 5 | 11 | | |
| | 16 | Baringo North | Kipsaraman | Kapteberewo | Kapkombe | ***1,070*** | 21.4 | | | | Tugen Ridge | Phonolite | 200 | 60 | 6 | 100 | | 70 | 80 | **56.0** | | 0.6 | 1 | 3 | 2 | 5 | 13 | **BH Drilling in DD** | |
| | 40 | Baringo North | Kabartonjo | Katiorin | Kapkirwok | ***1,250*** | 25 | | | | Tugen Ridge | Trachyte | 200 | 60 | 4 | 100 | | 70 | 80 | **56.0** | | 1.0 | 1 | 3 | 2 | 5 | 14 | **BH Drilling in DD** | |
| | 45 | Baringo North | Kabartonjo | Ossen | Tiriondonin | ***1,000*** | 20 | | | | Tugen Ridge | Trachyte | ***250*** | 60 | 6 | 100 | | 70 | 80 | **56.0** | | 0.4 | 1 | 3 | 2 | 5 | 15 | **BH Drilling in DD** | |
| | 46 | Baringo North | Kabartonjo | Ossen | Kaptum | ***1,230*** | 24.6 | | | | Tugen Ridge | Trachyte | 200 | 60 | 6 | 100 | | 70 | 80 | **56.0** | | 0.6 | 1 | 3 | 2 | 5 | 16 | **BH Drilling in DD** | |
| | 49 | Baringo North | Kabartonjo | Kelyo | Kureschun | ***1,600*** | 32 | | | | Tugen Ridge | Trachyte, Phonolite | ***250*** | 100 | 4 | 150 | | 70 | 80 | **56.0** | | 1.0 | 1 | 3 | 2 | 5 | 17 | **BH Drilling in DD** | |
| | 50 | Baringo North | Kabartonjo | Kelyo | Kipkokom | ***1,070*** | 21.4 | | | | Tugen Ridge | Basalt | ***250*** | 100 | 4 | 150 | | 70 | 80 | **56.0** | | 1.0 | 1 | 3 | 2 | 5 | 18 | **BH Drilling in DD** | |
| | 51 | Marigat | Marigat | Marigat | Kamagonge | 960 | 14.4 | | | | Marigat Lowland | Sediments | 100 | 50 | 4 | 75 | | 85 | 76 | **64.6** | | 0.5 | 1 | 2 | 3 | 5 | 19 | | |
| | 53 | Marigat | Marigat | Marigat | Kapsamson | 520 | 7.8 | | | | Marigat Lowland | Sediments | 100 | 50 | 4 | 75 | | 85 | 76 | **64.6** | | 0.5 | 1 | 2 | 3 | 5 | 20 | | |
| | **64** | **Marigat** | **Marigat** | **Salabani** | **Longiron** | **520** | **7.8** | | | | **Marigat Lowland** | **Sediments** | **100** | **50** | **2** | **75** | | **80** | **75** | **60.0** | | **1.0** | **1** | **2** | **3** | **5** | **21** | | |
| | **65** | **Marigat** | **Marigat** | **Salabani** | **Marti** | **530** | **8** | | | | **Marigat Lowland** | **Sediments** | **100** | **50** | **2** | **75** | | **80** | **75** | **60.0** | | **1.0** | **1** | **2** | **3** | **5** | **22** | | |
| | 104.1 | Baringo | Salawa | Salawa | Salawa Hospital1 | 630 | 12.6 | | | | Kerio Basalt | Basalt | 150 | 40 | 5 | 75 | | 85 | 75 | **63.8** | | 0.4 | 1 | 2 | 3 | 5 | 23 | | |
| | 104.2 | Baringo | Salawa | Salawa | Salawa Hospital2 | 630 | 12.6 | | | | Kerio Basalt | Basalt | 150 | 40 | 5 | 75 | | 85 | 75 | **63.8** | | 0.4 | 1 | 2 | 3 | 5 | 24 | | |
| | 107 | Baringo | Salawa | Kabarnet Soi | Kimoso | 580 | 11.6 | | | | Kerio Basalt | Basalt | 150 | 50 | 5 | 75 | | 85 | 75 | **63.8** | | 0.5 | 1 | 2 | 3 | 5 | 25 | | |
| | 109.2 | Baringo | Salawa | Kiboino | Oinobmoi centre2 | 560 | 11.2 | | | | Kerio Basalt | Basalt | 150 | 40 | 5 | 75 | | 85 | 75 | **63.8** | | 0.5 | 1 | 2 | 3 | 5 | 26 | | |
| | 111 | Baringo | Salawa | Kiboino | Kurumbopsoo | 850 | 17 | | | | Kerio Basalt | Basalt | 150 | 50 | 5 | 75 | | 85 | 75 | **63.8** | | 0.7 | 1 | 2 | 3 | 5 | 27 | | |
| | 122 | Baringo | Tenges | Ochii | Ochii Primary | 690 | 13.8 | | | | Tugen Ridge | Sediment, Basalt | 200 | 60 | 5 | 100 | | 80 | 80 | **64.0** | | 0.4 | 1 | 2 | 3 | 5 | 28 | | |
| | 123 | Baringo | Tenges | Tenges | Siginwo | ***1,050*** | 21 | | | | Tugen Ridge | Phonolite, Basalt | 200 | 60 | 6 | 100 | | 70 | 80 | **56.0** | | 0.6 | 1 | 3 | 2 | 5 | 29 | **BH Drilling in DD** | |
| | 136.1 | Baringo | Kabarnet | Ewalel | Gwalel(Talai?)-1 | ***1,590*** | 31.8 | | | | Tugen Ridge | Basalt, Phonolite | 200 | 60 | 6 | 100 | | 70 | 80 | **56.0** | | 0.6 | 1 | 3 | 2 | 5 | 30 | **BH Drilling in DD** | |
| | 136.2 | Baringo | Kabarnet | Ewalel | Gwalel(Talai?)-2 | ***1,390*** | 27.8 | | | | Tugen Ridge | Basalt, Phonolite | 200 | 60 | 6 | 100 | | 70 | 80 | **56.0** | | 0.6 | 1 | 3 | 2 | 5 | 31 | **BH Drilling in DD** | |
| | 1 | Baringo North | Barwessa | Lawan | Katiborok | 510 | 10.2 | | | | Kerio Basalt | Basalt | 150 | 40 | 5 | 75 | | 79 | 70 | **55.3** | | 0.1 | 1 | 2 | 2 | 4 | 32 | | |
| | 5 | Baringo North | Barwessa | Kabutiei | Kibuliak | 760 | 15.2 | | | | Kerio Basalt | Basalt | 150 | 40 | 5 | 75 | | 79 | 70 | **55.3** | | 0.5 | 1 | 2 | 2 | 4 | 33 | | |
| | 7 | Baringo North | Kipsaraman | Kaboskei | Chemondoi | 930 | 18.6 | | | | Tugen Ridge | Basalt | ***250*** | 60 | 6 | 100 | | 70 | 80 | **56.0** | | 0.4 | 1 | 2 | 2 | 4 | 34 | | |
| | 32 | Baringo North | Bartabwa | Ng'orora | Kapturo | 530 | 10.6 | | | | Tugen East Hilly Area | Basalt, Trachyte | 150 | 50 | 2.5 | 75 | | 68 | 85 | **57.8** | | 1.1 | 1 | 2 | 2 | 4 | 35 | | |
| | 36.1 | Baringo North | Barwessa | Barwessa | Barwessa-1 | 580 | 11.6 | | | | Kerio Basalt | Basalt | 150 | 40 | 5 | 75 | | 79 | 70 | **55.3** | | 0.4 | 1 | 2 | 2 | 4 | 36 | | |
| | 43.1 | Baringo North | Kabartonjo | Saimo Mosop | Kaptere1 | 720 | 14.4 | | | | Tugen Ridge | Trachyte | ***250*** | 80 | 4 | 125 | | 70 | 80 | **56.0** | | 0.5 | 1 | 2 | 2 | 4 | 37 | | |
| | 43.2 | Baringo North | Kabartonjo | Saimo Mosop | Kaptere2 | 680 | 13.6 | | | | Tugen Ridge | Trachyte | ***250*** | 80 | 4 | 125 | | 70 | 80 | **56.0** | | 0.5 | 1 | 2 | 2 | 4 | 38 | | |
| | 47.1 | Baringo North | Kabartonjo | Ossen | Ossen Forest station 1 | 750 | 15 | | | | Tugen Ridge | Trachyte | 200 | 100 | 4 | 150 | | 70 | 80 | **56.0** | | 0.5 | 1 | 2 | 2 | 4 | 39 | | |
| | 47.2 | Baringo North | Kabartonjo | Ossen | Ossen Forest station 2 | 810 | 16.2 | | | | Tugen Ridge | Trachyte | 200 | 100 | 4 | 150 | | 70 | 80 | **56.0** | | 0.6 | 1 | 2 | 2 | 4 | 40 | | |
| | 56 | Marigat | Marigat | Marigat | Kamimba | 480 | 7.2 | | | | Marigat Lowland | Sediments | 100 | 50 | 4 | 75 | | 85 | 76 | **64.6** | | 0.2 | 1 | 1 | 3 | 4 | 41 | | |
| | 58 | Marigat | Marigat | Marigat | Catholic | 430 | 6.5 | | | | Marigat Lowland | Sediments | 100 | 50 | 4 | 75 | | 85 | 76 | **64.6** | | 0.2 | 1 | 1 | 3 | 4 | 42 | | |
| | 60 | Marigat | Marigat | Marigat | Ndambul | 470 | 7.1 | | | | Marigat Lowland | Sediments | 100 | 50 | 4 | 75 | | 85 | 76 | **64.6** | | 0.4 | 1 | 1 | 3 | 4 | 43 | | |
| | 81 | Marigat | Marigat | Ewalel Soi | Kabusa | 640 | 9.6 | | | | Tugen East Hilly Area | Basalt, Sediments | 150 | 50 | 4 | 75 | | 70 | 85 | **59.5** | | 0.5 | 1 | 2 | 2 | 4 | 44 | | |
| | 101 | Baringo | Salawa | Lelmen | Kaptara | 640 | 12.8 | | | | Kerio Basalt | Basalt | 150 | 40 | 5 | 75 | | 79 | 70 | **55.3** | | 0.4 | 1 | 2 | 2 | 4 | 45 | | |
| | 102 | Baringo | Salawa | Lelmen | Kipsoit Primary | 570 | 11.4 | | | | Kerio Basalt | Basalt | 150 | 40 | 5 | 75 | | 79 | 70 | **55.3** | | 0.4 | 1 | 2 | 2 | 4 | 46 | | |
| | 112 | Baringo | Salawa | Kiboino | Sironoi | 530 | 10.6 | | | | Tugen Ridge | Basalt | ***250*** | 60 | 6 | 100 | | 70 | 80 | **56.0** | | 0.5 | 1 | 2 | 2 | 4 | 47 | | |
| | 113 | Baringo | Salawa | Kapropita Soi | Kasitet | 860 | 17.2 | | | | Kerio Basalt | Basalt | 150 | 50 | 5 | 75 | | 79 | 70 | **55.3** | | 0.7 | 1 | 2 | 2 | 4 | 48 | | |
| | 121 | Baringo | Tenges | Kisonei | Kisonei Primary | 450 | 9 | | | | Tugen Ridge | Sediment, Basalt | ***250*** | 60 | 5 | 100 | | 80 | 80 | **64.0** | | 0.2 | 1 | 1 | 3 | 4 | 49 | | |
| | 124.1 | Baringo | Tenges | Tenges | Tabarin1 | 740 | 14.8 | | | | Tugen Ridge | Phonolite, Basalt | 200 | 60 | 6 | 100 | | 70 | 80 | **56.0** | | 0.3 | 1 | 2 | 2 | 4 | 50 | | |
| | 124.2 | Baringo | Tenges | Tenges | Tabarin2 | 670 | 13.4 | | | | Tugen Ridge | Phonolite, Basalt | 200 | 60 | 6 | 100 | | 70 | 80 | **56.0** | | 0.3 | 1 | 2 | 2 | 4 | 51 | | |

| | NO | Province | Division | Location | Site/Village Name | Planned water supply population (2015) | Water supply volume (m3/day) | Access | Existing facitilties | Polulation | Geological areas | Geology | Depth(m) | Estimated static water level(m) | Yield (m3/h) | Dynamic level(m) | Water quality | Water volume (%) | Water quality (%) | **Success rate (%)** | Population <350 & SWL>40 | Necessary nr. (Yield/(Planned volume/8)) | Judging 1:Selected 2:Reserve 3:Exclude 4:Exclude | Ranking | | | Rank | Remarks | Reason for reserve or excluded sites |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Condition ① | Condition ② | Condtion ③ | | | – | Condition ④ | Condition ⑤ | – | Condition ⑥ | Condition ⑦ | | | Condition ⑧ | Condition ⑨ | | Pop. | Succes | Evaluation | | | |
| Selected Sites | 125 | Baringo | Tenges | Tuluongoi | Tuluongoi | 980 | 19.6 | | | | Tugen Ridge | Sediment, Basalt | 200 | 60 | 6 | 100 | | 70 | 80 | 56.0 | | 0.4 | 1 | 2 | 2 | 4 | 52 | | |
| | 126 | Baringo | Tenges | Tuluongoi | Tebei | 880 | 17.6 | | | | Tugen East Hilly Area | Sediment, Basalt | 150 | 50 | 4 | 75 | | 70 | 85 | 59.5 | | 0.9 | 1 | 2 | 2 | 4 | 53 | | |
| | 129 | Baringo | Tenges | Bekibon | Tinomoi | 940 | 18.8 | | | | Tugen East Hilly Area | Sediment, Basalt | ***250*** | 70 | 4 | 100 | | 65 | 85 | 55.3 | | 0.6 | 1 | 2 | 2 | 4 | 54 | | |
| | 130.1 | Baringo | Sacho | Kabasis | Timboiywo1 | 680 | 13.6 | | | | Tugen Ridge | Sediment, Basalt | 200 | 60 | 6 | 100 | | 70 | 80 | 56.0 | | 0.3 | 1 | 2 | 2 | 4 | 55 | | |
| | 130.2 | Baringo | Sacho | Kabasis | Timboiywo2 | 750 | 15 | | | | Tugen Ridge | Sediment, Basalt | 200 | 60 | 6 | 100 | | 70 | 80 | 56.0 | | 0.3 | 1 | 2 | 2 | 4 | 56 | | |
| | 133 | Baringo | Kabarnet | Orokwo | Kapchomuswo Sec | 590 | 11.8 | | | | Tugen Ridge | Sediment, Basalt | 200 | 60 | 6 | 100 | | 70 | 80 | 56.0 | | 0.3 | 1 | 2 | 2 | 4 | 57 | | |
| | 139 | Baringo | Kabarnet | Riwo | Serei | 510 | 10.2 | | | | Tugen Ridge | Basalt, Phonolite | 200 | 60 | 6 | 100 | | 70 | 80 | 56.0 | | 0.5 | 1 | 2 | 2 | 4 | 58 | | |
| | 183.1 | East Pokot | Nginyany | Nginyan West | Donge | 580 | 8.7 | | | | East Pokot Basalt | Basalt, Tuff | 150 | 60 | 1.5 | 75 | | 70 | 75 | 52.5 | | 1.3 | 1 | 2 | 2 | 4 | 59 | | |
| | 183.2 | East Pokot | Nginyany | Nginyan West | Donge | 850 | 12.8 | | | | East Pokot Basalt | Basalt, Tuff | 150 | 60 | 1.5 | 75 | | 70 | 75 | 52.5 | | 1.3 | 1 | 2 | 2 | 4 | 60 | | |
| | 184.1 | East Pokot | Nginyany | Kositei | Katukumwo1 | 670 | 10.1 | | | | Tugen East Hilly Area | Trachyte | 150 | 50 | 4 | 75 | | 70 | 85 | 59.5 | | 0.5 | 1 | 2 | 2 | 4 | 61 | | |
| | 184.2 | East Pokot | Nginyany | Kositei | Katukumwo2 | 670 | 10.1 | | | | Tugen East Hilly Area | Trachyte | 150 | 50 | 4 | 75 | | 70 | 85 | 59.5 | | 0.5 | 1 | 2 | 2 | 4 | 62 | | |
| | 186 | East Pokot | Nginyany | Ribko | Chesitet | 440 | 6.6 | | | | East Pokot Sediments | Sediments, Trachyte | 150 | 30 | 6 | 50 | | 80 | 82 | 65.6 | | 0.2 | 1 | 1 | 3 | 4 | 63 | | |
| | 2 | Baringo North | Barwessa | Lawan | Konoo | 480 | 9.6 | | | | Kerio Basalt | Basalt | 150 | 40 | 5 | 75 | | 79 | 70 | 55.3 | | 0.2 | 1 | 1 | 2 | 3 | 64 | | |
| | 3 | Baringo North | Barwessa | Lawan | Kormor | 350 | 7 | | | | Kerio Basalt | Basalt | 150 | 40 | 5 | 75 | | 79 | 70 | 55.3 | | 0.4 | 1 | 1 | 2 | 3 | 65 | | |
| | 10 | Baringo North | Kipsaraman | Kaboskei | Moigutwo | 420 | 8.4 | | | | Tugen Ridge | Tuff, Shale | 200 | 60 | 6 | 100 | | 70 | 80 | 56.0 | | 0.3 | 1 | 1 | 2 | 3 | 66 | | |
| | 12 | Baringo North | Barwessa | Kaboskei Kerio | Ayatia | 380 | 7.6 | | | | Kerio Basalt | Basalt | 150 | 40 | 5 | 75 | | 79 | 70 | 55.3 | | 0.4 | 1 | 1 | 2 | 3 | 67 | | |
| | 13 | Baringo North | Barwessa | Kaboskei Kerio | Kaboskei Kerio/Marigut | 480 | 9.6 | | | | Kerio Basalt | Basalt | 150 | 30 | 5 | 50 | | 79 | 70 | 55.3 | | 0.2 | 1 | 1 | 2 | 3 | 68 | | |
| | 28 | Baringo North | Kipsaraman | Sibilo | Kolongotwo | 450 | 9 | | | | Tugen East Hilly Area | Basalt | 150 | 40 | 4 | 75 | | 70 | 85 | 59.5 | | 0.5 | 1 | 1 | 2 | 3 | 69 | | |
| | 29 | Baringo North | Kipsaraman | Sibilo | Koibaware | 430 | 8.6 | | | | Tugen East Hilly Area | Basalt | 150 | 40 | 4 | 75 | | 70 | 85 | 59.5 | | 0.5 | 1 | 1 | 2 | 3 | 70 | | |
| | 31 | Baringo North | Kipsaraman | Sibilo | Chemorongion | 370 | 7.4 | | | | Tugen East Hilly Area | Basalt, Trachyte | 150 | 50 | 4 | 75 | | 70 | 85 | 59.5 | | 0.5 | 1 | 1 | 2 | 3 | 71 | | |
| | 33 | Baringo North | Bartabwa | Ng'orora | Rondinir | 450 | 9 | | | | Tugen East Hilly Area | Bassalt, Tuff | 150 | 50 | 4 | 75 | | 70 | 85 | 59.5 | | 0.5 | 1 | 1 | 2 | 3 | 72 | | |
| | 36.2 | Baringo North | Barwessa | Barwessa | Barwessa-2 | 430 | 8.6 | | | | Kerio Basalt | Basalt | 150 | 40 | 5 | 75 | | 79 | 70 | 55.3 | | 0.4 | 1 | 1 | 2 | 3 | 73 | | |
| | 39 | Baringo North | Kabartonjo | Katiorin | Seremwo | 430 | 8.6 | | | | Tugen Ridge | Trachyte | ***250*** | 60 | 3 | 100 | | 70 | 80 | 56.0 | | 0.6 | 1 | 1 | 2 | 3 | 74 | | |
| | 69 | Marigat | Marigat | Kimalel | Kapkechii | 360 | 5.4 | | | | Tugen East Hilly Area | Basalt | 150 | 50 | 4 | 75 | | 70 | 85 | 59.5 | | 0.4 | 1 | 1 | 2 | 3 | 76 | | |
| | 72 | Marigat | Marigat | Kimalel | Kimalel Hospital | 400 | 6 | | | | Tugen East Hilly Area | Basalt | ***250*** | 50 | 2 | 75 | | 70 | 85 | 59.5 | | 0.5 | 1 | 1 | 2 | 3 | 77 | | |
| | 74 | Marigat | Marigat | Kimalel | Lokoiwopsonchun | 400 | 6 | | | | Tugen East Hilly Area | Basalt | 150 | 50 | 2 | 75 | | 70 | 85 | 59.5 | | 0.5 | 1 | 1 | 2 | 3 | 79 | | |
| | 75 | Marigat | Marigat | Kimalel | Kinyach | 360 | 5.4 | | | | Tugen East Hilly Area | Phonolite | ***250*** | 50 | 2 | 75 | | 70 | 85 | 59.5 | | 0.7 | 1 | 1 | 2 | 3 | 80 | | |
| | 77 | Marigat | Marigat | Kimondis | Tirng'ongwonin | 370 | 5.6 | | | | Tugen East Hilly Area | Basalt | 150 | 50 | 2 | 75 | | 65 | 85 | 55.3 | | 0.7 | 1 | 1 | 2 | 3 | 81 | | |
| | 78 | Marigat | Marigat | Kimondis | Kibingor | 480 | 7.2 | | | | Tugen East Hilly Area | Basalt | 150 | 50 | 2 | 75 | | 65 | 85 | 55.3 | | 0.7 | 1 | 1 | 2 | 3 | 82 | | |
| | 114 | Baringo | Salawa | Kapropita Soi | Sichei | 370 | 7.4 | | | | Kerio Basalt | Basalt | 150 | 50 | 5 | 75 | | 79 | 70 | 55.3 | | 0.4 | 1 | 1 | 2 | 3 | 83 | | |
| | 119 | Baringo | Sacho | Chepkero | Chepkero Primary | 480 | 9.6 | | | | Kerio Basalt | Sediment, Basalt | 150 | 70 | 5 | 100 | | 79 | 70 | 55.3 | | 0.4 | 1 | 1 | 2 | 3 | 84 | | |
| | 120.1 | Baringo | Tenges | Kisonei | Mogorwa | 410 | 8.2 | | | | Kerio Basalt | Sediment, Basalt | 150 | 50 | 2.5 | 75 | | 79 | 70 | 55.3 | | 0.5 | 1 | 1 | 2 | 3 | 85 | | |
| | 120.2 | Baringo | Tenges | Kisonei | Mogorwa | 410 | 8.2 | | | | Kerio Basalt | Sediment, Basalt | 150 | 50 | 2.5 | 75 | | 79 | 70 | 55.3 | | 0.7 | 1 | 1 | 2 | 3 | 86 | | |
| | 127 | Baringo | Tenges | Tuluongoi | Ilyakat | 400 | 8 | | | | Tugen East Hilly Area | Phonolite, Basalt | 150 | 50 | 4 | 75 | | 70 | 85 | 59.5 | | 0.5 | 1 | 1 | 2 | 3 | 87 | | |
| | 134 | Baringo | Kabarnet | Orokwo | Kiwanja Ndege | 490 | 9.8 | | | | Tugen Ridge | Sediment, Basalt | 200 | 60 | 6 | 100 | | 70 | 80 | 56.0 | | 0.3 | 1 | 1 | 2 | 3 | 88 | | |
| | 135 | Baringo | Kabarnet | Orokwo | Pemwai centre | 460 | 9.2 | | | | Tugen Ridge | Basalt, Phonolite | 200 | 60 | 6 | 100 | | 70 | 80 | 56.0 | | 0.2 | 1 | 1 | 2 | 3 | 89 | | |
| | 140 | Baringo | Kabarnet | Kituro | Turupkir | 390 | 7.8 | | | | Tugen Ridge | Phonolite, Basalt | 200 | 60 | 4 | 100 | | 70 | 80 | 56.0 | | 0.3 | 1 | 1 | 2 | 3 | 90 | | |
| | 187 | East Pokot | Nginyany | Ribko | Kasakaram | 600 | 9 | | | | East Pokot Basalt | Trachyte | 150 | 60 | 0.6 | 75 | | 70 | 75 | 52.5 | | 3.3 | 1 | 2 | 2 | 4 | 92 | | |
| | 182 | East Pokot | Nginyany | Ribko | Chepanda | 430 | 6.5 | | | | East Pokot Basalt | Basalt, Tuff | 150 | 60 | 1 | 75 | | 70 | 75 | 52.5 | | 1.4 | 1 | 1 | 2 | 3 | 93 | | |
| | 179 | East Pokot | Churo | Kaptuya | Lomerimeri | 380 | 5.7 | | | | Mochingai Highland | Phonolite | ***250*** | 60 | 2 | 100 | | 63 | 80 | 50.4 | | 0.7 | 1 | 1 | 2 | 3 | 95 | | |

| | NO | Province | Division | Location | Site/Village Name | Planned water supply population (2015) | Water supply volume (m3/day) | Access | Existing facitilties | Polulation | Geological areas | Geology | Depth(m) | Estimated static water level(m) | Yield (m3/h) | Dynamic level(m) | Water quality | Water volume (%) | Water quality (%) | Success rate (%) | Population <350 & SWL>40 | Necessary nr. (Yield/(Planned volume/8)) | Judging 1:Selected 2:Reserve 3:Exclude 4:Exclude | Ranking | | | Rank | Remarks | Reason for reserve or excluded sites |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Condition ① | Condition ② | Condtion ③ | | | – | Condition ④ | Condition ⑤ | – | Condition ⑥ | Condition ⑦ | | | Condition ⑧ | Condition ⑨ | | Pop. | Succes | Evaluation | | | |
| | 44 | Baringo North | Kabartonjo | Saimo Mosop | Boin | 430 | 8.6 | | | | Tugen Ridge | Trachyte | 250 | 80 | 4 | 125 | | 70 | 80 | 56.0 | | | 2Rsv. | 1 | 2 | 3 | 75 | reserve | Local condition |
| | 116 | Baringo | Sacho | Kapkelelwa | Katunoi | 430 | 8.6 | | | | Kerio Basalt | Sediment, Basalt | 150 | 50 | 5 | 75 | | 79 | 70 | 55.3 | | 0.4 | 2Rsv. | 1 | 2 | 3 | 91 | reserve | Local condition |
| | 35 | Baringo North | Bartabwa | Ng'orora | Chemoe | 480 | 9.6 | | | | Tugen East Hilly Area | Trachyte | 150 | 50 | 2.5 | 75 | | 60 | 85 | 51.0 | | 0.7 | 2Rsv. | 1 | 2 | 3 | 94 | reserve | Priority reserve site for DD |
| | 159 | East Pokot | Mondi | Silale | Cheptunoyo | 390 | 5.9 | | | | East Pokot Central Lowland | Basalt, Welded tuff | 150 | 50 | 3 | 75 | | 60 | 70 | 42.0 | | 0.3 | 2Rsv. | 1 | 2 | 3 | 96 | reserve | Success rate |
| | 90 | Marigat | Mochongoi | Mochongoi | Kapkechir | 730 | 11 | | | | Mochingai Highland | Phonolite | 250 | 80 | 2 | 125 | | 50 | 80 | 40.0 | | 0.7 | 2Rsv. | 2 | 2 | 4 | 97 | reserve | Success rate |
| | 92 | Marigat | Mochongoi | Mochongoi | Kipkandule | 550 | 8.3 | | | | Mochingai Highland | Phonolite | 250 | 80 | 2 | 125 | | 50 | 80 | 40.0 | | 0.7 | 2Rsv. | 2 | 2 | 4 | 98 | reserve | Success rate |
| | 95 | Marigat | Mochongoi | Chebinyiny | Nyalilbuch | 760 | 11.4 | | | | Mochingai Highland | Sediments, Basalt | 200 | 60 | 2 | 100 | | 50 | 80 | 40.0 | | 1.0 | 2Rsv. | 2 | 2 | 4 | 99 | reserve | Success rate |
| | 98 | Marigat | Mochongoi | Arabal | Menmeno | 610 | 9.2 | | | | Mochingai Highland | Sediments, Basalt | 150 | 60 | 2 | 100 | | 50 | 80 | 40.0 | | 1.0 | 2Rsv. | 2 | 2 | 4 | 100 | reserve | Success rate |
| | 150 | East Pokot | Tangulbei | Kokwototo | Katungura | 530 | 8 | | | | Mochingai Highland | Sediment, Basalt | 200 | 60 | 2 | 100 | | 50 | 80 | 40.0 | | 1.0 | 2Rsv. | 2 | 2 | 4 | 101 | reserve | Success rate |
| | 86 | Marigat | Marigat | Sandai | Samuran | 480 | 7.2 | | | | Mochingai Highland | Basalt | 150 | 60 | 4 | 100 | | 50 | 80 | 40.0 | | 0.4 | 2Rsv. | 1 | 2 | 3 | 102 | reserve | Success rate |
| | 89 | Marigat | Mochongoi | Mochongoi | Mochongoi centre | 450 | 6.8 | | | | Mochingai Highland | Phonolite | 250 | 80 | 2 | 125 | | 50 | 80 | 40.0 | | 0.5 | 2Rsv. | 1 | 2 | 3 | 103 | reserve | Success rate |
| | 94 | Marigat | Mochongoi | Chebinyiny | Sambaka | 490 | 7.4 | | | | Mochingai Highland | Sediments, Basalt | 250 | 60 | 2 | 100 | | 50 | 80 | 40.0 | | 0.7 | 2Rsv. | 1 | 2 | 3 | 104 | reserve | Success rate |
| | 96 | Marigat | Mochongoi | Arabal | Sokonin | 390 | 5.9 | | | | Mochingai Highland | Basalt | 150 | 60 | 2 | 100 | | 50 | 80 | 40.0 | | 0.7 | 2Rsv. | 1 | 2 | 3 | 105 | reserve | Success rate |
| | 145 | East Pokot | Tangulbei | Korosi | Nakolete | 380 | 5.7 | | | | Mochingai Highland | Sediment, Basalt | 250 | 60 | 2 | 100 | | 50 | 80 | 40.0 | | 0.7 | 2Rsv. | 1 | 2 | 3 | 106 | reserve | Success rate |
| Reserve Sites | 146 | East Pokot | Tangulbei | Tangulbei | Kalapata | 350 | 5.3 | | | | Mochingai Highland | Sediment, Basalt | 200 | 60 | 2 | 100 | | 50 | 80 | 40.0 | | 0.7 | 2Rsv. | 1 | 2 | 3 | 107 | reserve | Success rate |
| | 149 | East Pokot | Tangulbei | Orus | Siria | 370 | 5.6 | | | | Mochingai Highland | Trachyte, Welded tuff | 200 | 60 | 1 | 100 | | 50 | 80 | 40.0 | | 1.4 | 2Rsv. | 1 | 2 | 3 | 108 | reserve | Success rate Expected water volume shortage |
| | 156 | East Pokot | Mondi | Naudo | Akwichatis | 1,000 | 15 | | | | Mochingai Highland | Sediment, Basalt | 250 | 60 | 2 | 100 | | 50 | 80 | 40.0 | | 1.4 | 2Rsv. | 3 | 2 | 5 | 109 | reserve | Success rate Expected water volume shortage |
| | 157 | East Pokot | Mondi | Naudo | Nasorot | 1,000 | 15 | | | | Mochingai Highland | Sediment, Basalt | 200 | 60 | 2 | 100 | | 50 | 80 | 40.0 | | 1.4 | 2Rsv. | 3 | 2 | 5 | 110 | reserve | Success rate Expected water volume shortage |
| | 26 | Baringo North | Kabartonjo | Bartum | Barkilach | 430 | 8.6 | | | | Tugen East Hilly Area | Basalt | 150 | 50 | 1 | 75 | | 60 | 85 | 51.0 | | 1.8 | 2Rsv. | 1 | 2 | 3 | 111 | reserve | Expected water volume shortage |
| | 27 | Baringo North | Kabartonjo | Bartum | Usuonin | 380 | 7.6 | | | | Tugen East Hilly Area | Basalt | 150 | 50 | 1 | 75 | | 60 | 85 | 51.0 | | 1.8 | 2Rsv. | 1 | 2 | 3 | 112 | reserve | Expected water volume shortage |
| | 30 | Baringo North | Kipsaraman | Sibilo | Chepkewel | 380 | 7.6 | | | | Tugen East Hilly Area | Basalt | 150 | 50 | 1 | 75 | | 62 | 85 | 52.7 | | 1.8 | 2Rsv. | 1 | 2 | 3 | 113 | reserve | Expected water volume shortage |
| | 15 | Baringo North | Kipsaraman | Kapteberewo | Kapamin | 750 | 15 | | | | Tugen Ridge | Phonolite | 250 | 60 | 1 | 100 | | 70 | 80 | 56.0 | | 1.9 | 2Rsv. | 2 | 2 | 4 | 114 | reserve | Expected water volume shortage |
| | 42.1 | Baringo North | Kabartonjo | Saimo Mosop | Kapchepkor1 | 660 | 13.2 | | | | Tugen Ridge | Trachyte | 250 | 80 | 4 | 125 | | 70 | 80 | 56.0 | | 0.5 | 2Rsv. | 2 | 2 | 4 | 117 | Reserve for 43.1 | Overlapping with another site |
| | 42.2 | Baringo North | Kabartonjo | Saimo Mosop | Kapchepkor2 | 790 | 15.8 | | | | Tugen Ridge | Trachyte | 250 | 80 | 4 | 125 | | 70 | 80 | 56.0 | | 0.6 | 2Rsv. | 2 | 2 | 4 | 118 | Reserve for 43.2の | Overlapping with another site |
| | 48 | Baringo North | Kabartonjo | Kelyo | Kaptumin | 1,280 | 25.6 | | | | Tugen Ridge | Trachyte | 200 | 100 | 4 | 150 | | 60 | 80 | 48.0 | | 1.0 | 2Rsv. | 3 | 2 | 5 | 119 | Reserve for 49,50 | Another site within 2km, success rate |
| | 105.1 | Baringo | Salawa | Salawa | Salawa Primary1 | 970 | 19.4 | | | | Kerio Basalt | Basalt | 150 | 40 | 5 | 75 | | 85 | 75 | 63.8 | | 0.5 | 2Rsv. | 2 | 3 | 5 | 120 | Reserve for 104.1 | Overlapping with another site |
| | 105.2 | Baringo | Salawa | Salawa | Salawa Primary2 | 890 | 17.8 | | | | Kerio Basalt | Basalt | 150 | 40 | 5 | 75 | | 85 | 75 | 63.8 | | 0.5 | 2Rsv. | 2 | 3 | 5 | 121 | Reserve for 104.2 | Overlapping with another site |
| | 108 | Baringo | Salawa | Kabarnet Soi | Saonin | 530 | 10.6 | | | | Kerio Basalt | Basalt | 150 | 40 | 5 | 75 | | 85 | 75 | 63.8 | | 0.5 | 2Rsv. | 2 | 3 | 5 | 122 | Reserve for 109 | Overlapping with another site |

| | NO | Province | Division | Location | Site/Village Name | Planned water supply population (2015) | Water supply volume (m3/day) | Access | Existing facitilties | Polulation | Geological areas | Geology | Depth(m) | Estimated static water level(m) | Yield (m3/h) | Dynamic level(m) | Water quality | Water volume (%) | Water quality (%) | Success rate (%) | Population <350 & SWL>40 | Necessary nr. (Yield/(Planned volume/8)) | Judging 1:Selected 2:Reserve 3:Exclude 4:Exclude | Ranking | | | Rank | Remarks | Reason for reserve or excluded sites |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Condition ① | Condition ② | Condtion ③ | | | — | Condition ④ | Condition ⑤ | — | Condition ⑥ | Condition ⑦ | | | Condition ⑧ | Condition ⑨ | | Pop. | Succes | Evaluation | | | |
| Sites not Selected | 11 | Baringo North | Barwessa | Kaboskei Kerio | Katikit | 300 | 6 | | | | Kerio Sediments | Sediments | 120 | 40 | 5 | 75 | | 87 | 85 | 74.0 | | | 3Exd. | 1 | 4 | 5 | 12 | | Small population |
| | 73 | Marigat | Marigat | Kimalel | Kisamisonchun | 320 | 4.8 | | | | Tugen East Hilly Area | Basalt | 120 | 40 | 1 | 50 | | 70 | 85 | 59.5 | | | 3Exd. | 1 | 2 | 3 | 78 | | Small population |
| | 62 | Marigat | Marigat | Eldume | Ilchurai | 290 | 4.4 | | | | Marigat Lowland | Sediments | 100 | 40 | 4 | 75 | | 85 | 76 | 64.6 | | 0.3 | 3Exd. | 1 | 3 | 4 | 115 | | Small population |
| | 168 | East Pokot | Kolowa | Loiwat | Chepelion | 260 | 3.9 | | | | East Pokot Basalt | Basalt | 120 | 40 | 0.6 | 75 | | 70 | 60 | 42.0 | | 0.7 | 3Exd. | 1 | 2 | 3 | 116 | | Success rate |
| | 63 | Marigat | Marigat | Eldume | Eldume centre | 710 | 10.7 | | | | Marigat East Lowland | Sediments | 100 | 30 | 4 | 50 | Treated | 80 | 25 | 20.0 | | 0.4 | 3Exd. | 2 | 0 | 2 | 123 | | Water quality |
| | 84 | Marigat | Marigat | Loboi | Chelaba | 510 | 7.7 | | | | Marigat East Lowland | Basalt | 100 | 40 | 4 | 75 | Treated | 80 | 25 | 20.0 | | | 3Exd. | 2 | 0 | 2 | 124 | | Water quality |
| | 88 | Marigat | Mukutani | Kiserian | Logumgum | 960 | 14.4 | | | | Marigat East Lowland | Sediments | 50 | 30 | 2 | 50 | Treated | 80 | 25 | 20.0 | | 1.4 | 3Exd. | 2 | 0 | 2 | 125 | | Water quality |
| | 154 | East Pokot | Mondi | Naudo | Riongo | 640 | 9.6 | | | | Naudo Lowland | Sediment, Basalt, Welded tuff | 150 | 110 | 1 | 125 | Inacceptable | 40 | 50 | 20.0 | | | 3Exd. | 2 | 0 | 2 | 126 | | Fluoride |
| | 61 | Marigat | Marigat | Eldume | Abori | 420 | 6.3 | | | | Marigat East Lowland | Sediments | 50 | 30 | 2 | 50 | Treated | 80 | 25 | 20.0 | | | 3Exd. | 1 | 0 | 1 | 127 | | Water quality |
| | 67 | Marigat | Marigat | Ng'ambo | Lesuuwa | 370 | 5.6 | | | | Marigat East Lowland | Sediments | 50 | 30 | 2 | 50 | Inacceptable | 80 | 25 | 20.0 | | | 3Exd. | 1 | 0 | 1 | 128 | | Fluoride |
| | 70 | Marigat | Marigat | Kimalel | Loropil | 430 | 6.5 | | | | Marigat East Lowland | Sediments | 50 | 30 | 1 | 50 | Inacceptable | 80 | 25 | 20.0 | | | 3Exd. | 1 | 0 | 1 | 129 | | Fluoride |
| | 83 | Marigat | Marigat | Loboi | Kiwanja Ndege | 360 | 5.4 | | | | Marigat East Lowland | Sediments | 50 | 30 | 2 | 50 | Inacceptable | 80 | 25 | 20.0 | | | 3Exd. | 1 | 0 | 1 | 130 | | Fluoride |
| | 85 | Marigat | Marigat | Sandai | Chepkotoiyan | 400 | 6 | | | | Marigat East Lowland | Sediments | 50 | 30 | 2 | 50 | Inacceptable | 80 | 25 | 20.0 | | | 3Exd. | 1 | 0 | 1 | 131 | | Fluoride |
| | 87 | Marigat | Mukutani | Kiserian | Mosuro | 380 | 5.7 | | | | Marigat East Lowland | Sediments | 50 | 30 | 2 | 50 | Inacceptable | 80 | 25 | 20.0 | | | 3Exd. | 1 | 0 | 1 | 132 | | Fluoride |
| | 141 | East Pokot | Tangulbei | Orus | Lalwasoyen | 300 | 4.5 | | | | Naudo Lowland | Sediment, Basalt | 150 | 110 | 1 | 125 | Inacceptable | 40 | 50 | 20.0 | Excluded | | 3Exd. | 1 | 0 | 1 | 133 | | Fluoride |
| | 165 | East Pokot | Kolowa | Ng'oron | Ngoron | 810 | 12.2 | | | | Precambrian Gneiss | Gneiss | 150 | 40 | 0.5 | 75 | | 30 | 75 | 22.5 | | | 3Exd. | 2 | 0 | 2 | 134 | | Success rate |
| | 163 | East Pokot | Kolowa | Kolowa | Chepturu | 370 | 5.6 | | | | Precambrian Gneiss | Gneiss | 150 | 40 | 0.6 | 75 | | 30 | 75 | 22.5 | | | 3Exd. | 1 | 0 | 1 | 135 | | Success rate |
| | 169 | East Pokot | Kolowa | Kipnai | Krelion | 360 | 5.4 | | | | Precambrian Gneiss | Gneiss | 150 | 50 | 0.5 | 75 | | 30 | 75 | 22.5 | | | 3Exd. | 1 | 0 | 1 | 136 | | Success rate |
| | 190 | East Pokot | Nginyany | Ribko | Maron | 370 | 5.6 | | | | Precambrian Gneiss | Phonolite, Gneiss | 250 | 40 | 0.5 | 75 | | 30 | 75 | 22.5 | | | 3Exd. | 1 | 0 | 1 | 137 | | Success rate |
| | 66 | Marigat | Marigat | Salabani | Kampi ya Samaki | 1,390 | 20.9 | | | | Marigat Lowland | Trachyte, Tuff | 100 | 50 | 4 | 75 | Treated | 50 | 60 | 30.0 | | | 3Exd. | 3 | 0 | 3 | 138 | | Water quality |
| | 24.1 | Baringo North | Bartabwa | Kinyach | Toboroi | 620 | 12.4 | | | | East Pokot Basalt | Phonolite | 200 | 50 | 2 | 75 | | 40 | 75 | 30.0 | | 1.0 | 3Exd. | 2 | 0 | 2 | 139 | | Success rate |
| | 24.2 | Baringo North | Bartabwa | Kinyach | Toboroi | 620 | 12.4 | | | | East Pokot Basalt | Phonolite | 200 | 50 | 2 | 75 | | 40 | 75 | 30.0 | | 1.0 | 3Exd. | 2 | 0 | 2 | 140 | | Success rate |
| Sites not Selected | 25 | Baringo North | Kabartonjo | Bartum | Lingok | 300 | 6 | | | | Tugen East Hilly Area | Trachyte | 120 | 60 | 4 | 75 | | 50 | 60 | 30.0 | Excluded | | 3Exd. | 1 | 0 | 1 | 141 | | Small population/HP imp. |
| | 144 | East Pokot | Tangulbei | Tangulbei | Lomuyek | 400 | 6 | | | | East Pokot Central Lowland | Basalt | 120 | 50 | 0.5 | 100 | Inacceptable | 50 | 60 | 30.0 | | | 3Exd. | 1 | 0 | 1 | 142 | | Fluoride |
| | 181 | East Pokot | Nginyany | Kositei | Katikit | 1,120 | 16.8 | | | | East Pokot Basalt | Tuff | 120 | 60 | 1 | 75 | | 70 | 50 | 35.0 | | | 3Exd. | 3 | 0 | 3 | 143 | | Water quality |
| | 151 | East Pokot | Mondi | Loruk | Tuwo | 560 | 8.4 | | | | East Pokot Central Lowland | Sediment, Basalt | 150 | 70 | 3 | 100 | Inacceptable | 60 | 60 | 36.0 | | | 3Exd. | 2 | 0 | 2 | 144 | | Fluoride |
| | 152 | East Pokot | Mondi | Loruk | Lemuyek | 750 | 11.3 | | | | East Pokot Central Lowland | Basalt | 150 | 70 | 3 | 100 | Inacceptable | 60 | 60 | 36.0 | | | 3Exd. | 2 | 0 | 2 | 145 | | Fluoride |
| | 153 | East Pokot | Mondi | Loruk | Chebilat | 750 | 11.3 | | | | East Pokot Central Lowland | Sediment, Basalt | 180 | 70 | 3 | 100 | Inacceptable | 60 | 60 | 36.0 | | | 3Exd. | 2 | 0 | 2 | 146 | | Fluoride |
| | 160 | East Pokot | Mondi | Loyamorok | Kosiokon | 750 | 11.3 | | | | East Pokot Sediments | Sediment, Trachyphonolite | 120 | 30 | 6 | 50 | | 60 | 60 | 36.0 | | 0.3 | 3Exd. | 2 | 0 | 2 | 147 | | Success rate |
| | 171 | East Pokot | Churo | Churo | Naminito | 550 | 8.3 | | | | Mochingai Highland | Phonolite | 180 | 60 | 1 | 100 | | 45 | 80 | 36.0 | | | 3Exd. | 2 | 0 | 2 | 148 | | Success rate |
| | 143 | East Pokot | Tangulbei | Tangulbei | Kiliwok | 440 | 6.6 | | | | East Pokot Central | Basalt | 120 | 50 | 3 | 100 | Inacceptable | 65 | 60 | 39.0 | | | 3Exd. | 1 | 0 | 1 | 149 | | Fluoride |
| | 148 | East Pokot | Tangulbei | Orus | Orus | 390 | 5.9 | | | | Mochingai Highland | Basalt, Welded tuff | 180 | 60 | 2 | 100 | | 50 | 80 | 40.0 | | | 3Exd. | 1 | 2 | 3 | 150 | | Small community |
| | 131 | Baringo | Sacho | Kabasis | Kabasis | 1,650 | 33 | | | | Tugen Ridge | Sediment, Basalt | 200 | 60 | 6 | 100 | | 55 | 80 | 44.0 | | | 3Exd. | 3 | 2 | 5 | 151 | | Test drilling fail Success rate |
| | 176 | East Pokot | Churo | Churo | Komolwo | 280 | 4.2 | | | | Mochingai Highland | Phonolite | 180 | 60 | 2 | 100 | | 63 | 80 | 50.4 | Excluded | | 3Exd. | 1 | 2 | 3 | 152 | | Small population/HP imp. |
| | 79 | Marigat | Marigat | Kimondis | Wokerben | 480 | 7.2 | | | | Tugen East Hilly Area | Basalt | 120 | 50 | 2 | 75 | | 65 | 85 | 55.3 | | 0.7 | 3Exd. | 1 | 2 | 3 | 153 | | Small community |
| | 115 | Baringo | Salawa | Kapropita Soi | Kisok | 270 | 5.4 | | | | Kerio Basalt | Basalt | 130 | 50 | 5 | 75 | | 79 | 70 | 55.3 | Excluded | | 3Exd. | 1 | 2 | 3 | 154 | | Small population/HP imp. |
| | 117 | Baringo | Sacho | Kapkelelwa | Saimet | 320 | 6.4 | | | | Kerio Basalt | Basalt | 150 | 60 | 5 | 100 | | 79 | 70 | 55.3 | Excluded | | 3Exd. | 1 | 2 | 3 | 155 | | Small population/HP imp. |
| | 82 | Marigat | Marigat | Ewalel Soi | Barsemoi | 530 | 8 | | 有り | | Tugen East Hilly Area | Basalt | 120 | 50 | 4 | 75 | | 70 | 85 | 59.5 | | | 3Exd. | 2 | 2 | 4 | 156 | | Existing facility |
| | 68 | Marigat | Marigat | Kimalel | Kipchemei | 400 | 6 | | | | Tugen East Hilly Area | Basalt | 120 | 50 | 4 | 75 | | 70 | 85 | 59.5 | | 0.4 | 3Exd. | 1 | 2 | 3 | 157 | | Small community |
| | 128 | Baringo | Tenges | Tuluongoi | Katkamuma | 220 | 4.4 | | | | Tugen East Hilly Area | Basalt | 120 | 50 | 4 | 75 | | 70 | 85 | 59.5 | Excluded | | 3Exd. | 1 | 2 | 3 | 158 | | Small population/HP imp. |
| | 54 | Marigat | Marigat | Marigat | Sirinyo | 360 | 5.4 | | | | Marigat Lowland | Sediments | 100 | 50 | 4 | 75 | | 85 | 76 | 64.6 | | 0.4 | 3Exd. | 1 | 3 | 4 | 159 | | Small community |
| | 97 | Marigat | Mochongoi | Arabal | Partalo | 520 | 7.8 | 不可 | | | Mochingai Highland | Basalt | 150 | 60 | 2 | 100 | | 50 | 80 | 40.0 | | | 4Exd. | 2 | 2 | 4 | 160 | | Inaccessible Site unknown |
| | 17 | Baringo North | Kipsaraman | Kapteberewo | Chambai Primary | 690 | 13.8 | 不可 | | | | Phonolite | 200 | 80 | 0 | | | - | - | - | | | 4Exd. | 2 | | | 161 | | Inaccessible |
| | 14 | Baringo North | Barwessa | Kaboskei Kerio | Chesangich | 370 | 7.4 | 不可 | | | | | | 0 | 0 | | | - | - | - | | | 4Exd. | 1 | | | 162 | | Inaccessible |
| | 19 | Baringo North | Kipsaraman | Kipkata | Barketieu Primary | 430 | 8.6 | 不可 | | | | | | 0 | 0 | | | - | - | - | | | 4Exd. | 1 | | | 163 | | Inaccessible |
| | 41 | Baringo North | Kabartonjo | Katiorin | Kapkomol | 320 | 6.4 | 不可 | | | | | | 0 | 0 | | | - | - | - | | | 4Exd. | 1 | | | 164 | | Inaccessible |
| | 118 | Baringo | Sacho | Chepkero | Kwamkeiyon | 370 | 7.4 | 不可 | | | | | | 0 | 0 | | | - | - | - | | | 4Exd. | 1 | | | 165 | | Inaccessible |
| | 178 | East Pokot | Churo | Kaptuya | Lolkos | 280 | 4.2 | 不可 | | | | | | 0 | 0 | | | - | - | - | | | 4Exd. | 1 | | | 166 | | Inaccessible |
| **Total** | | | | | | 98,170 | 60.7% | | | | | | | | | | | | | | | | 166 | | | | | | |
| **90 sites** | | | | | | 59,580 | | 0 | 1 | 0 | | | | | | | 0 | 73.4 | 77.3 | 58.7 | 0 | | 1=90 | | | | | **BH Drilling=10** | |
| **Incl. reserve sites (118)** | | | | | | 76,460 | | | | | | | | | | | | 70 | 78 | 56 | | | 118-5 | | | | | | |

(9) Effect of the Project

1) Beneficiary Population

The population with access to safe and stable water will increase by 59,000, and the water coverage rate in Baringo County will be 24% in 2011 to 36% in 2015. The planned water service population of each district is shown below.

Table 2-14 Water Service Population and Coverage Rate

| District | North Baringo | Marigat | Baringo Central | East Pokot | Baringo Area | Kenya Rural Area |
|---|---|---|---|---|---|---|
| Population in 2011 | 96,800 | 43,100 | 124,500 | 137,500 | 401,900 | 28,841,000 |
| Estimated population with access to safe water in 2011 | 25,200 | 9,900 | 42,300 | 20,600 | 98,000 | 11,536,400 |
| Water Coverage Rate (%) | 26% | 23% | 34% | 15% | 24% | 40% |
| Population in 2015 | 103,200 | 46,000 | 132,600 | 146,500 | 428,300 | - |
| Increased Population by the Project | 19,930 | 7,240 | 27,530 | 4,510 | 59,210 | |
| Expected population with access to safe water in 2015 | 45,130 | 17,140 | 69,830 | 25,110 | 157,210 | - |
| Water Coverage Rate in 2015 (%) | 44% | 37% | 53% | 17% | 37% | - |
| Plan Year 2017 population | 106,500 | 47,400 | 136,900 | 151,200 | 442,000 | - |
| Plan Year 2017 estimated service population | 45,130 | 17,140 | 69,830 | 25,110 | 157,210 | - |
| Water supply rate in 2017 (%) | 42% | 36% | 51% | 17% | 36% | - |

* The population for 2015 and 2017 were estimated using the Census in 2009 with a growth rate of 1.6％.

For the rural areas, 1.9% was used. The water supply rate in rural Kenya was estimated at 40% in the “Ministerial Strategic Plan 2009-2012, 2008.” The water supply rate in 2017 was estimated using the same water supply population in 2015.

2) Other Benefits

a) Waterborne diseases

According to the social survey, the infection rate of diarrhea is very high, 24% of the population in the target area. Data from the district hospital shows half of patients are infants less than 5 years old. The reason is assumed that the number of borehole facilities is very few and usage of river and dug well is very common for drinking purposes in the area. It is expected that this infection rate will decrease when safe water is supplied.

b) Improvement of water fetching and sanitary condition

Water fetching is a job of women and children according to the social survey. Water fetching has a risk on sanitation and safety since they need to dig the riverbed and take water from the river or pond where many domestic animals also drink. Distances to the existing water source are 2 to 5km in the dry season, and to other boreholes in neighboring communities account for more than 5km.

The Project will improve conditions of water fetching and benefit women and children. Some 49.6% of the total women population (around 29,500) and 49.8% of total children less than 14 years old (around 29,600) are going to benefit from the Project.

### 2-2-2-2 Water Supply Facility Plan with Borehole

(1) Size of Service Population

Water supply facilities are planned in accordance with the size of population. The planned population in a target area is 500 to 2500. Communities with a larger population are planned with more than one borehole.

Some boreholes are located too close to each other with neighboring communities. At the mountain ridge, there is no adequate location for the construction of facilities. Taking these conditions into account, 7 sites with population of 1,500 are included. The size of facilities is categorized by the population size: 500, 750, 1000 and 1500. The facility is therefore planned in accordance with the population size. The number of sites by population is as follows:

- 500 : 34 sites
- 750 : 33 sites ( 3 sites taken from test drilling)
- 1000 : 13 sites ( 1 site taken from test drilling)
- 1500 : 10 sites ( 1 site taken from test drilling)

(2) Success Criteria of Boreholes

1) Pumping volume

Level 1.5 (a point source with a power pump type)

The Project aims at level 1.5 (a point source with a power pump type) with target populations of 500-1500. The water volumes need to be calculated in accordance with the size. Drilling boreholes in the target area aims at cracks in the bedrock aquifer fracture zone of the Rift Valley to search for water aquifers. At times it is anticipated that potential of groundwater in the region does not meet the need of water supply volume.

The Project drills a maximum 2 boreholes per site. For a 1.5 level system using a power supply, $1m^3$/hr volume is aimed as the minimum. On the other hand, Rift Valley has very complex geographical features that the risk of water volume shortage is high. In such circumstances, demanding a ridged water volume discourages bidders for the construction work.

In case of commercial power supply and generator, it is possible to prolong operation hours. In this case, if the yields are 70-60% of the planned volume, a longer hours of operation can cover the daily planned water supply volume.

In case of solar system, the standard operation hours are set during the rainy season where solar radiation is minimal. However, more than 5.5 hours of solar radiation can be expected at times. Also, during the rainy season there are other water sources to meet the daily needs and the usage of water supply facilities may become less. Therefore, it is possible to set 80-90% of the planned water volume as a success.

For the sites with high priority, the success criterion is set lower than the first drilling to secure the success of borehole. The minimum of 1m$^3$/hr is secured and, in addition, the following criteria are set:

First drilling: 60-90% of planned water supply volume / hr, depending on topographic and geological conditions.

Second drilling: 60% of planned water supply volume / hr, and 1m$^3$/hr or more

The systems with commercial power supply and generator operate from 8 hours/day to as long as 12 hours/day; therefore, 60-70% of the planned water supply volume/hr is regarded as acceptable. The solar system on the other hand, can operate 10-20% longer during the dry season, and during the rainy season the rainwater can be used for the daily needs.

The successfully drilled boreholes in the preparatory study were maintained safely by Kenya until the Project installed pumps and power facilities. The failed boreholes were filled back and the boreholes with insufficient water quantity were handed over to Kenya.

2) Water Quality

The Kenyan water quality standards manual serves as reference. Water quality that do not meet the standards is a failure and withdrawn.

The water supply manual indicates the criterion for fluoride, 1.5mg/L. In Kenya there is another guideline known as “Drinking Water Quality and Effluent Monitoring Guideline,” in which fluoride level is set at 1.5mg/L with the remark “in exceptional cases due to regional and climate restrictions, 3mg/L may be applied.”

Table 2-15 Comparison of Kenya and WHO Water Quality Standards

| Water Quality Items | Unit | Kenya Standard | WHO Standards (2004) |
|---|---|---|---|
| Arsenic | mg/L | 0.05 | 0.01 |
| Fluoride | mg/L | 3.0 (1.5) | 1.5 |
| Manganese | mg/L | 0.5 | 0.4 |
| Fe | mg/L | 1.0 | 0.3 (1984) |
| Total Dissolved Substances | mg/L | 1500 | 1000 (1984) |

Note: Items in parenthesis have no adversary health effect so that no indication was made after the 2004 version.

(3) Outline of Borehole Construction

The drilling depths are set at 100m, 150m, 200m and 250m depending on the results of electrical exploration and geological data, as well as information on existing boreholes. Borehole depths and the number of drillings are shown in Table 2-16.

Table 2-16 Borehole Depths and Number of Drillings by District

| District | Borehole Depths | | | | | Sum |
|---|---|---|---|---|---|---|
| | 50m | 100m | 150m | 200m | 250m | |
| North Baringo | 0 | 0 | 15 | 6 | 7 | 30 |
| Central Baringo | 0 | 5(2) | 17 | 17(1) | 3 | 38 |
| Marigat | 0 | 7 | 5 | 0 | 2 | 15 |
| East Pokot | 0 | 1 | 10(2) | 1 | 0 | 7 |
| Totak | 0 | 12(2) | 47(2) | 23(1) | 13 | 90(5) |

Note: There were 85 drillings made in total during the construction stage, including 5 successful test drillings in the preparatory study

The drilling method is DHT (Down the Hole Hammer), and pipe diameter is 6-inch steel casing. The major specifications for drilling are as elaborated below.

1) Casing and screen

Six (6) inch steel casing and screen are employed as the standard. The steel casing and screen are 6m. A slit is made on the casing to make a screen. The width of slit is approx. 2mm, mouth opening rate is 4% and more. Parts are connected by welding.

2) Drilling diameter

Drilling diameter is 12 inches from 0 to 12m. Thereafter, the diameter is changed to 10 inches until the planned depth.

3) Gravel filling, cementing

Products for gravel filling materials are available in Kenya. Size 2.5 to 5mm is used for caliber. Cementing is done after insertion of borehole casing and gravel filling. The 12 inch drilling hole is cemented until the ground level to protect the borehole from surface pollutants.

4) Pumping test

Pumping test is conducted after insertion of casing. A pump is installed for pumping test using temporal generator to conduct a step draw-down test, continuous pumping test and water level recovery test.

- Step draw down test (1hr/step * 5 steps)

- Continuous test (more than 18 hrs)

- Recovery test (more than 6 hrs)

5) Water quality test

Water samples are taken at the pumping test stage to examine water quality. The water sample is sent to a laboratory in Nakuru or Nairobi where reagents stock and equipment are easily accessible.

### 2-2-2-3 Water Facility Superstructure

(1) Selection of water supply facility types

1) Types of pumping system

a) Solar Pump

Two types of solar pumping system (DC or AC) are the options. DC type without inverter was observed in the target area during the preparatory study, and reports have shown that breakdowns were frequent with the inverter. From the maintenance perspective, DC type is preferable in the area. The criteria for selection of solar pumping system depend on the pumping volume and groundwater level. In the target area, lowlands without commercial power supply are the candidate sites for solar pumping system. At highlands, this system is not appropriate due to natural conditions such as a large annual precipitation volume.

b) Commercial power supply and submersible water pump

Availability of high-voltage power lines (3 phases, more than 400V) is a precondition to use this system. From the operation and maintenance point of view, this type is the most appropriate for the target areas.

c) Generator and submersible water pump

Generator is a further option in case the two systems above are not possible. However, some communities have difficulty to purchase fuel to run the generator both in terms of cost and distance. At smaller communities this option is not affordable to choose.

2) Comparison of estimated costs of each pumping system

The estimated costs for each system are shown in Table 2-17. Generator is more expensive compared to solar and commercial electric power. In terms of construction costs per person, a solar system for 500 population size is economically more viable to construct than a hand pump for 250 population size.

Table 2-17 Comparison of Estimated Costs by Pumping System

| | Unit | Handpump (refer.) | Solar pump | | | Diesel+submersible pump | | | Electricity+submersible pump | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Target population | Person | 250 | 350 | 500 | 750 | 500 | 750 | 1000 | 500 | 750 | 1000 |
| Pop.range | Person | 150-250 | 300-350 | 351-500 | 501-750 | 251-500 | 501-750 | 751-1000 | 251-500 | 501-750 | 751-1000 |
| Water supply volume | m3/day | 5 | 7 | 10 | 15 | 10 | 15 | 20 | 10 | 15 | 20 |
| Water supply volume | L/hr | 0 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| Total pumping head | m | 40 | 75 | 75 | 75 | 140 | 141 | 141 | 140 | 141 | 141 |
| Pump ex. | Type | AfridevHP | SQFlexD | SQFlexE | SQFlexE | SP3A-25 | SP3A-33 | SP3A-33 | SP3A-33 | SP3A-33 | SP3A-33 |
| Diesel ex | kVA | | | | | 5.3 | 7.7 | 7.7 | | | |
| Facilities | | Cost estimates | | | | | | | | | |
| Borehole | 1000 ksh | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 |
| Handpump | 1000 ksh | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Solar pump | 1000 ksh | 0 | 1,200 | 1,333 | 1,524 | 0 | 0 | 0 | 0 | 0 | 0 |
| Submersible pump | 1000 ksh | 0 | 0 | 0 | 0 | 700 | 800 | 860 | 700 | 800 | 860 |
| Diesel | 1000 ksh | 0 | 0 | 0 | 0 | 780 | 935 | 935 | 0 | 0 | 0 |
| Electric lead-in | 1000 ksh | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 650 | 650 | 650 |
| Platform | 1000 ksh | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Kiosk | 1000 ksh | 0 | 780 | 780 | 780 | 0 | 0 | 0 | 780 | 780 | 780 |
| Kiosk | 1000 ksh | 0 | 0 | 0 | 0 | 1,080 | 1,080 | 1,080 | 0 | 0 | 0 |
| Elevated watertank | 1000 ksh | 0 | 700 | 700 | 700 | 700 | 700 | 700 | 700 | 700 | 700 |
| Sum | 1000 ksh | 2,200 | 4,680 | 4,813 | 5,004 | 5,260 | 5,515 | 5,575 | 4,830 | 4,930 | 4,990 |
| Cost/person | 1000 ksh | 8.80 | 13.37 | 9.63 | 6.67 | 10.52 | 7.35 | 5.58 | 9.66 | 6.57 | 4.99 |

3) Cost for operation and maintenance

The operation and maintenance costs are estimated by population size of 250, 350, 750 and 1000. The water supply unit was set at 20L. Operation costs differ depending on the system applied. There is need for payment to operators, water vendors and other running costs (Table 2-18).

Table 2-18 Operation and Maintenance Costs

| Pumping Facilities | Unit | Hand Pump | Solar Pump | | | Generator＋ Submersible Motor Pump | | | Commercial Electric Power ＋ Submersible Motor Pump | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Population size | pp | 250 | 350 | 500 | 750 | 500 | 750 | 1000 | 500 | 750 | 1000 |
| Water supply volume/day | $m^3$ | 5.0 | 7.0 | 100 | 15.0 | 100 | 15.0 | 20.0 | 100 | 15.0 | 20.0 |
| Total head | m | 40 | 75 | 75 | 110 | 110 | 110 | 110 | 110 | 110 | 110 |
| Power/fuel | Ksh/20L | 0 | 0 | 0 | 0 | 2.2 | 1.6 | 1.2 | 0.2 | 0.2 | 0.2 |
| O&M | Ksh/20L | 0.6 | 2.1 | 1.5 | 1.0 | 1.6 | 1.2 | 1.0 | 1.1 | 0.9 | 0.6 |
| Total | Ksh/20L | 0.6 | 2.1 | 1.5 | 1.0 | 3.8 | 2.8 | 2.2 | 1.3 | 1.1 | 0.8 |

Solar pump and commercial electric power supply cost 2Ksh for 20L/day and generator costs 4Ksh for 500 people.

4) Comparison of Pumps

Table 2-19 Comparison of Pumps

| Pumping system | Advantage | Disadvantage |
|---|---|---|
| Solar pump | • Available without power distribution lines<br>• Natural power usage<br>• No cost incurred for power<br>• O&M is easy | • Depends on weather and seasonal solar power<br>• General pumps have restricted capacity by water level and water volume |
| Commercial power supply + submersible water pump | • Comparatively less cost for power<br>• O&M is needed only for pump, thus easy. | • Power distribution lines are available only at certain communities<br>• Installation takes longer time and transmission and distribution lines need additional costs |
| Generator + submersible water pump | • Available without power distribution lines | • Need to buy and transport fuel<br>• O&M costs relatively high<br>• Construction costs relatively high |
| Hand pump | • Easier for operation and maintenance by communities<br>• No need for power | • Need to have spare parts sellers and knowledge to change parts<br>• Not usable with a deep water level |

5) Review of solar pumping system

Based on the discussions above, power pumping facilities were carefully selected for each target community. Selection was carried out according to the flow in Figure 3-6 considering assessment of potential groundwater development. Commercial power is used in case it is available, and if it is difficult, a solar pump is deployed.

The amount of solar radiation is not measured in the target area. Data from the NASA satellite system is summarized in Table 2-20. The data are an average of 22 years (1983-2004), which is calculated as a representative value by 1 mesh of latitude x longitude. In the target area, there is enough amount of solar radiation (kWh/$m^2$/day). In general, solar pumping system is appropriate for this area.

Table 2-20 Monthly Average Solar Radiation in Northern Kenya

| Month | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average | 6.24 | 6.71 | 6.59 | 5.94 | 5.68 | 5.33 | 5.09 | 5.33 | 6.19 | 5.97 | 5.62 | 6.05 | 5.89 |

Source: JICA Rural Electrification by Renewable Energy Modeling Project

Regional characteristics need to be taken into account to deploy a solar pumping system. The data shown in Table 2-20 are representative values of both high and lowlands. In reality, highlands receive more rain and solar radiation is less than at lowlands.

The weather station in the target area has only the data of precipitation. Nakuru is located outside of the Project area, but nearby, thus taken as an indicative data set to evaluate. Monthly average solar radiation hours in Nakuru were 5.8-9.4 hours, with an average of 8 hours.

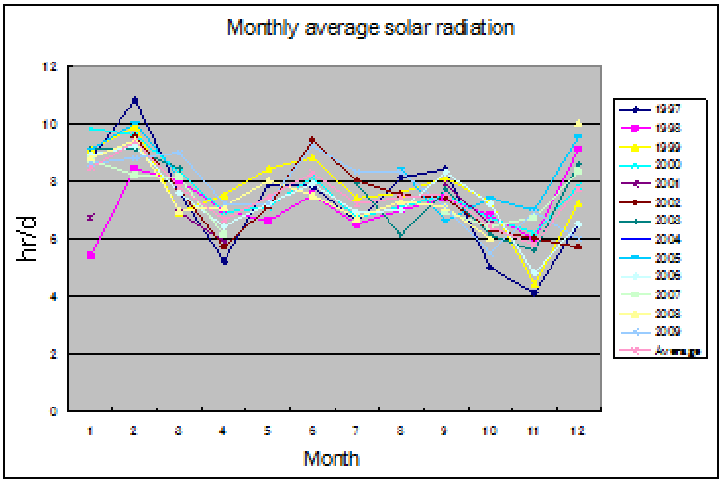



Figure 2-4 Monthly Average Solar Radiation

The annual precipitation in Nakuru is 970mm. During 1997-2009, the duration of solar radiation was 4-6 hours in April and November with precipitation of 150-200mm per month. In highlands and lowlands in the target area, they receive 1,300-1,400mm of rainfall precipitation per year, while 200-250mm in April-May and July-August. The condition of solar radiation may be more severe. Under such conditions, 8 hours are counted for a submersible pump and 5.5 hours for a solar pump.

The following equation shows the output of the pumps.

$$P = 0.163 \cdot Q \cdot H / \eta$$

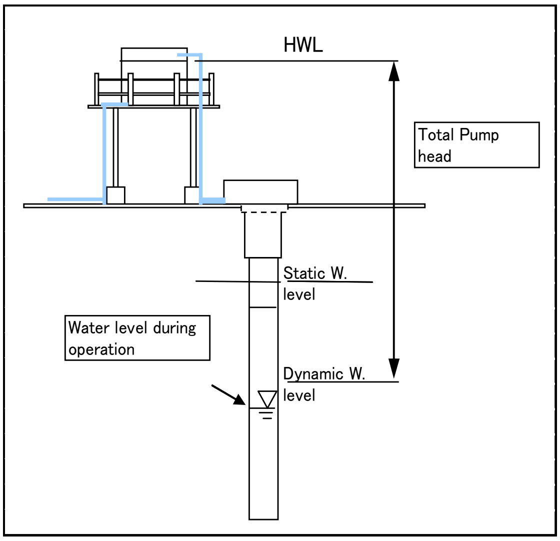
P: motor output (kW)

Q: The amount of the pump discharge

H: Total pump head

$\eta$ : Pump efficiency (%)

The range of use of solar pumps is assessed, based on the pump performance curves that are locally available, using pumping quantity and the total pump head (elevation difference between the reservoir water level and water level during the pump operation) (Figure 2-5). Solar pump can be adjustable with different numbers of solar panel. With the maximum output of 1400W, 130m of pump head and 2.3$m^3$/h is reachable. Selection is made using these formulas (Figure 2-6).



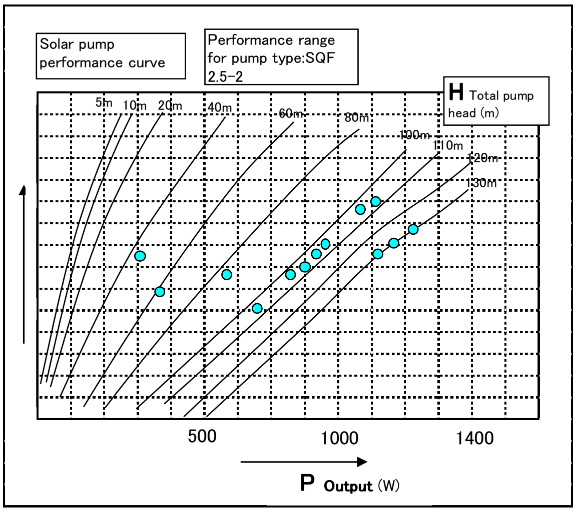




Figure 2-5 Total Pump Head Concept

Figure 2-6 Performance Curve of Solar Pump

6) Selection of pumping system

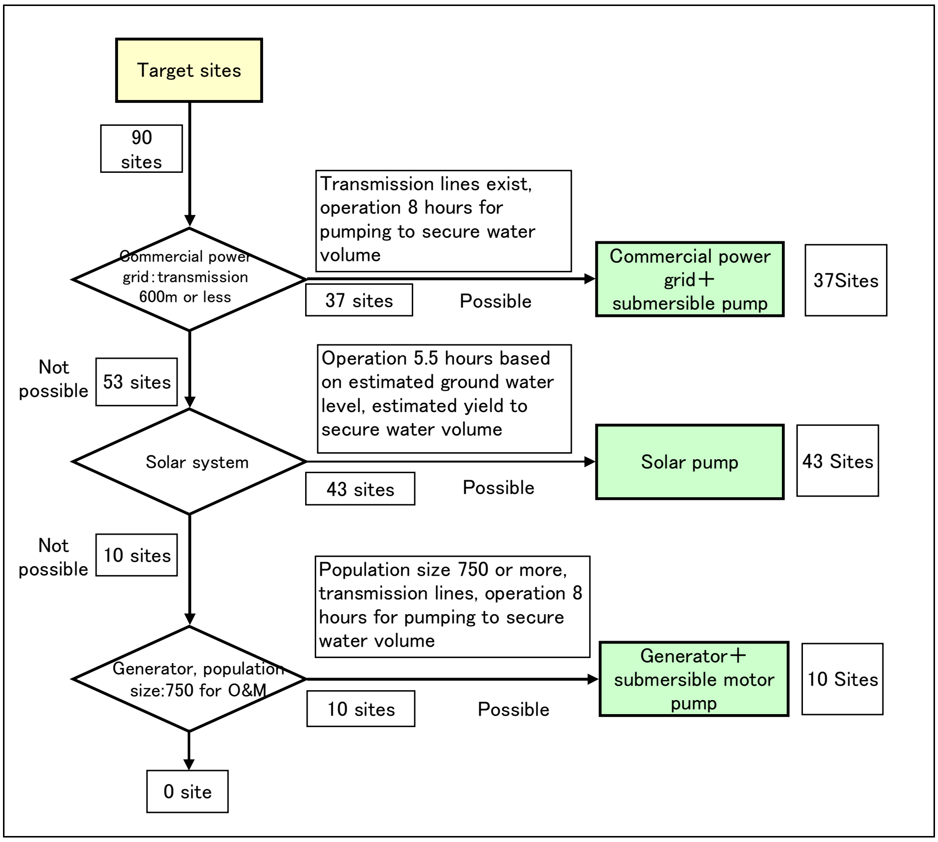



Figure 2-7 Selection Logics for Pump Types

Selection criteria are as follows:

a) Commercial Electricity

- Electricity grid is located within 600m of the water source
- A plan is made for 8 operation hours

b) Solar System

- The underground water level is within 110m from the surface
- 80% or more of the planned water volume can be secured with the average daily operation of 5.5 hours
- Commercial power grid is not available and fuel supply is also difficult

c) Generator

- Commercial electric power is not available and the criteria described in b) above cannot be satisfied.
- The population needs to be more than 750 for sustainable operations and maintenance

Table 2-21 shows the number of pumps by district: solar pump: 43; commercial power supply: 37; generator: 10.

Table 2-21 Water Supply Systems by District

| District | Solar | Electric Power | Generator | Total |
|---|---|---|---|---|
| North Baringo | 12 | 14 | 2 | 28 |
| Marigat | 9 | 5 | 0 | 14 |
| Baringo Central | 14 | 18 | 6 | 38 |
| East Pokot | 8 | 0 | 2 | 10 |
| Total | 43 | 37 | 10 | 90 |

(2) Design of Water Supply Facilities

The designs for the Project consider the following aspects to select standardized designs: pumping methods, scales of water supply population (below 350, 500, 750, 1000 and 1500) and groundwater levels.

Table 2-22 Water Supply Systems

| System | Facility Components | | | | | | |
|---|---|---|---|---|---|---|---|
| | Borehole Pit | Solar Modules | Commercial Electric Power Connection | Generator | Elevated Water Tank | Water Vending Kiosk | Fence |
| Solar power pumping system | ● | ● | — | — | ● | ● | ● |
| Commercial electric power | ● | — | ● | — | ● | ● | ● |
| Generator | ● | — | — | ● | ● | ● | ● |
| Hand pump | ● | — | — | — | — | — | ● |

(3) Facility Outline

Components of each facility set are shown in Figure 2-8.

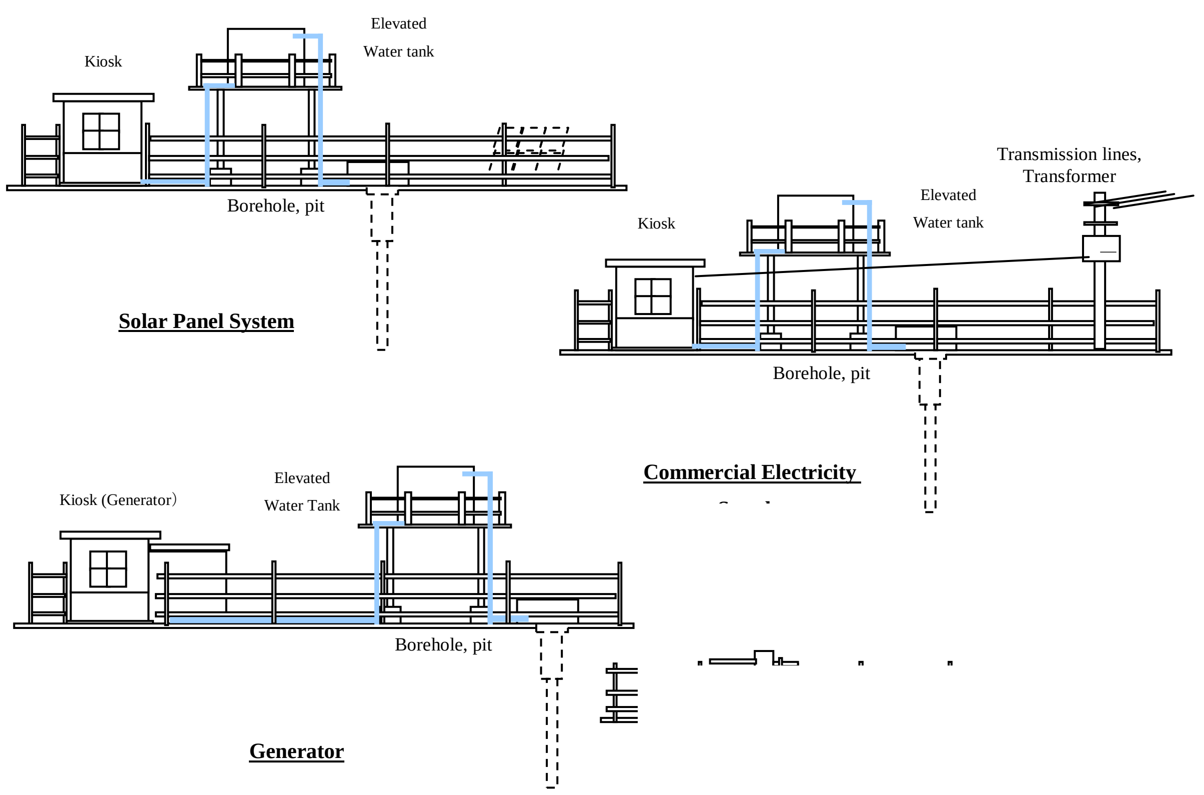



Figure 2-8　　Facility Outline

Power supply facilities having different specifications of scale are shown in the table below. The overview of each facility is outlined in the following paragraphs.

Table 2-23 Power Supply Facilities and Specifications

| Item | | Solar | | Commercial Electricity | | | | Diesel | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Community population | | 500 | 750 | 500 | 750 | 1000 | 1500 | 750 | 1000 | 1500 | |
| Population Range | | 351～500 | 501～750 | 351～500 | 501～750 | 751～1000 | 1001～1500 | 501～750 | 751～1000 | 1001～1500 | |
| Nr of sites | | 24 | 19 | 10 | 14 | 6 | 7 | 3 | 6 | 1 | 90 |
| Borehole (Nr of sites by depth) | Depth 100m | 2 | 4 | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 10 |
| | Depth 150m | 17 | 12 | 4 | 7 | 1 | 1 | 1 | 2 | 0 | 45 |
| | Depth 200m | 2 | 2 | 2 | 5 | 3 | 4 | 2 | 1 | 1 | 22 |
| | Depth 250m | 3 | 1 | 2 | 2 | 0 | 2 | 0 | 3 | 0 | 13 |
| Spec. of pump | Yield/day (m3/d) | 1.0-1.8 | 1.4-2.7 | 0.8-1.2 | 1.3-1.9 | 1.8-2.5 | 2.7-5.5 | 1.3-1.9 | 2.1-2.5 | 2.6-3.5 | |
| | Pump head(m) | 85-130 | 65-130 | 80-180 | 80-180 | 80-180 | 105-180 | 85-135 | 105-130 | 130 | |
| | Pump output(kW) | 0.7-1.5 | 0.7-1.5 | 1.1-1.5 | 1.1-4.0 | 1.5-4.0 | 2.2-4.0 | 1.1-4.0 | 1.5-2.2 | 4 | |
| | Remarks | | | | | | Test success borehole No.137 Kapkawa:7.7m 3/dx180mx 5.5kW | | | | |
| Diesel | Output | – | | | | | | 5, 12kVA | | | |
| | Starter | – | | | | | | Stardelta type | | | |
| Elevated water tank | Volume (m3) | 10 | | | | 16 | | 10 | 16 | | |
| | Height | 3 | | | | | | | | | |
| | Material | Steel aggregates, plastic tank | | | | | | | | | |
| Transmission pipes | Pipe diameter | 40 | | | | | | | | | |
| | Length (m) high/low (school) lands | 30/200 | | | | | | | | | |
| | Material | Zinc coated steel pipes | | | | | | | | | |
| Kiosk | Size(m2) | 8 | | | | | | 13 | | | |
| | Material | Concrete poles, block walls, zinc roofing | | | | | | | | | |
| Trough | Size | 0.7x5.0x0.55: | | | | | | | | | |
| | Material | Concret blocks/bricks | | | | | | | | | |

(4) Pumping facility

Pump types are: solar pump, a general submersible water pump for commercial electric power and generator use. The use of commercial electric power is taken as an option for the sites that had already transmission lines in April 2011 at the preparation study. There are many sales agents of submersible motor pump and photovoltaic systems in Kenya. Experience in the target area and maintenance services are taken into account to select a procurer.

At each borehole, the dynamic water level is calculated by adding a water level drop to a static water level during operation. Further, water supply quantities and the pump performance curve were examined to select a water pump. The selection criteria were explicated in (1), Selection of pumps for water supply facilities, and (2), Selection of power. For the selection of submersible water pump in highlands and lowlands, drilling points shall be lower than roads on ridges and water is conveyed to a kiosk at the higher road side, so that 30m pump head is added to the expected dynamic water level.

The system is selected, based on the design principles, to accommodate fluctuations in water level and yield. The types of pumps are limited to a minimum number. One solar pumping system type was selected for 43 sites. The number of photovoltaic panels will change according to the power needs. General submersible water pumps are selected from 7 different choices in Table 2-24.

Table 2-24 Population Scale, Volume, Pump Head

| Total Pump Head (m) | Pumping Quantity ($m^3$/hr) | Quantity (per machine) | Remarks |
|---|---|---|---|
| 110 | 8.0 | 1 | Kapkawa |
| 180 | 4.0 | 12 | |
| 130 | 2.8 | 3 | |
| 155 | 1.8 | 12 | |
| 110 | 2.2 | 7 | |
| 160 | 1.2 | 3 | |
| 110 | 1.3 | 9 | |
| Total | | 47 | |

(5) Generator

Generators are installed at 18 sites in total. The starting method is the star-delta type. Two types of output, 5.5KVA and 10KVA, were selected which are 3 times larger than the output of pumps.

Table 2-25 Population Scale and Pumping Capacity, Pump Head

| Capacity (kVA) | Quantity (machine) | Starting method |
|---|---|---|
| 5.5 | 1 | Star delta |
| 10 | 9 | Star delta |
| Total | 10 | |

(6) Elevated Water Tank

In the target area, tanks in steel, concrete and plastic are commonly found. Steel gets rusty where leakages occur and eventually become unusable. Concrete types are placed on the ground and have become obsolete. The use of plastic types has increased in recent years, and for the Project there is a wide range of selection for various volume needs.

Table 2-26 Water Tanks Summary

| Type of Tank | Installation Achievement | Price | Operation and Maintenance |
|---|---|---|---|
| Steel Water Tank | ○ | ○ | △ |
| Concrete Water Tank | ○ | ○ | ○ |
| Plastic Water Tank | ◎ | ◎ | ◎ |

For the Project, elevated plastic tanks fixed on top of steel legs are employed.

The communities that have existing reservoirs are Salawa Hospital (104-1) and Kapkawa (137-1). Both sites have springs as water source but the springs dry up during the dry season. Salawa Hospital (104-1) has a reservoir at a higher location than the hospital, which is convenient for use.

{Kapkawa (137-1) was successfully drilled during the 2nd preparatory survey.) Many residents have no water connection, thus the project include connections to existing reservoirs, new tank construction and kiosk to sell water. Considering the project to be rural water supply, elevated water tank and storage capacity are set, in accordance with Design Manual, in the range of 50 to 100% of daily water supply. Two types of capacities of tanks are selected for the project: $10m^3$ for less than 500 750 users and $16m^3$ for 750 to 1,500 users. The elevation height is set at 3m to secure enough water pressure for distribution.

Table 2-27 Pumping Capacity and Quantity

| Capacity ($m^3$) | Quantity | Remarks |
|---|---|---|
| 10 | 55 | |
| 16 | 34 | |
| Total | 89 | 1 existing pond is used |

(7) Water Vending Kiosk

A water vending kiosk has a water pump control panel inside. An incoming panel is also equipped on the kiosk for commercial electric power use. A standard floor area of about 8.0m2 (2.3mx 3.5m) is designed for all sites. If a generator is applied for the system, a generator room (steel net wall, floor area $5.0m^2$) is annexed outside the kiosk. The number of tap is a flat 4 to improve the efficiency of sale of water.

(8) Water Pipe

In the middle and high lands, borehole positions selected are lower than the ridge on which roads run. Therefore, water pipes are placed to send water from the borehole to a higher located kiosk. Transmission distance is on average 200m according to the preparatory survey result.

In the lowlands, in principle the boreholes and water vending kiosk are located at the same premises, thus the length of the pipe is 30m. In case of schools, a kiosk needs to be placed outside of the school premises so as to have a 200m transmission pipe. The discharge of the pipes is calculated with the Hezen-Williams equation, as follows:

$$H=10.666 \times C^{-1.85} \times D^{-4.87} \times Q^{1.85} \times L$$

H: Friction Head Loss (m)

C: Coefficient of velocity

D: Pipe diameter (m)

Q: Water discharge quantity ($m^3$/sec)

L: Length (m)

The diameter of 40mm is appropriate considering the friction head loss not to be too large with the water discharge of 1 $m^3$/sec to 3 $m^3$/sec. The Project uses the zinc galvanized steel pipes placed on the ground since the area is rocky at some locations.

Table 2-28 Overview of Water Transmission Pipes

| | Diameter | Material | Length | Remarks |
|---|---|---|---|---|
| High, middle-lands, school | 40mm | Galvanized steel pipe | Average 200m | Borehole is lower than kiosk. Schools in lowland |
| Lowland | Ibid. | Ibid. | Average 30m | Borehole, elevated water tank and kiosk located in the same premise |

(9) Trough for livestock

In the target area, most communities keep goats, sheep and other livestock. If there is sufficient water supply, water is given to livestocks. A trough is constructed outside the fence for reasons of hygiene. Troughs are made of concrete blocks, brick, or mortar with a standard size of 0.55m x 0.7m x 5.0m.

(10) Fence

Fences are necessary to prevent intrusion of wild animals and theft. The area is rocky so that the installation needs professional hands with drilling equipment. Fence is a steel pump with entanglement.

(11) Success Criteria and Installation of Facilities

The success criteria of borehole and installation of facilities are determined as shown in the following table.

Table 2-29 Success Criteria and Installation of Facilities

| Population Size | First Drilling (Trial) | Second Trial | Remarks |
|---|---|---|---|
| 1500 | Secured more than 60-90% of design water supply and more than 1m$^3$/hr: Boreholes deemed successful, to establish the initial design of water supply facilities.<br>Secured less than 90% of design water supply→2nd drilling trial | 2nd try at the same site: Secured more than 60% of design water supply and more than 1 m$^3$/hr: boreholes deemed successful, to establish the initial design of water supply facilities. | For 1500 population size, during the detailed design, 9 sites are drilled and the facility designs determined except 1 site already successful from the preparatory study. |
| 1000 | Did not satisfy the above conditions→2nd drilling trial | 2nd try at the same site: Secured more than 60% of design water supply and more than 1 m$^3$/hr: boreholes deemed successful, to establish the initial design of water supply facilities.<br>Did not satisfy the above conditions→2nd drilling trial | For 1000 population size, during the detailed design, 1 site is drilled and the facility designs determined. 1 site already successful from the preparatory study, remaining is 9 sites.<br>Initially designed pumps are used, in case of commercial power, operating hours are extended.<br>If the number of photovoltaic panels is in surplus, the rest is kept by DWO. |
| 750 | ditto | ditto | ditto |
| 500 | ditto | ditto | ditto |

# Table 2-30 Water Supply System Analysis

| Nr. | Site Name | District | Population 2011 (Pers.) | School Day Sch. (Pers.) | School Boarding (Pers.) | School Pop. Convert (Pers.) | Water supply population Planned year 2015 (Pers.) | Planned year 2015 Corrected (pers.) | 2017 (ref.) (Pers.) | Water supply unit (L/d･Pers) | Day supply volume 2015 ($m^3$/d) | Priority | Size | System type | Distance to power grid (m) | BH depth (m) | Success rate (Volume) | Success rate (Quality) | Success rate (%) | Static (m) | Dynamic (m) | Total pump head (m) | Yield estimate (m3/h) | Trans. Pipe Diam. (mm) | Trans. Pipe Velocity (m/sec) | Water tank Type | Water tank Volume (m3) | Water tank H (m) | Defluorin | Kiosk | Generator room | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Katiborok | Baringo North | 450 | 520 | | 30 | 510 | 750 | 530 | 20 | 10.2 | 31 | 3 | 3Phases | 50 | 150 | 79 | 70 | 55.3 | 40 | 75 | 85 | 16.0 | 40 | 0.3 | H | 10 | 3 | | 1 | | DD掘さく |
| 2 | Konoo | Baringo North | 450 | 252 | | 3 | 480 | 500 | 500 | 20 | 9.6 | 64 | 2 | 3Phases | 50 | 150 | 79 | 70 | 55.3 | 40 | 75 | 85 | 5.0 | 40 | 0.3 | H | 10 | 3 | | 1 | | |
| 3 | Kormor | Baringo North | 310 | 350 | | 20 | 350 | 500 | 360 | 20 | 7.0 | 65 | 2 | Solar | | 150 | 79 | 70 | 55.3 | 40 | 75 | 105 | 5.0 | 40 | 0.3 | H | 10 | 3 | | 1 | | |
| 5 | Kibuliak | Baringo North | 670 | 772 | | 44 | 760 | 1,000 | 790 | 20 | 15.2 | 32 | 4 | 3Phases | 30 | 150 | 79 | 70 | 55.3 | 40 | 75 | 85 | 5.0 | 40 | 0.4 | H | 16 | 3 | | 1 | | |
| 6 | Kapnarok | Baringo North | 360 | 360 | | 18 | 400 | 500 | 420 | 20 | 8.0 | 11 | 2 | Solar | | 150 | 87 | 86 | 74.8 | 40 | 75 | 105 | 5.0 | 40 | 0.3 | H | 10 | 3 | | 1 | | |
| 7 | Chemondoi | Baringo North | 860 | 567 | | 14 | 930 | 1,000 | 960 | 20 | 18.6 | 33 | 4 | Generator | | 250 | 70 | 80 | 56 | 60 | 100 | 130 | 6.0 | 40 | 0.5 | H | 16 | 3 | | 1 | | |
| 10 | Moigutwo | Baringo North | 340 | 740 | | 57 | 420 | 500 | 440 | 20 | 8.4 | 66 | 2 | Solar | | 200 | 70 | 80 | 56 | 60 | 100 | 130 | 6.0 | 40 | 0.3 | H | 10 | 3 | | 1 | | |
| 12 | Ayatia | Baringo North | 340 | 300 | | 13 | 380 | 500 | 390 | 20 | 7.6 | 67 | 2 | Solar | | 150 | 79 | 70 | 55.3 | 40 | 75 | 105 | 5.0 | 40 | 0.3 | H | 10 | 3 | | 1 | | |
| 13 | Marigut | Baringo North | 430 | 463 | | 25 | 480 | 500 | 500 | 20 | 9.6 | 68 | 2 | 3Phases | 50 | 150 | 79 | 70 | 55.3 | 30 | 50 | 80 | 5.0 | 40 | 0.3 | H | 10 | 3 | | 1 | | |
| 16 | Kapkombe | Baringo North | 1,000 | 280 | | | 1,070 | 1,000 | 1,100 | 20 | 21.4 | 12 | 5 | 3Phases | 50 | 200 | 70 | 80 | 56 | 60 | 100 | 130 | 6.0 | 40 | 0.6 | H | 16 | 3 | | 1 | | BH Drilling in DD |
| 28 | Kolongotwo | Baringo North | 420 | | | | 450 | 500 | 460 | 20 | 9.0 | 69 | 2 | Solar | | 150 | 70 | 85 | 59.5 | 40 | 75 | 105 | 4.0 | 40 | 0.4 | H | 10 | 3 | | 1 | | |
| 29 | Koibaware | Baringo North | 310 | 1,090 | | 94 | 430 | 500 | 440 | 20 | 8.6 | 70 | 2 | Solar | | 150 | 70 | 85 | 59.5 | 40 | 75 | 105 | 4.0 | 40 | 0.3 | H | 10 | 3 | | 1 | | |
| 31 | Kipchemoi | Baringo North | 350 | 600 | | 43 | 370 | 500 | 380 | 20 | 7.4 | 71 | 2 | Solar | | 150 | 70 | 85 | 59.5 | 50 | 75 | 85 | 4.0 | 40 | 0.3 | H | 10 | 3 | | 1 | | |
| 32 | Kapturo | Baringo North | 460 | 600 | | 37 | 530 | 750 | 550 | 20 | 10.6 | 34 | 3 | Solar | | 150 | 68 | 85 | 57.8 | 50 | 75 | 105 | 2.5 | 40 | 0.4 | H | 10 | 3 | | 1 | | |
| 33 | Chepkesin | Baringo North | 400 | 400 | | 20 | 450 | 500 | 460 | 20 | 9.0 | 72 | 2 | Solar | | 150 | 70 | 85 | 59.5 | 50 | 75 | 105 | 4.0 | 40 | 0.4 | H | 10 | 3 | | 1 | | |
| 36.1 | Barwessa-1 | Baringo North | 400 | 630 | 100 | 143 | 580 | 750 | 600 | 20 | 11.6 | 35 | 3 | 3Phases | 100 | 150 | 79 | 70 | 55.3 | 40 | 75 | 105 | 5.0 | 40 | 0.3 | H | 10 | 3 | | 1 | | |
| 36.2 | Barwessa-2 | Baringo North | 400 | | | | 430 | 500 | 440 | 20 | 8.6 | 73 | 2 | Solar | | 150 | 79 | 70 | 55.3 | 40 | 75 | 105 | 5.0 | 40 | 0.3 | H | 10 | 3 | | 1 | | |
| 38 | Likwon | Baringo North | 470 | 340 | 120 | 131 | 640 | 750 | 660 | 20 | 12.8 | 2 | 3 | Solar | | 150 | 87 | 85 | 74 | 40 | 75 | 105 | 5.0 | 40 | 0.5 | H | 16 | 3 | | 1 | | |
| 39 | Seremwo | Baringo North | 400 | 220 | | 2 | 430 | 500 | 440 | 20 | 8.6 | 74 | 2 | Solar | | 250 | 70 | 80 | 56 | 60 | 100 | 130 | 3.0 | 40 | 0.3 | H | 10 | 3 | | 1 | | |
| 40 | Kapkirwok | Baringo North | 600 | 350 | 570 | 575 | 1,250 | 1,500 | 1,290 | 20 | 25.0 | 13 | 5 | 3Phases | 200 | 200 | 70 | 80 | 56 | 60 | 100 | 130 | 4.0 | 40 | 0.7 | H | 16 | 3 | | 1 | | BH Drilling in DD |
| 43.1 | Kaptere1 | Baringo North | 160 | 1,050 | 420 | 517 | 720 | 750 | 740 | 20 | 14.4 | 36 | 3 | 3Phases | 150 | 250 | 70 | 80 | 56 | 80 | 125 | 155 | 4.0 | 40 | 0.4 | H | 16 | 3 | | 1 | | |
| 43.2 | Kaptere2 | Baringo North | 640 | | | | 680 | 750 | 700 | 20 | 13.6 | 37 | 3 | 3Phases | 150 | 250 | 70 | 80 | 56 | 80 | 125 | 155 | 4.0 | 40 | 0.4 | H | 16 | 3 | | 1 | | |
| 45 | Tiriondonin | Baringo North | 450 | 560 | 450 | 484 | 990 | 1,000 | 1,030 | 20 | 19.8 | 14 | 4 | Generator | | 250 | 70 | 80 | 56 | 60 | 100 | 130 | 6.0 | 40 | 0.5 | H | 16 | 3 | | 1 | | BH Drilling in DD |
| 46 | Kaptum | Baringo North | 620 | 1,130 | 450 | 532 | 1,230 | 1,500 | 1,270 | 20 | 24.6 | 15 | 5 | 3Phases | 200 | 200 | 70 | 80 | 56 | 60 | 100 | 130 | 6.0 | 40 | 0.7 | H | 16 | 3 | | 1 | | BH Drilling in DD |
| 47.1 | Ossen Forest station1 | Baringo North | 134 | 1,240 | 450 | 567 | 750 | 750 | 770 | 20 | 15.0 | 38 | 3 | 3Phases | 200 | 200 | 70 | 80 | 56 | 100 | 150 | 180 | 4.0 | 40 | 0.4 | H | 16 | 3 | | 1 | | |
| 47.2 | Ossen Forest station2 | Baringo North | 757 | | | | 810 | 1,000 | 830 | 20 | 16.2 | 39 | 4 | 3Phases | 200 | 200 | 70 | 80 | 56 | 100 | 150 | 180 | 4.0 | 40 | 0.4 | H | 16 | 3 | | 1 | | |
| 49 | Kureschun | Baringo North | 1,500 | 280 | | | 1,600 | 1,500 | 1,650 | 20 | 32.0 | 16 | 5 | 3Phases | 100 | 250 | 70 | 80 | 56 | 100 | 150 | 180 | 4.0 | 40 | 0.9 | H | 16 | 3 | | 1 | | BH Drilling in DD |
| 50 | Kipkokom | Baringo North | 1,000 | 400 | | | 1,070 | 1,500 | 1,100 | 20 | 21.4 | 17 | 5 | 3Phases | 300 | 250 | 70 | 80 | 56 | 100 | 150 | 180 | 4.0 | 40 | 0.6 | H | 16 | 3 | | 1 | | BH Drilling in DD |
| 51 | Kamagonge | Marigat | 450 | | 450 | 450 | 960 | 1,000 | 990 | 15 | 14.4 | 18 | 4 | 3Phases | 300 | 100 | 85 | 76 | 64.6 | 50 | 75 | 105 | 4.0 | 40 | 0.4 | H | 16 | 3 | | 1 | | DD掘さく |
| 53 | Kapsamson | Marigat | 450 | 640 | | 42 | 520 | 750 | 540 | 15 | 7.8 | 19 | 3 | Solar | | 100 | 85 | 76 | 64.6 | 50 | 75 | 105 | 4.0 | 40 | 0.3 | H | 10 | 3 | | 1 | | |
| 56 | Kamimba | Marigat | 450 | 81 | | | 480 | 500 | 490 | 15 | 7.2 | 40 | 2 | 3Phases | 200 | 100 | 85 | 76 | 64.6 | 50 | 75 | 85 | 4.0 | 40 | 0.2 | H | 10 | 3 | | 1 | | |
| 58 | Catholic | Marigat | 390 | 296 | | 10 | 430 | 500 | 440 | 15 | 6.5 | 41 | 2 | 3Phases | 200 | 100 | 85 | 76 | 64.6 | 50 | 75 | 105 | 4.0 | 40 | 0.2 | H | 10 | 3 | | 1 | | |
| 60 | Ndambul | Marigat | 380 | 770 | | 58 | 470 | 500 | 480 | 15 | 7.1 | 42 | 2 | Solar | | 100 | 85 | 76 | 64.6 | 50 | 75 | 105 | 4.0 | 40 | 0.3 | H | 10 | 3 | | 1 | | |
| 64 | Longiron | Marigat | 490 | 224 | | | 520 | 750 | 540 | 15 | 7.8 | 20 | 3 | Solar | | 100 | 80 | 75 | 60 | 50 | 75 | 85 | 2.0 | 40 | 0.3 | H | 10 | 3 | | 1 | | |
| 65 | Marti | Marigat | 460 | 612 | | 38 | 530 | 750 | 550 | 15 | 8.0 | 21 | 3 | Solar | | 100 | 80 | 75 | 60 | 50 | 75 | 85 | 2.0 | 40 | 0.3 | H | 10 | 3 | | 1 | | |
| 69 | Kapkechii | Marigat | 315 | 395 | | 24 | 360 | 500 | 370 | 15 | 5.4 | 75 | 2 | Solar | | 150 | 70 | 85 | 59.5 | 50 | 75 | 105 | 4.0 | 40 | 0.2 | H | 10 | 3 | | 1 | | |
| 72 | Kimalel Hospital | Marigat | 380 | | | | 400 | 500 | 420 | 15 | 6.0 | 76 | 2 | 3Phases | 100 | 250 | 70 | 85 | 59.5 | 50 | 75 | 105 | 2.0 | 40 | 0.2 | H | 10 | 15 | | 1 | | |
| 74 | Lokoiwopsonchun | Marigat | 370 | 200 | | 2 | 400 | 500 | 410 | 15 | 6.0 | 77 | 2 | 3Phases | 100 | 150 | 70 | 85 | 59.5 | 50 | 75 | 105 | 2.0 | 40 | 0.2 | H | 10 | 3 | | 1 | | |
| 75 | Kinyach | Marigat | 320 | 356 | | 20 | 360 | 500 | 370 | 15 | 5.4 | 78 | 2 | Solar | | 250 | 70 | 85 | 59.5 | 50 | 75 | 105 | 2.0 | 40 | 0.2 | H | 10 | 3 | | 1 | | |
| 77 | Tirng'ongwonin | Marigat | 350 | 125 | | | 370 | 500 | 380 | 15 | 5.6 | 79 | 2 | Solar | | 150 | 65 | 85 | 55.3 | 50 | 75 | 105 | 2.0 | 40 | 0.2 | H | 10 | 3 | | 1 | | |
| 78 | Kibingor | Marigat | 450 | 240 | | 2 | 480 | 500 | 500 | 15 | 7.2 | 80 | 2 | Solar | | 150 | 65 | 85 | 55.3 | 50 | 75 | 105 | 2.0 | 40 | 0.3 | H | 10 | 3 | | 1 | | |
| 81 | Kabusa | Marigat | 600 | 279 | | | 640 | 750 | 660 | 15 | 9.6 | 43 | 3 | Solar | | 150 | 70 | 85 | 59.5 | 50 | 75 | 105 | 4.0 | 40 | 0.4 | H | 10 | 3 | | 1 | | |

| Nr. | Site Name | District | Population 2011 (Pers.) | School Day Sch. (Pers.) | School Boarding (Pers.) | School Pop. Convert (Pers.) | Water supply population Planned year 2015 (Pers.) | Water supply population Corrected (pers.) | Water supply population 2017 (ref.) (Pers.) | Water supply unit (L/d･Pers) | Day supply volume 2015 ($m^3$/d) | Priority | Size | System type | Distance to power grid (m) | BH depth (m) | Success rate (Volume) | Success rate (Quality) | Success rate (%) | Static (m) | Dynamic (m) | Total pump head (m) | Yield estimate (m3/h) | Trans. Pipe Diam. (mm) | Trans. Pipe Velocity (m/sec) | Water tank Type | Water tank Volume (m3) | Water tank H (m) | Defluorin | Kiosk | Generator room | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 101 | Kaptara | Baringo | 600 | 288 | | | 640 | 750 | 660 | 20 | 12.8 | 44 | 3 | 3Phases | 50 | 150 | 79 | 70 | 55.3 | 40 | 75 | 105 | 5.0 | 40 | 0.4 | H | 16 | 3 | | 1 | | |
| 102 | Kipsoit Primary | Baringo | 500 | 598 | | 35 | 570 | 750 | 590 | 20 | 11.4 | 45 | 3 | 3Phases | 50 | 150 | 79 | 70 | 55.3 | 40 | 75 | 105 | 5.0 | 40 | 0.3 | H | 10 | 3 | | 1 | | |
| 103.1 | Kakwane | Baringo | 550 | 128 | 41 | 41 | 630 | 750 | 650 | 20 | 12.6 | 3 | 3 | Solar | | 100 | 100 | 100 | 100 | 40 | 60 | 70 | 5.0 | 40 | 0.5 | H | 16 | 3 | | 1 | | Successful BH |
| 103.2 | Kakwane | Baringo | 750 | | | | 800 | 1,000 | 820 | 20 | 16.0 | 4 | 4 | 3Phases | | 100 | 87 | 86 | 74.8 | 40 | 75 | 85 | 5.0 | 40 | 0.4 | H | 16 | 3 | | 1 | | |
| 104.1 | Salawa Hospital1 | Baringo | 590 | | | | 630 | 750 | 650 | 20 | 12.6 | 22 | 3 | 3Phases | 100 | 150 | 85 | 75 | 63.8 | 40 | 75 | 135 | 5.0 | 40 | 0.3 | EX-G | 70 | | | 1 | | |
| 104.2 | Salawa Hospital2 | Baringo | 590 | | | | 630 | 750 | 650 | 20 | 12.6 | 23 | 3 | 3Phases | 100 | 150 | 85 | 75 | 63.8 | 40 | 75 | 135 | 5.0 | 40 | 0.3 | H | 16 | | | 1 | | |
| 106 | Eron Primary | Baringo | 700 | 210 | | | 750 | 750 | 770 | 20 | 15.0 | 5 | 3 | 3Phases | 150 | 150 | 87 | 86 | 74.8 | 40 | 75 | 105 | 5.0 | 40 | 0.4 | H | 16 | 3 | | 1 | | |
| 107 | Kimoso | Baringo | 540 | 205 | | | 580 | 750 | 590 | 20 | 11.6 | 24 | 3 | Solar | | 150 | 85 | 75 | 63.8 | 50 | 75 | 105 | 5.0 | 40 | 0.5 | H | 10 | 3 | | 1 | | |
| 109.1 | Oinobmoi centre1 | Baringo | 1,343 | | | | 1,430 | 1,500 | 1,480 | 20 | 28.6 | 6 | 5 | 3Phases | 200 | 150 | 85 | 75 | 63.8 | 40 | 75 | 105 | 5.0 | 40 | 0.8 | H | 16 | 3 | | 1 | | BH Drilling in DD |
| 109.2 | Oinobmoi centre2 | Baringo | | 562 | 470 | 526 | 560 | 750 | 580 | 20 | 11.2 | 25 | 3 | Solar | | 150 | 85 | 75 | 63.8 | 40 | 75 | 105 | 5.0 | 40 | 0.5 | H | 10 | 3 | | 1 | | |
| 110 | Kapsikoryan | Baringo | 900 | 185 | | | 960 | 1,000 | 990 | 20 | 19.2 | 7 | 4 | Generator | | 150 | 100 | 100 | 100 | 60 | 90 | 120 | 2.5 | 40 | 0.5 | H | 16 | 3 | | 1 | | Successful BH |
| 111 | Kurumbopsoo | Baringo | 800 | 240 | | | 850 | 1,000 | 880 | 20 | 17.0 | 26 | 4 | Solar | | 150 | 85 | 75 | 63.8 | 50 | 75 | 105 | 5.0 | 40 | 0.6 | H | 16 | 3 | | 1 | | Design 84% of the planned volume |
| 112 | Sironoi | Baringo | 500 | 175 | | | 530 | 750 | 550 | 20 | 10.6 | 46 | 3 | Solar | | 250 | 70 | 80 | 56 | 60 | 100 | 130 | 6.0 | 40 | 0.4 | H | 10 | 3 | | 1 | | |
| 113 | Kasitet | Baringo | 810 | 240 | | | 860 | 1,000 | 890 | 20 | 17.2 | 47 | 4 | Solar | | 150 | 79 | 70 | 55.3 | 50 | 75 | 105 | 5.0 | 40 | 0.6 | H | 16 | 3 | | 1 | | Design 84% of the planned volume |
| 114 | Sichei | Baringo | 350 | | | | 370 | 500 | 380 | 20 | 7.4 | 81 | 2 | Solar | | 150 | 79 | 70 | 55.3 | 50 | 75 | 105 | 5.0 | 40 | 0.3 | H | 10 | 3 | | 1 | | |
| 119 | Chepkero Primary | Baringo | 450 | 200 | | | 480 | 500 | 490 | 20 | 9.6 | 82 | 2 | Solar | | 150 | 79 | 70 | 55.3 | 70 | 100 | 130 | 5.0 | 40 | 0.4 | H | 10 | 3 | | 1 | | |
| 120.1 | Mogorwa-1 | Baringo | 180 | 138 | 200 | 205 | 410 | 500 | 420 | 20 | 8.2 | 83 | 2 | 3Phases | 300 | 150 | 79 | 70 | 55.3 | 50 | 75 | 105 | 2.5 | 40 | 0.2 | H | 10 | 3 | | 1 | | |
| 120.2 | Mogorwa-2 | Baringo | 180 | 138 | 200 | 205 | 410 | 500 | 420 | 20 | 8.2 | 84 | 2 | Solar | | 150 | 79 | 70 | 55.3 | 50 | 75 | 105 | 2.5 | 40 | 0.3 | H | 10 | 3 | | 1 | | |
| 121 | Kisonei Primary | Baringo | 400 | 473 | | 27 | 460 | 500 | 470 | 20 | 9.2 | 48 | 2 | 3Phases | 200 | 250 | 80 | 80 | 64 | 60 | 100 | 130 | 5.0 | 40 | 0.3 | H | 10 | 3 | | 1 | | |
| 122 | Ochii Primary | Baringo | 650 | 316 | | | 690 | 750 | 710 | 20 | 13.8 | 27 | 3 | Generator | | 200 | 80 | 80 | 64 | 60 | 100 | 130 | 5.0 | 40 | 0.4 | H | 16 | 3 | | 1 | | |
| 123 | Siginwo | Baringo | 990 | 190 | | | 1,050 | 1,000 | 1,090 | 20 | 21.0 | 28 | 5 | Generator | | 200 | 70 | 80 | 56 | 60 | 100 | 130 | 6.0 | 40 | 0.6 | H | 16 | 3 | | 1 | | BH Drilling in DD |
| 124.1 | Tabarin1 | Baringo | 70 | | 620 | 620 | 740 | 750 | 760 | 20 | 14.8 | 49 | 3 | 3Phases | 200 | 200 | 70 | 80 | 56 | 60 | 100 | 130 | 6.0 | 40 | 0.4 | H | 16 | 3 | | 1 | | |
| 124.2 | Tabarin2 | Baringo | 630 | 212 | | | 670 | 750 | 690 | 20 | 13.4 | 50 | 3 | Generator | 200 | 200 | 70 | 80 | 56 | 60 | 100 | 130 | 6.0 | 40 | 0.4 | H | 16 | 3 | | 1 | | |
| 125 | Tuluongoi | Baringo | 724 | 350 | 200 | 200 | 980 | 1,000 | 1,020 | 20 | 19.6 | 51 | 4 | 3Phases | 300 | 200 | 70 | 80 | 56 | 60 | 100 | 130 | 6.0 | 40 | 0.5 | H | 16 | 3 | | 1 | | |
| 126 | Tebei | Baringo | 829 | 400 | | | 880 | 1,000 | 910 | 20 | 17.6 | 52 | 4 | Solar | | 150 | 70 | 85 | 59.5 | 50 | 75 | 105 | 4.0 | 40 | 0.6 | H | 16 | 3 | | 1 | | Design 84% of the planned volume |
| 127 | Ilyakat | Baringo | 376 | 150 | | | 400 | 500 | 410 | 20 | 8.0 | 85 | 2 | Solar | | 150 | 70 | 85 | 59.5 | 50 | 75 | 105 | 4.0 | 40 | 0.3 | H | 10 | 3 | | 1 | | |
| 129 | Tinomoi | Baringo | 886 | 142 | | | 940 | 1,000 | 970 | 20 | 18.8 | 53 | 4 | Generator | | 250 | 65 | 85 | 55.3 | 70 | 100 | 130 | 4.0 | 40 | 0.5 | H | 16 | 3 | | 1 | | |
| 130.1 | Timboiywo1 | Baringo | 598 | 689 | | 39 | 680 | 750 | 700 | 20 | 13.6 | 54 | 3 | 3Phases | 100 | 200 | 70 | 80 | 56 | 60 | 100 | 130 | 6.0 | 40 | 0.4 | H | 16 | 3 | | 1 | | |
| 130.2 | Timboiywo2 | Baringo | 702 | | | | 750 | 750 | 770 | 20 | 15.0 | 55 | 3 | 3Phases | 100 | 200 | 70 | 80 | 56 | 60 | 100 | 130 | 6.0 | 40 | 0.4 | H | 16 | 3 | | 1 | | |
| 133 | Kapchomuswo Sec | Baringo | 300 | 1,300 | 140 | 255 | 590 | 750 | 610 | 20 | 11.8 | 56 | 3 | 3Phases | 200 | 200 | 70 | 80 | 56 | 60 | 100 | 130 | 6.0 | 40 | 0.3 | H | 10 | 3 | | 1 | | |
| 134 | Kiwanja Ndege | Baringo | 450 | 300 | | 8 | 490 | 500 | 500 | 20 | 9.8 | 86 | 2 | Solar | | 200 | 70 | 80 | 56 | 60 | 100 | 130 | 6.0 | 40 | 0.4 | H | 10 | 3 | | 1 | | |
| 135 | Pemwai centre | Baringo | 436 | | | | 460 | 500 | 480 | 20 | 9.2 | 87 | 2 | 3Phases | 200 | 200 | 70 | 80 | 56 | 60 | 100 | 130 | 6.0 | 40 | 0.3 | H | 10 | 3 | | 1 | | |
| 136.1 | Talai-1 | Baringo | | 500 | 1,440 | 1,490 | 1,590 | 1,500 | 1,640 | 20 | 31.8 | 29 | 5 | 3Phases | 200 | 200 | 70 | 80 | 56 | 60 | 100 | 130 | 6.0 | 40 | 0.9 | H | 16 | 3 | | 1 | | BH Drilling in DD |
| 136.2 | Talai-2 | Baringo | 1,300 | | | | 1,390 | 1,500 | 1,430 | 20 | 27.8 | 30 | 5 | Generator | | 200 | 70 | 80 | 56 | 60 | 100 | 130 | 6.0 | 40 | 0.8 | H | 16 | 3 | | 1 | | BH Drilling in DD |
| 137.1 | Kapkawa-1 | Baringo | 960 | | 250 | 250 | 1,290 | 1,500 | 1,330 | 48 | 61.9 | 1 | 5 | 3Phases | 30 | 200 | 100 | 100 | 100 | 50 | 75 | 105 | 10.0 | 75 | 0.5 | H・EX-G | 10・200 | 3・2 | | 1 | | Successful BH |
| 137.2 | Kapkawa-2 | Baringo | 320 | 1,660 | | 150 | 500 | 500 | 520 | 20 | 10.0 | 8 | 2 | Solar | | 200 | 85 | 85 | 72.3 | 60 | 100 | 130 | 10.0 | 40 | 0.4 | H | 10 | 3 | | 1 | | |
| 139 | Serei | Baringo | 400 | 980 | | 78 | 510 | 750 | 530 | 20 | 10.2 | 57 | 3 | Solar | | 200 | 70 | 80 | 56 | 60 | 100 | 130 | 6.0 | 40 | 0.4 | H | 10 | 3 | | 1 | | |
| 140 | Turupkir | Baringo | 350 | 354 | | 18 | 390 | 500 | 400 | 20 | 7.8 | 88 | 2 | 3Phases | 300 | 200 | 70 | 80 | 56 | 60 | 100 | 130 | 4.0 | 40 | 0.2 | H | 10 | 3 | | 1 | | |
| 155 | Naudo | East Pokot | 700 | 300 | | | 750 | 750 | 770 | 15 | 11.3 | 9 | 3 | Generator | | 150 | 100 | 100 | 100 | 110 | 125 | 135 | 6.0 | 40 | 0.3 | H | 10 | 3 | | 1 | | Successful BH |
| 179 | Lomerimeri | East Pokot | 360 | 72 | | | 380 | 500 | 400 | 15 | 5.7 | 89 | 2 | Solar | | 250 | 63 | 80 | 50.4 | 60 | 100 | 130 | 2.0 | 40 | 0.2 | H | 10 | 3 | | 1 | | |
| 182 | Chepanda | East Pokot | 401 | | | | 430 | 500 | 440 | 15 | 6.5 | 90 | 2 | Solar | | 150 | 70 | 75 | 52.5 | 60 | 75 | 105 | 1.0 | 40 | 0.3 | H | 10 | 3 | | 1 | | |
| 183.1 | Donge-1 | East Pokot | 240 | | 300 | 300 | 580 | 750 | 590 | 15 | 8.7 | 58 | 3 | Solar | | 150 | 70 | 75 | 52.5 | 60 | 75 | 105 | 1.5 | 40 | 0.3 | H | 10 | 3 | | 1 | | |
| 183.2 | Donge-2 | East Pokot | | 153 | 785 | 800 | 850 | 1,000 | 880 | 15 | 12.8 | 59 | 4 | Generator | | 150 | 70 | 75 | 52.5 | 60 | 75 | 105 | 1.5 | 40 | 0.4 | H | 16 | 3 | | 1 | | |
| 184.1 | Katukumwo1 | East Pokot | 625 | | | | 670 | 750 | 690 | 15 | 10.1 | 60 | 3 | Solar | | 150 | 70 | 85 | 59.5 | 50 | 75 | 105 | 4.0 | 40 | 0.4 | H | 10 | 3 | | 1 | | |
| 184.2 | Katukumwo2 | East Pokot | 625 | | | | 670 | 750 | 690 | 15 | 10.1 | 61 | 3 | Solar | | 150 | 70 | 85 | 59.5 | 50 | 75 | 105 | 4.0 | 40 | 0.4 | H | 10 | 3 | | 1 | | |
| 185 | Chesakam | East Pokot | 337 | 130 | 184 | 184 | 560 | 750 | 570 | 15 | 8.4 | 10 | 3 | Solar | | 100 | 100 | 100 | 100 | 10 | 35 | 65 | 6.0 | 40 | 0.3 | H | 10 | 3 | | 1 | | Successful BH |
| 186 | Chesitet | East Pokot | 400 | 350 | | 15 | 440 | 500 | 460 | 15 | 6.6 | 62 | 2 | Solar | | 150 | 80 | 82 | 65.6 | 30 | 50 | 80 | 6.0 | 40 | 0.3 | H | 10 | 3 | | 1 | | |
| 187 | Kasakaram | East Pokot | 560 | 165 | | | 600 | 750 | 620 | 15 | 11.3 | 63 | 3 | Solar | | 150 | 70 | 75 | 52.5 | 60 | 75 | 85 | 0.6 | 40 | 0.4 | H | 10 | 3 | | 1 | | |
| Total | 77 Villagies 90 Points | | 46,487 | 30,204 | 7,840 | 9,455 | 59,580 | 68,750 | 61,450 | | | | <350:0<br>500:34<br>750:33<br>1000:13<br>1500:10 | Solar:43<br>3Phases:37<br>Generator:10<br>Handpump:0 | Average:154 | Total Drilling Dep. In Construction Stage: 12600 | | | Average:56<br>100m:65<br>150m:57<br>200m:54<br>250m:52 | | | | | | | H(Elevated Water Tank):89<br>10m3:55<br>16m3:34 | | | | 90 | | BH Drilling in DD: 10 |

水槽タイプ：Hは高架水槽、Gは地上型水槽、EXは既存水槽を示す。例EX-G：既存地上型。

| Nr. | Site Name | District | Population 2011 (Pers.) | School Day Sch. (Pers.) | School Boarding (Pers.) | School Pop. Convert (Pers.) | Water supply population Planned year 2015 (Pers.) | Water supply population Planned year 2015 Corrected (pers.) | Water supply population 2017 (ref.) (Pers.) | Water supply unit (L/d・Pers) | Day supply volume 2015 ($m^3/d$) | Priority | Size | System type | Distance to power grid (m) | BH depth (m) | Success rate (Volume) | Success rate (Quality) | Success rate (%) | Static (m) | Dynamic (m) | Total pump head (m) | Yield estimate (m3/h) | Trans. Pipe Diam. (mm) | Trans. Pipe Velocity (m/sec) | Water tank Type | Water tank Volume (m3) | Water tank H (m) | Defluorin | Kiosk | Generator room | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | Kapamin | Baringo North | 690 | 515 | | 17 | 750 | 750 | 780 | 20 | 15.0 | **94** | 3 | Generator | | ***250*** | 70 | 80 | 56 | 60 | 100 | 130 | 1.0 | 40 | 0.4 | H | 16 | 3 | | 1 | | |
| 26 | Barkilach | Baringo North | 400 | | | | 430 | 500 | 440 | 20 | 8.6 | **100** | 2 | Solar | | 150 | 60 | 85 | 51 | 50 | 75 | 85 | 1.0 | 40 | 0.3 | H | 10 | 3 | | 1 | | |
| 27 | Usuonin | Baringo North | 300 | 670 | | 52 | 380 | 500 | 390 | 20 | 7.6 | **101** | 2 | Solar | | 150 | 60 | 85 | 51 | 50 | 75 | 105 | 1.0 | 40 | 0.3 | H | 10 | 3 | | 1 | | |
| 30 | Chepkewel | Baringo North | 350 | 200 | | 3 | 380 | 500 | 390 | 20 | 7.6 | **99** | 2 | Solar | | 150 | 62 | 85 | 52.7 | 50 | 75 | 105 | 1.0 | 40 | 0.3 | H | 10 | 3 | | 1 | | |
| 35 | Chemoe | Baringo North | 450 | 125 | | | 480 | 500 | 490 | 20 | 9.6 | **102** | 2 | Solar | | 150 | 60 | 85 | 51 | 50 | 75 | 105 | 2.5 | 40 | 0.4 | H | 10 | 3 | | 1 | | |
| 42.1 | Kapchepkor1 | Baringo North | 186 | 680 | 370 | 429 | 650 | 750 | 680 | 20 | 13.0 | **95** | 3 | 3Phases | 200 | ***250*** | 70 | 80 | 56 | 80 | 125 | 155 | 4.0 | 40 | 0.4 | H | 16 | 3 | | 1 | | |
| 42.2 | Kapchepkor2 | Baringo North | 744 | | | | 790 | 1,000 | 820 | 20 | 15.8 | **96** | 4 | 3Phases | 200 | ***250*** | 70 | 80 | 56 | 80 | 125 | 155 | 4.0 | 40 | 0.4 | H | 16 | 3 | | 1 | | |
| 44 | Boin | Baringo North | 400 | 200 | | | **430** | **500** | 440 | 20 | 8.6 | **97** | 2 | 3Phases | 200 | ***250*** | 70 | 80 | 56 | 80 | 125 | 155 | 4.0 | 40 | 0.2 | H | 10 | 3 | | 1 | | 予備 |
| 48 | Kaptumin | Baringo North | 1,200 | 350 | | | 1,280 | 1,500 | 1,320 | 20 | 25.6 | **103** | 5 | 3Phases | 300 | 200 | 60 | 80 | 48 | 100 | 150 | 180 | 4.0 | 40 | 0.7 | H | 16 | 3 | | 1 | | |
| 86 | Samuran | Marigat | 450 | 140 | | | 480 | 500 | 490 | 15 | 7.2 | **112** | 2 | Solar | | 150 | 50 | 80 | 40 | 60 | 100 | 130 | 4.0 | 40 | 0.3 | H | 10 | 3 | | 1 | | |
| 89 | Mochongoi centre | Marigat | 402 | 432 | | 23 | 450 | 500 | 470 | 15 | 6.8 | **113** | 2 | 3Phases | 200 | ***250*** | 50 | 80 | 40 | 80 | 125 | 155 | 2.0 | 40 | 0.2 | H | 10 | 3 | | 1 | | |
| 90 | Kapkechir | Marigat | 640 | 773 | | 45 | 730 | 750 | 750 | 15 | 11.0 | **107** | 3 | Generator | | ***250*** | 50 | 80 | 40 | 80 | 125 | 155 | 2.0 | 40 | 0.3 | H | 10 | 3 | | 1 | | |
| 92 | Kipkandule | Marigat | 500 | 420 | | 17 | 550 | 750 | 570 | 15 | 8.3 | **108** | 3 | Generator | | ***250*** | 50 | 80 | 40 | 80 | 125 | 155 | 2.0 | 40 | 0.2 | H | 10 | 3 | | 1 | | |
| 94 | Sambaka | Marigat | 450 | 287 | | 6 | 490 | 500 | 500 | 15 | 7.4 | **114** | 2 | Solar | | ***250*** | 50 | 80 | 40 | 60 | 100 | 130 | 2.0 | 40 | 0.3 | H | 10 | 3 | | 1 | | |
| 95 | Nyalilbuch | Marigat | 518 | 219 | 195 | 195 | 760 | 1,000 | 780 | 15 | 11.4 | **109** | 4 | Generator | | 200 | 50 | 80 | 40 | 60 | 100 | 130 | 2.0 | 40 | 0.3 | H | 10 | 3 | | 1 | | |
| 96 | Sokonin | Marigat | 320 | 612 | | 45 | 390 | 500 | 400 | 15 | 5.9 | **115** | 2 | Solar | | 150 | 50 | 80 | 40 | 60 | 100 | 130 | 2.0 | 40 | 0.2 | H | 10 | 3 | | 1 | | |
| 98 | Menmeno | Marigat | 570 | 176 | | | 610 | 750 | 630 | 15 | 9.2 | **110** | 3 | Solar | | 150 | 50 | 80 | 40 | 60 | 100 | 130 | 2.0 | 40 | 0.4 | H | 10 | 3 | | 1 | | |
| 105.1 | Salawa Primary1 | Baringo | 93 | | 821 | 821 | 970 | 1,000 | 1,010 | 20 | 19.4 | **91** | 4 | 3Phases | 100 | 150 | 85 | 75 | 63.8 | 40 | 75 | 105 | 5.0 | 40 | 0.5 | EX-G | | | | 1 | | |
| 105.2 | Salawa Primary2 | Baringo | 837 | | | | 890 | 1,000 | 920 | 20 | 17.8 | **92** | 4 | 3Phases | 100 | 150 | 85 | 75 | 63.8 | 40 | 75 | 105 | 5.0 | 40 | 0.5 | H | 16 | 3 | | 1 | | |
| 108 | Saonin | Baringo | 500 | | | | 530 | 750 | 550 | 20 | 10.6 | **93** | 3 | Solar | | 150 | 85 | 75 | 63.8 | 40 | 75 | 105 | 5.0 | 40 | 0.4 | H | 10 | 3 | | 1 | | |
| 116 | Katunoi | Baringo | 400 | 187 | | | **430** | **500** | 440 | 20 | 8.6 | **98** | 2 | Solar | | 150 | 79 | 70 | 55.3 | 50 | 75 | 105 | 5.0 | 40 | 0.3 | H | 10 | 3 | | 1 | | |
| 145 | Nakolete | East Pokot | 355 | | | | 380 | 500 | 390 | 15 | 5.7 | **116** | 2 | Solar | | ***250*** | 50 | 80 | 40 | 60 | 100 | 130 | 2.0 | 40 | 0.2 | H | 10 | 3 | | 1 | | |
| 146 | Kalapata | East Pokot | 200 | 200 | 120 | 130 | 350 | 500 | 360 | 15 | 5.3 | **117** | 2 | Solar | | 200 | 50 | 80 | 40 | 60 | 100 | 110 | 2.0 | 40 | 0.2 | H | 10 | 3 | | 1 | | |
| 149 | Siria | East Pokot | 330 | 310 | | 15 | 370 | 500 | 380 | 15 | 5.6 | **118** | 2 | Solar | | 200 | 50 | 80 | 40 | 60 | 100 | 110 | 1.0 | 40 | 0.2 | H | 10 | 3 | | 1 | | |
| 150 | Katungura | East Pokot | 500 | 180 | | | 530 | 750 | 550 | 15 | 8.0 | **111** | 3 | Solar | | 200 | 50 | 80 | 40 | 60 | 100 | 110 | 2.0 | 40 | 0.3 | H | 10 | 3 | | 1 | | |
| 156 | Akwichatis | East Pokot | 1,050 | 155 | | | 1,000 | 1,000 | 1,150 | 15 | 15.0 | **105** | 5 | Generator | | 250 | 50 | 80 | 40 | 60 | 100 | 130 | 2.0 | 40 | 0.5 | H | 16 | 3 | | 1 | | |
| 157 | Nasorot | East Pokot | 980 | 319 | | | 1,000 | 1,000 | 1,080 | 15 | 15.0 | **106** | 5 | Generator | | 200 | 50 | 80 | 40 | 60 | 100 | 130 | 2.0 | 40 | 0.4 | H | 16 | 3 | | 1 | | |
| 159 | Cheptunoyo | East Pokot | 260 | 1,229 | | 110 | **390** | **500** | 410 | 15 | 5.9 | **104** | 2 | 3Phases | 100 | 150 | 60 | 70 | 42 | 50 | 75 | 85 | 3.0 | 40 | 0.2 | H | 10 | 3 | | 1 | | |
| **Total** | **26 Villages<br>28 Points** | | **14,075** | 8,379 | 1,506 | 1,907 | **16,870** | **19,750** | 17,580 | | | | **<350:0<br>500:14<br>750:7<br>1000:4<br>1500:3** | **Solar:13<br>3Phases:8<br>Generator:0<br>Handpump:0** | **Average:175** | | | | **Average:56<br>100m:65<br>150m:57<br>200m:54<br>250m:52** | | | | | | | **H(Elevated Water Tank):27<br>10m3:20<br>16m3:7** | | | | **28** | | |

### 2-2-2-4 Procurement of Equipment

The DWO in Baringo area possesses a vehicle and other kinds of equipment and they are well maintained. The vehicles are old due to long usage, casing frequent breakdowns. Table 2-31 elaborates the necessity of procurement of goods. The procured goods are supervised by the Baringo area DWO.

Table 2-31 Procurement of Goods

| Period | Contents Diameter |
|---|---|
| During the Project | The staffs of DWO need to coordinate activities among divisions, locations and sub-locations, thus it is necessary to have a transport means. A computer is needed to keep records of the boreholes and monitoring. |
| After the Project | The water supply facilities are maintained by the recipient communities and the DWO will assist the communities. A means of transport is indispensable for mobilization of the DWO staff to monitor and assist the communities. |

The specifications of the necessary equipment are as follows:

a) Vehicle for operation and maintenance (1 double-cabin pick-up, 4WD): to transport DWO staff and community members as well as materials and equipment under rough road conditions.
b) Motorbikes (2 motorbikes, 175cc): to transport technicians of the DWO for monitoring of the facilities. Marigat and East Pokot offices will receive them.
c) Computer (1 set): to keep track records of water facility data, operation and maintenance information of the facilities. A printer is also procured together with a computer.

## 2-2-3 Outline Design Drawings

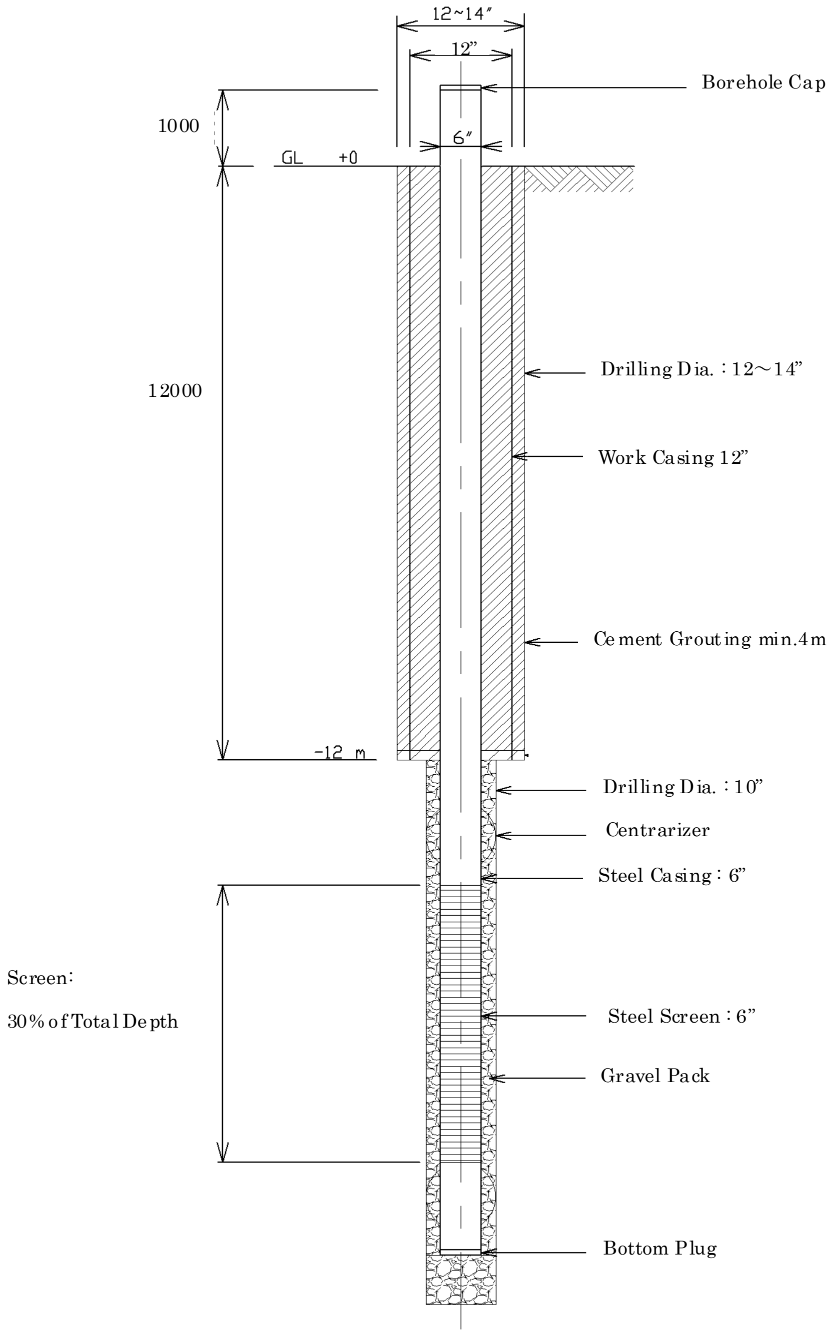



Figure 2-9 Structure of Borehole

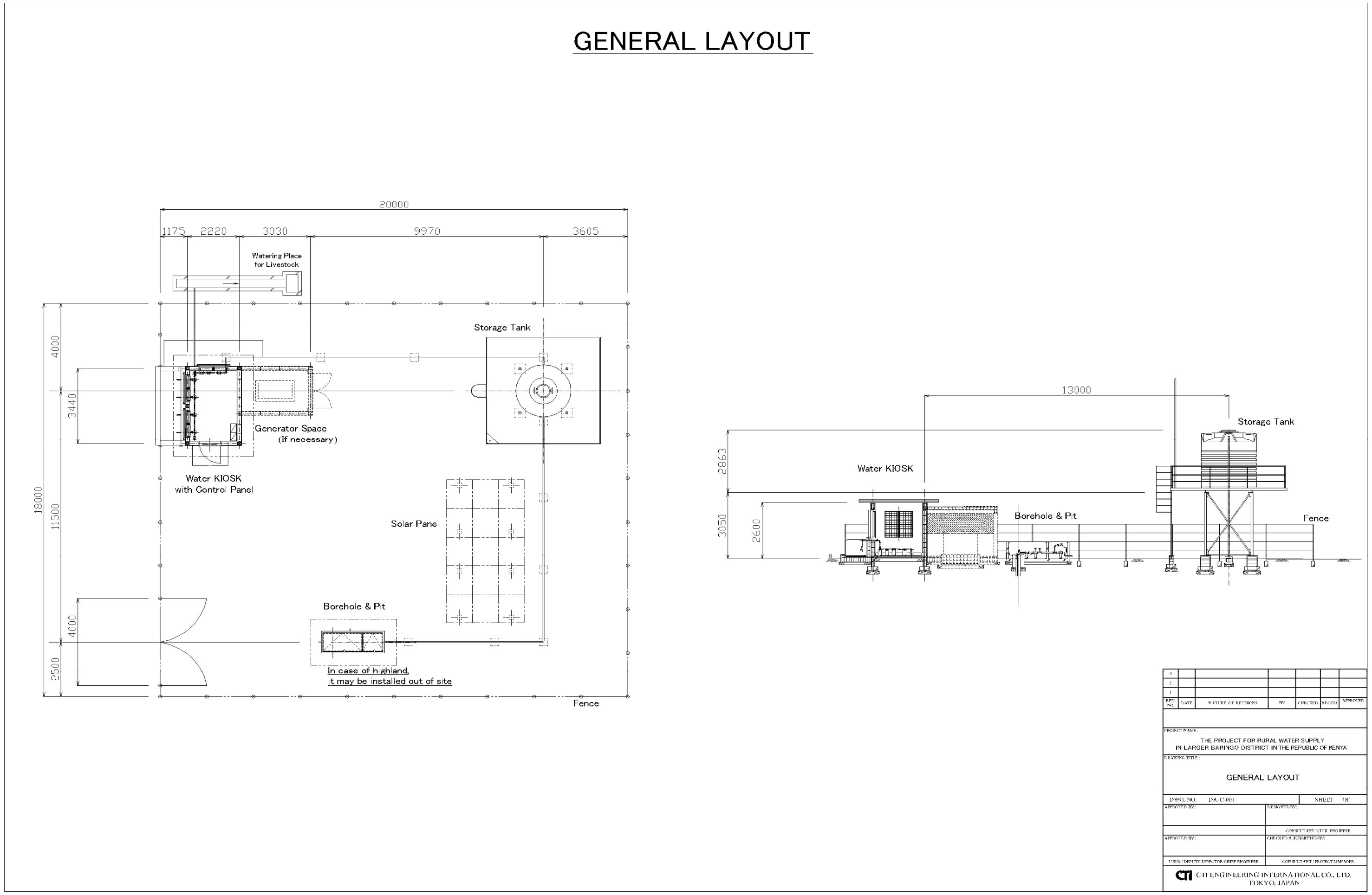



Figure 2-10　General Layout of Facilities

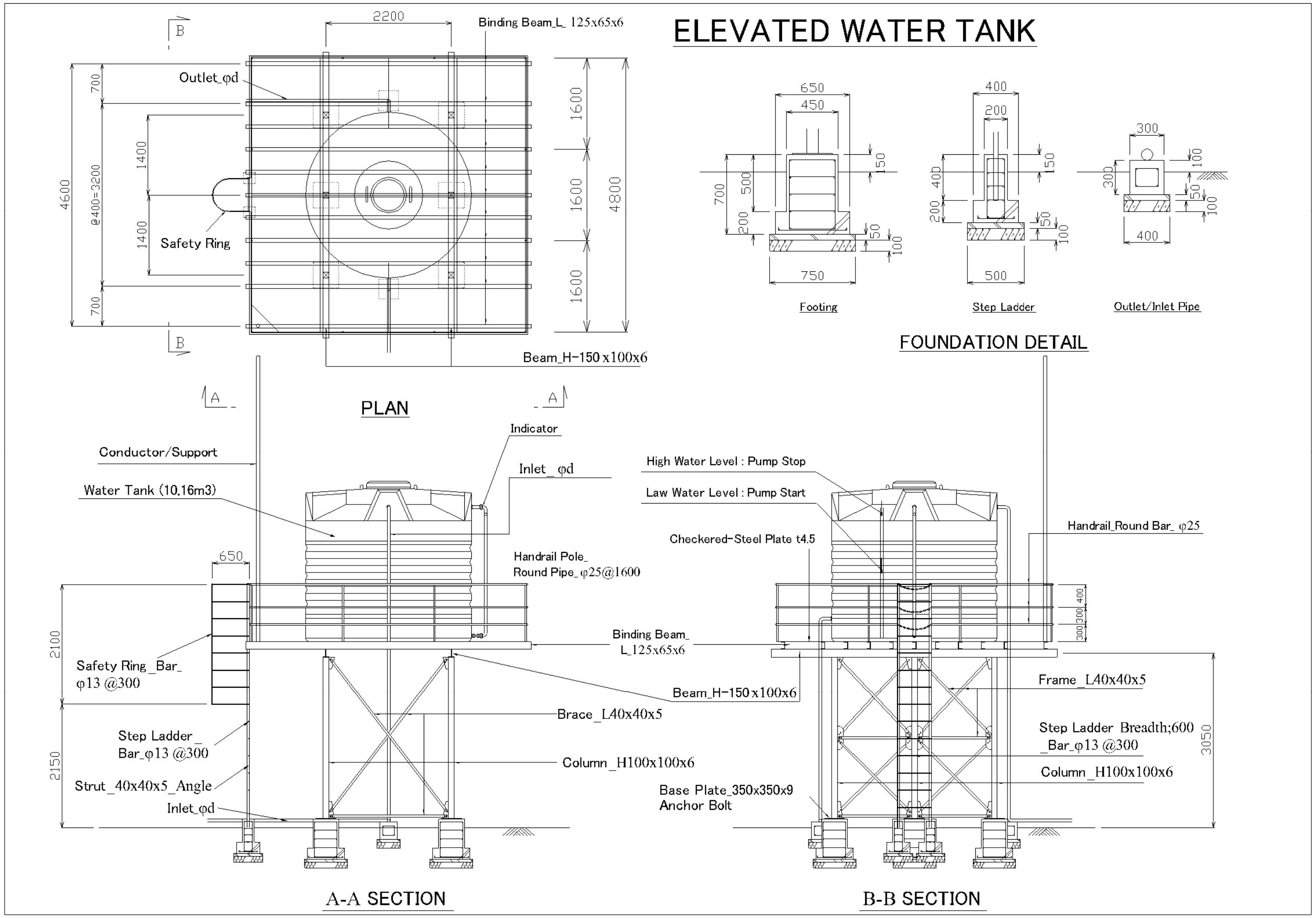



Figure 2-11 Structure of Elevated Water Tank

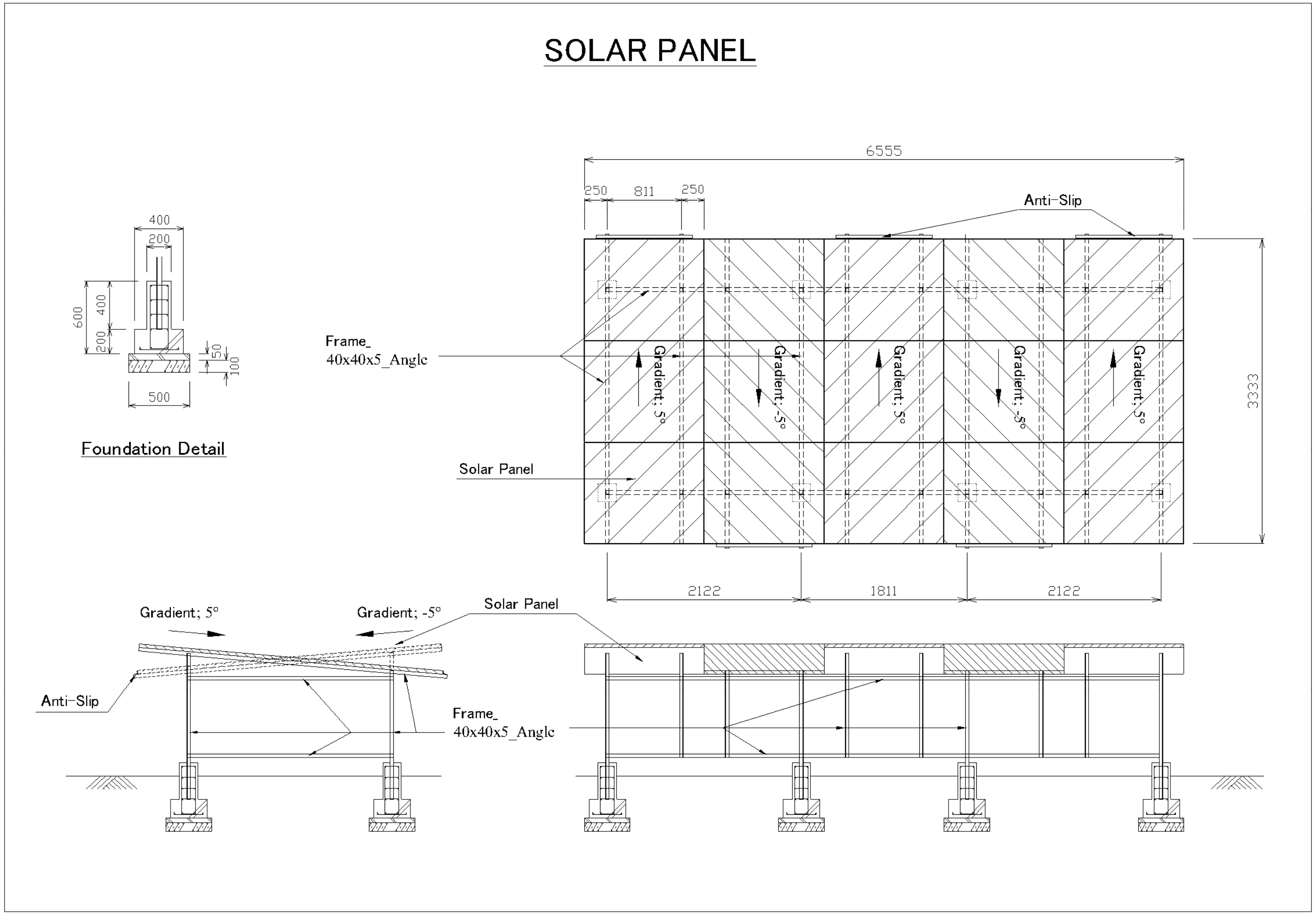



Figure 2-12 Solar Panel

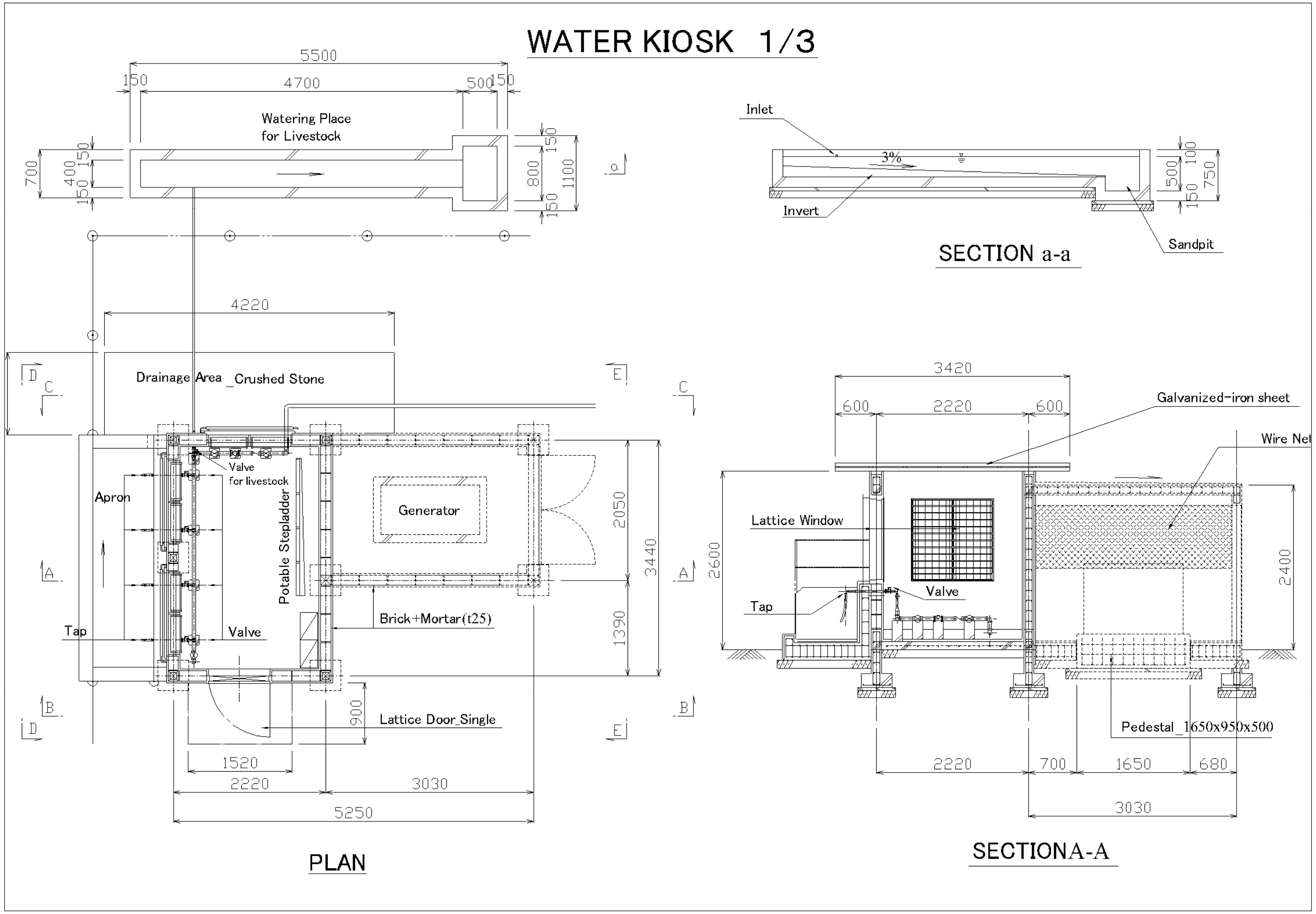



Figure 2-13 Water Kiosk, Generator Room, Water Trough

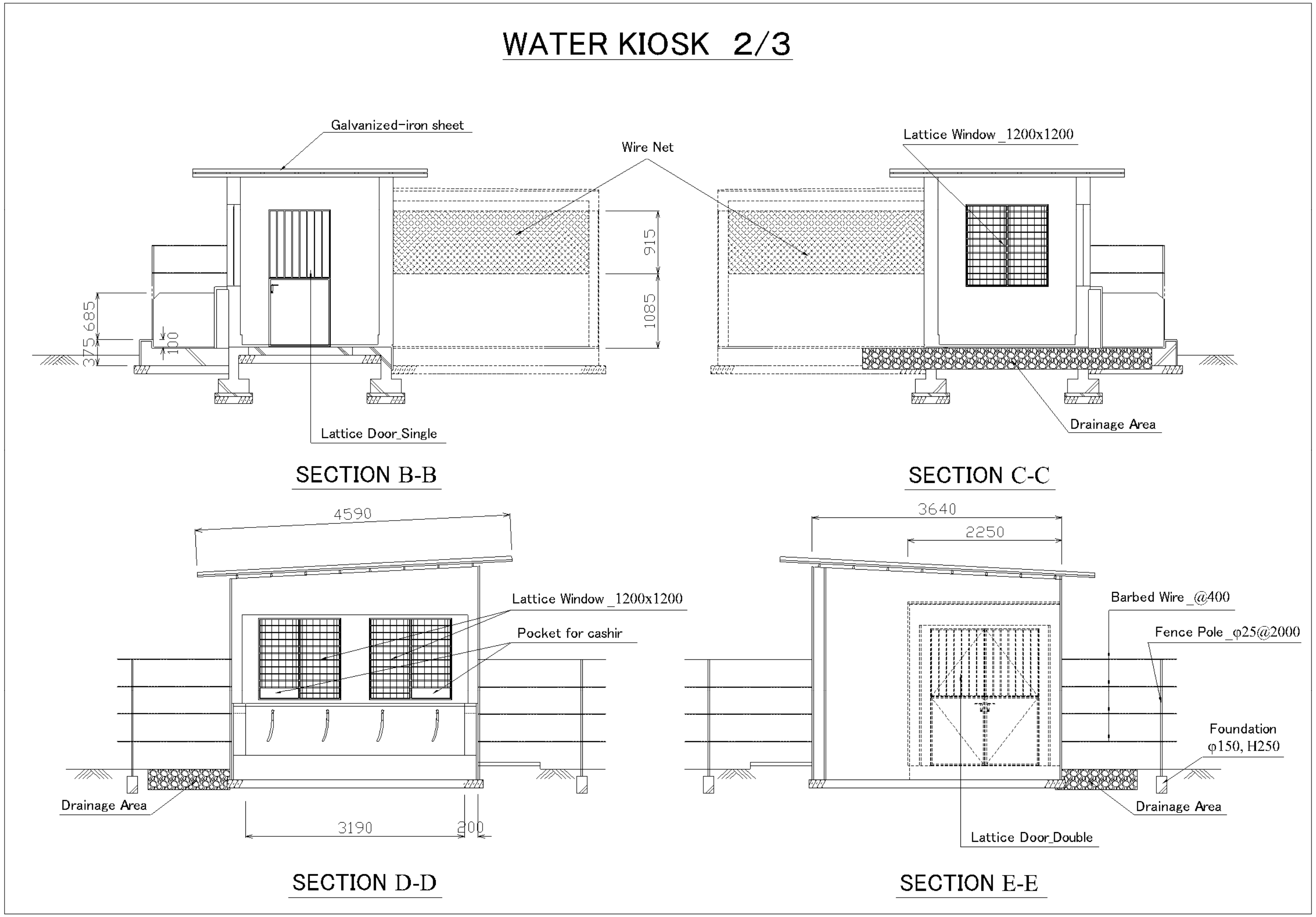
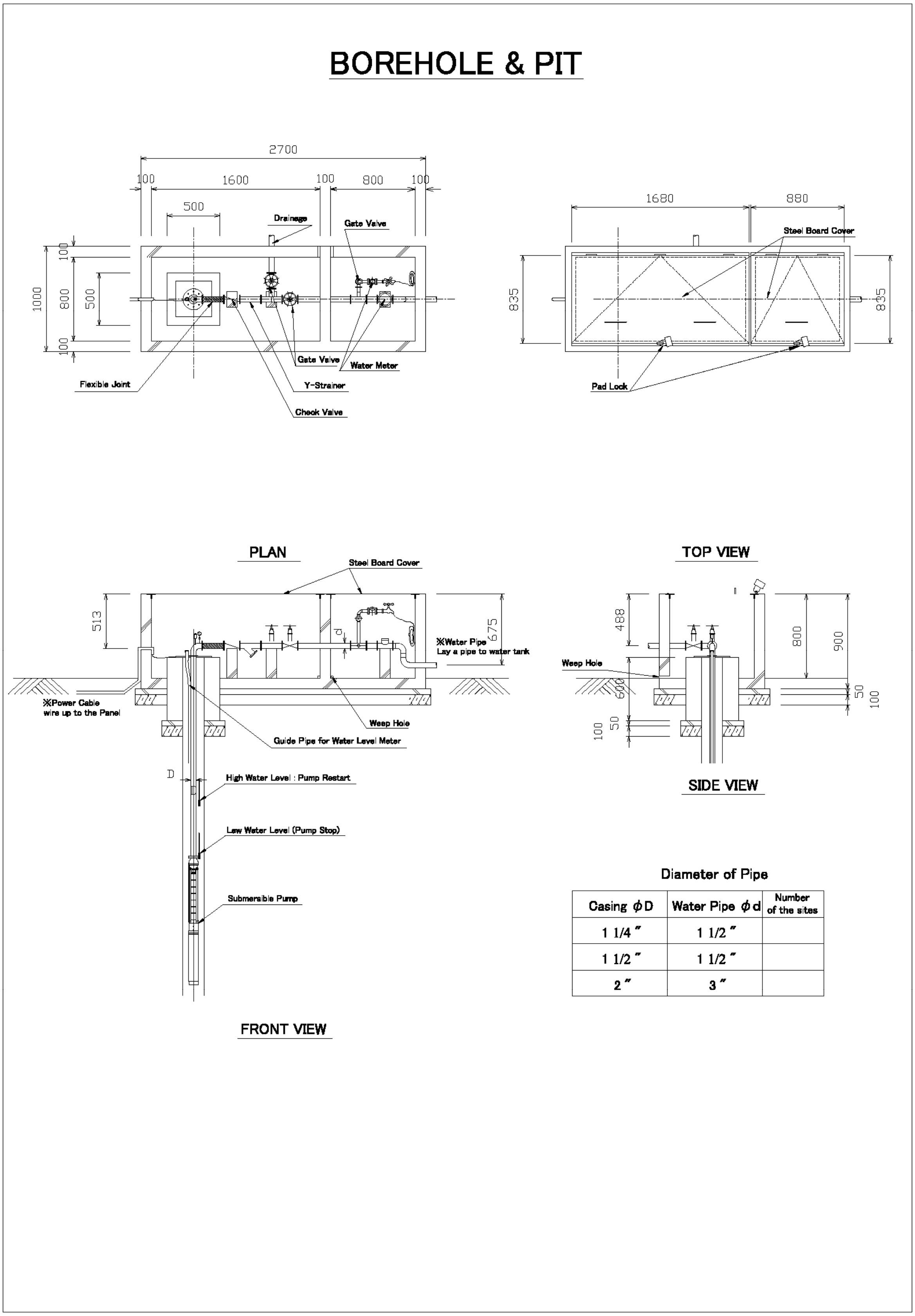



Figure 2-14 Water Kiosk, Generator Room




| Casing φD | Water Pipe φd | Number of the sites |
|---|---|---|
| 1 1/4" | 1 1/2" | |
| 1 1/2" | 1 1/2" | |
| 2" | 3" | |

Figure 2-15　　Intake Facility

## 2-2-4 Implementation/Procurement Plan

### 2-2-4-1 Implementation Policy

(1) Basic Conditions

After execution of the Exchange of Notes (E/N) and Grant Agreement (GA) between the Government of Kenya and the Government of Japan, the Government of Kenya will execute a contract with a Japanese consultant for facility design, equipment procurement and implementation supervision with which a detailed design process will set out facility construction works and equipment procurement. Thereafter, a tendering is conducted in the presence of a representative of Kenya to select a Japanese contractor to proceed with the procurement of equipment and construction.

For the construction and procurement, the following construction policy will guide the works:

1. In accordance with the Japanese grant aid scheme, the Project is implemented by the Department of Water Offices of MOWI as the implementation agency.

2. The planned target area requires 3 teams for construction works to keep a sufficient quality control considering the climate and geographical conditions. The drilling is undertaken by a local private contractor.

(2) Construction System and Work Schedule

a) Drilling Schedule

The Project covers the drilling of 85 boreholes apart from the 5 successful test boreholes drilled during the preparatory study. The Project installs powered pumps (level 1.5). The designs of facilities are standardized by the size of the communities so as to reduce risks of design changes. In addition, 10 sites with 1,000 to 1,500 population are drilled first during the D/D stage to reduce the risk of design changes during the construction work. Therefore, 75 sites are drilled during the implementation stage.

For the overall construction, the following conditions are taken into consideration:

The planned number of boreholes (except the 5 test drillings) amounts to 85 (depth 100m x 8, 150m x 43, 200m x 22, 250m x 12)

Borehole success rate: average 56% (100m: 65%, 150m: 58%, 200m: 54%, 250m: 53%)

Total drilling Number of Boreholes = 85/0.56 = 152

Unsuccessful number of Boreholes = 67

Detailed Design: number of drilling 10/0.54 = 19 (Average depth: 210m)

(Success: 10, failure due to water quality: 3, failure due to water volume: 6)

Construction Stage: number of drilling 75/0.56 = 133

Preparation (Base camp set up, selection of a local sub-contractor 2.5 months)

Cycle time of construction

b) Construction period

The construction work is set up with 3 teams as follows:

The E/N and G/A require 1 month, the detailed design needs 4.0 months for the field survey, 2.5 months for in-house preparation (data analysis and preparation of tender documents), 0.5 months for approval of tender documents, and 3 months for PQ, tendering and contracting. Altogether 10.0 months are needed prior to the conclusion of a contract with a contractor.

After successful borehole drilling, 8 days are required to assess a well's success by water quality and 6 days are necessary to assess it by water volume. Considering bank holidays and the rainy season, the rate of non-working days is 1.35. The estimated construction period is 24 months as shown in Table 2-32. Therefore, 35.5 months are needed after the E/N is executed.

Table 2-32 Construction Period

| Item | | Period | Remarks |
|---|---|---|---|
| Preparation | | 2.5 months | |
| Well Drilling | Successful borehole | 34.20 months | 8 days/well x 95 wells x 1.35 = 34.20 months |
| | Unsuccessful borehole | 10.26 months | 6 days / well x 38 wells x 1.35 days = 10.26 months |
| | Total | 15 months/team | Total＝44.46 month, 44.46 month/ 3 teams = 14.82 = 15 months |
| Borehole Development, pumping test, water quality test, installation of appurtenant facilities and test operation | | 6.5 months | |
| Total | | 24 months | Drilling and upper facilities construction are to be conducted simultaneously. |

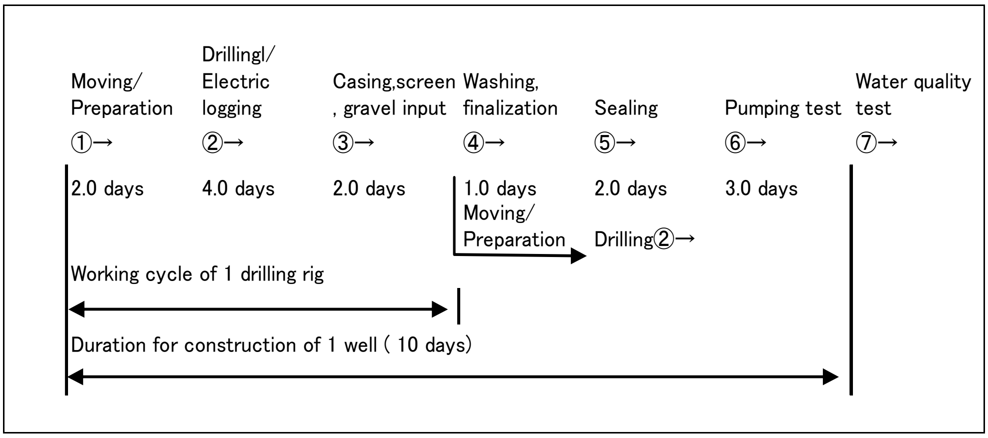



Figure 2-16 Borehole Construction Cycle Time

c) Implementation

Figure 2-17 shows the organization chart of civil works. Under an office representative, administrator/bookkeeper, civil engineer, drilling engineer and hydrogeology engineer will supervise the works together with the local engineers.

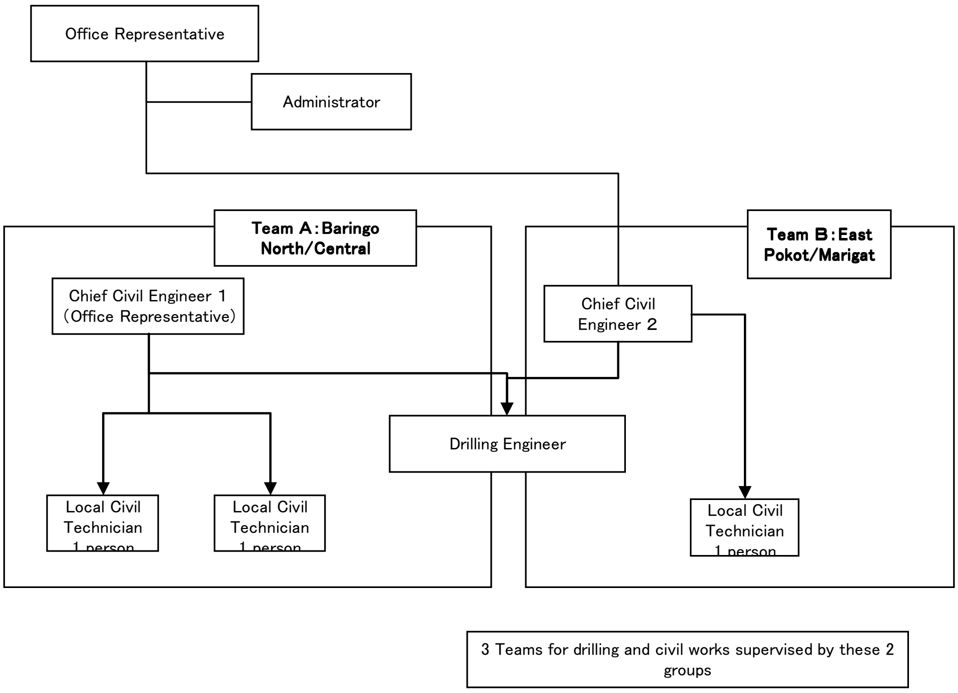



Figure 2-17 Implementation Organization

### 2-2-4-2 Implementation Conditions

(1) Accessibility to sites

The target communities have no problem of access to sites during the dry season, but during the rainy seasons road condition gets worse, therefore, it is anticipated that access to certain sites is difficult. Accessibility needs to be well thought over to plan a construction schedule.

The 90 target sites are scattered in 4 districts in Large Baringo. Paved routes are Route B4 from Nakuru, from the intersection of Marigat and Kabarnet extending alongside Lake Baringo up to the north end, and a portion of the route towards west to Kabarnet. All other roads are gravel roads.

On the highland, some parts of unpaved roads are slippery; thus, with the slope transportation by rig is difficult. In Marigat and East Pokot, certain roads need to cross the river so that during rainy seasons those routes are inaccessible.

The rainy seasons are April to June and October to November. Access to the communities during these months is not possible. Working efficiency will thus slow down during the rainy season.

(2) Temporary Construction Yard

The target area spreads over 200km x 100km. Due to poor road conditions in the hills, a temporary stockyard to keep construction materials and equipment is set up at Marigat which is the entrance to the district from Nairobi and Nakuru, and in Kabarnet as the base camp for the Project.

(3) Quality Control

The target area has no place to conduct concrete tests. Since the temporary construction yard needs a concrete testing laboratory (concrete slump test, curing tank), the laboratory may be set up in Kabarnet.

Simple water quality tests are to be conducted at the time of drilling. Samples may be tested either in Nakuru at RV-WSB or in Nairobi at the laboratory of Kenyatta University for appropriateness as drinking water.

(4) EIA Application

An environment license is required since the Project is considered as groundwater development. Since the Project is not intended to be constructed in a forest reserve, a relatively simple project report is sufficient to acquire a license. Upon submission of the report, the appraisal is made and finished within 45 days. The project report shall consist of the overall features of the Project such as facilities, environment and interviews with the community members. The report is to be produced by a registered consultant at NEMA.

(5) Drilling Permission

Drilling works require permission from WRWA, whose process requires 3 months to complete. An application form should be filled out together with the electrical exploration results as well as data of existing boreholes in the same area. In the preparatory study, since the timeframe was too short, temporal application was submitted and accepted for 2 weeks on the condition that the survey data would be submitted at a later time. For the implementation of the Project, an application is to be submitted during the D/D stage so as to receive permission prior to the commencement of the works. The process is administered by RV-WSB.

(6) Power Supply

In the target area, transmission lines are placed along the main route. In many communities there are no distribution lines placed for community use. The Project may secure power supply for pumps, but the capacity is too small for construction works. Therefore, for the construction works, a temporal power generator is needed. In case commercial power supply is used for pumps, an application has to be submitted to Kenya Electric Power Company. The construction period shall take the necessary timeframe into account for power supply preparation. The application is administered by RV-WSB.

(7) Water Supply

Tap water is available at the district capital. Since water is scarce in the area, groundwater from the test borehole is to be utilized for the construction works. Temporal pumps are to be used up to 50% of the pumping capacity. Civil works shall start after drilling to share water for the construction work.

(8) Means of Communication

Telephone lines are available only in the district capital. Mobile phones are available, yet the network is feeble in some communities. To establish the necessary communication flow for the project's implementation, radio contacts or a satellite phones need to be ready for use in case of emergency.

(9) Accommodation for Japanese Engineers

Some hotels are available in Kabarnet and Marigat and the west of Lake Baringo. In East Pokot, an accommodation needs to be prepared at the temporary yard.

### 2-2-4-3 Scope of Work

The Project implemented under the Japanese grant aid scheme will have divisions of work and procurement between Kenya and Japan as mentioned below.

The implementing agency is MOWI of Kenya as the chief executive office of the Project. The Project is implemented in accordance with the funding scheme of Japan. Therefore, in the course of project implementation, necessary administrative procedures need to be processed without delay at each stage. The responsibilities are as listed below.

1. To conclude a Grant Agreement (GA) based on the Exchange of Notes (E/N);
2. To conclude a contract with a Japanese consultant based on the E/N and GA;
3. To conclude a contract with a Japanese contractor based on the E/N;
4. To open an A/P at the Japanese bank designated in order to pay the contracting fees to the contractor upon conclusion of a contract;
5. To pay service charges to the Japanese bank in accordance with the banking arrangement (upon opening A/P);
6. To open an office for supervision of the works (Mwanza, Neno District Department of Development) and deploy staff;
7. To accord Japanese consultants and contractors such facilities as may be necessary for their entry into Malawi and stay therein and to issue a long term stay permit for the performance of their work and pay the fees (as necessary);
8. To accord Japanese consultants and contractors such facilities as may be necessary for their business and engineer's registration, and pay the corresponding fees (as necessary);
9. To expropriate land for facility construction (immediately after the contract conclusion);
10. To prepare for access to construction sites;
11. To accord tax exemption with regard to facility construction works and procurement of equipment;
12. To arrange payment of Customs duties for equipment and materials to be procured from Japan or in a third country;
13. To attend inspection of facilities and equipment (upon consultant's request);
14. To issue a certificate of payment to the consultant and contractor; and
15. To assist community-based operations and maintenance and to provide necessary support after handover of the facilities.

### 2-2-4-4 Consultant's Supervision

Construction supervision is provided into 2 stages: detailed design and construction supervision.

The works under the detailed design stage are listed below as to facility construction and procurement of equipment as stipulated in the basic design.

1. Preparation of detailed design drawings;
2. Preparation of specifications of construction works and procurement of equipment;
3. Preparation of tender documents;
4. Calculation of bidding target price;and
5. Execution of tendering process.

The contents of the field survey for the detailed design are as follows:

1. Electric exploration to determine the drilling points (vertical and horizontal exploration for 152 drilling points);
2. Analysis of the electric exploration to determine the drilling points (2 point markings at each site);
3. Drilling (19 sites of drilling to produce 10 success sites);

4. Upper facility construction study and design at sites (simplified survey and soil examination);
5. Construction and operation and maintenance support (soft component);
6. Confirmation of construction and procurement plan;
7. Market research for cost estimation; and
8. Additional survey for the detailed design study.

The works at the construction supervision stage are as listed below.

1. Approval of the construction plan, design, as well as inspection of materials;
2. Confirmation of works of the Kenya side;
3. Supervision of progress of works;
4. Supervision of facility construction;
5. Report to both countries' authorities as to the progress of the works;
6. Supervision of delivery progress of procured equipment and materials;
7. Supervision of procurement and inspection before delivery;
8. Completion of inspection; and
9. Cooperation with payments and other administrative processes.

Listed below are the engineers/experts necessary at each stage to conduct the stipulated tasks:

A. Detailed Design Stage

| | | |
|---|---|---|
| Chief Engineer | 1 person | Manager |
| Hydrogeologist 1 | 1 person | Electrical exploration, soil examination supervision, borehole site selection |
| Hydrogeologist 2 | 1 person | ditto |
| Drilling Engineer | 1 person | Drilling supervision, borehole structure design |
| Assistant Chief/Civil Engineer | 1 person | Facility design and operation, construction supervision |
| Procurement/Cost Estimation Expert | 1 person | Civil works and procurement planning/cost estimation |
| Civil Engineer 2 | 1 person | Coordinator, tender documents preparation |

B. Construction Supervision Stage

| | | |
|---|---|---|
| Chief Engineer | 1 person | Commencement and completion of the works |
| Civil Engineer | 1 person | Commencement of the facility construction and completion of the works |

| | | |
|---|---|---|
| Hydrogeologist | 1 person | Commencement of borehole construction |
| Resident Engineer | 1 person | During the construction (handing over of equipment) |

C. Soft Component Stage

| | | |
|---|---|---|
| Operations and maintenance/Hygiene education | 1 person | Operations and maintenance/sanitation and hygiene education |

### 2-2-4-5 Quality Control Plan

The consultant will conduct analysis and testing on the following items for quality control of borehole drilling in relation to the subcontractor.

Borehole Construction

Pumping Test (step-drawdown test, continuous test: Every borehole
Water Quality Test (MOWI temporary water quality standards): Every borehole
Gravel Packing (Particle size analysis): Every delivery

Borehole Intake Facilities

Concrete trial mixture test (aggregate particle size analysis, compressive strength test): for each mixture
Concrete Quality Control Test (slump test, compressive strength): Once at each 5 water point
Reinforcing Bar/Inspection Certificate: Every delivery

Solar Pump, Generator, Submersible Pump, Hand Pump

Visual Inspection: Every delivery
Test Operation: Every installation

### 2-2-4-6 Procurement Plan

(1) Procurement of Equipment

Cement, bricks, aggregates, reinforcing bar and other construction materials are to be purchased in Kenya to lower costs. Mud materials are a consumption material needed for drilling. Imported products are on the local market, so that it is to be purchased in Kenya. Casings, screen and pumping pipes will also be procured in Kenya. Solar pumps, submersible motor pumps, and generators are sold through local agents in Kenya. There are also local agents selling pick-up trucks. Considering the future needs for maintenance, these equipment are to be procured in Kenya.

Table 2-33 Countries Planned for the Procurement of Equipment and Materials

| No. | Items | Kenya | Third Country | Japan |
|---|---|---|---|---|
| 1 | Casing | ○ | | |
| 2 | Screen | ○ | | |
| 3 | Aggregates | ○ | | |
| 4 | Cement, reinforcing bars | ○ | | |
| 5 | Pipes | ○ | | |
| 6 | Pump | ○ | | |
| 7 | Solar pump | ○ | | |
| 8 | Generator | ○ | | |
| 9 | Double cabin Pick-up Truck | ○ | ○ | |
| 10 | Motorcycle | ○ | ○ | |
| 11 | Personal Computer | ○ | ○ | ○ |

## 2-2-4-7 Operational Guidance Plan

The initial guidance and instructions for operation and daily maintenance of facilities are given to WUA members after the completion of facility set up. The instructions are given by the contractor.

## 2-2-4-8 Soft Component Plan

The following social intervention program is planned for water supply facilities constructed under this project for their sustainable and effective use. The program aims to strengthen the capacity of communities for the operation and maintenance to be performed by them.

(1) Background of Soft Component

The target communities have no water supply facilities; therefore, after installation of the facilities, it is necessary to provide support and training on maintenance and operation. According to Kenya's sustainable operation and maintenance strategy, the training and sensitization program is planned to strengthen the capacity of local communities.

(2) Objective

The goal of the program is "to form a water users association by the local communities, which carries out the operation and maintenance of facilities at village level water supply, and water supply facilities can be used sustainably" and, in addition, to strengthen the capacity of the DWO staff to provide support to the local communities.

(3) Activities

A workshop is to be organized for the DWO staff with themes of program objectives and handbooks. Thereafter, informative stakeholder meetings are to be conducted with district officials, the community chiefs, and other relevant stakeholders to facilitate establishment of WUA at the 90 sites. Training programs for WUA members and water users are to be coordinated, including maintenance and repair of water supply facilities, daily inspection by officers, hygiene education and training, water fees collection, etc. The program is to be carried out by Japanese and local consultants in cooperation with the DWO.

Table 2-34 Contents of Soft-Component Program

| Activities | Contents | Schedules |
|---|---|---|
| 1-1 Workshop on operation and maintenance | • Consultation on operation and maintenance by water users associations<br>• Consultation on the implementation of the soft component program<br>• Consultation on WUA training | Before construction |
| 1-2 Workshop on WUA handbook and hygiene education | • Consultation on the hygiene education materials<br>• Production of WUA handbook | Before the construction |
| 2-1 Explanation to district offices | • Stakeholder meeting on operation and maintenance system | Before the construction |
| 2-2 Training for community leaders | • Orientation on roles and responsibilities of WUA<br>• Orientation on the soft component program<br>• Request to assist in the formation of WUA and submission of the confirmation of WUA formation<br>• Request to assist in the selection of members | At the commencement of construction |
| 2-3 WUA training | • Orientation on operation and maintenance, roles and responsibilities of water users association<br>• Preparation of rules and regulations of WUA (opening hours, tenure, bookkeeping, how to use the facilities, cleaning, how to keep the fund)<br>• Setting of water fees (communities, non-community members, livestock)<br>• Rule making on water usage for animals (methods, quantity)<br>• Measures against theft, vandalism<br>• Planned activities of sensitization program for the local communities<br>• Daily operation and maintenance, procedures for repair<br>• Daily maintenance of surrounding of facilities | At the commencement and during construction |
| 2-4 Community training | • Introduction of WUA and activities<br>• Orientation and information dissemination on how to use the facilities<br>• Collection of water fees<br>• Operation in case of trouble | At the inauguration |
| 2-5 Monitoring of O&M | • Monitoring on the progress of activities, water supply facilities conditions<br>• Interviews on the outcomes of activities<br>• Advice | After the construction |
| 3-1 Hygiene education | • Preparation of hygiene education at the communities<br>• Hygiene education<br>• Cleaning of animal watering trough | After the construction |

### 2-2-4-9 Implementation Schedule

After the signing of E/N and G/A, MOWI will enter into an agreement with a Japanese consultant for the design and implementation of the Project.

After conclusion of a contract, the consultant will conduct the detailed design (D/D) field surveys and prepare tender documents. During the D/D, 10 boreholes are to be drilled in the larger 10 communities to increase the accuracy of design. A tender for the works will then be undertaken by MOWI with the assistance of the consultant. Then, the successful bidder which shall be a Japanese contractor signs a contract after successful negotiation with MOWI.

A base camp is prepared during the preparatory works and before borehole construction is started. Thereafter, 75 boreholes are constructed by the local subcontractors under the supervision of the Japanese contractor. Water supply facilities are constructed by the contractor for 90 boreholes. Approximately 25 months are required for the construction work. Soft component activities are conducted from the commencement up to the completion of construction works.

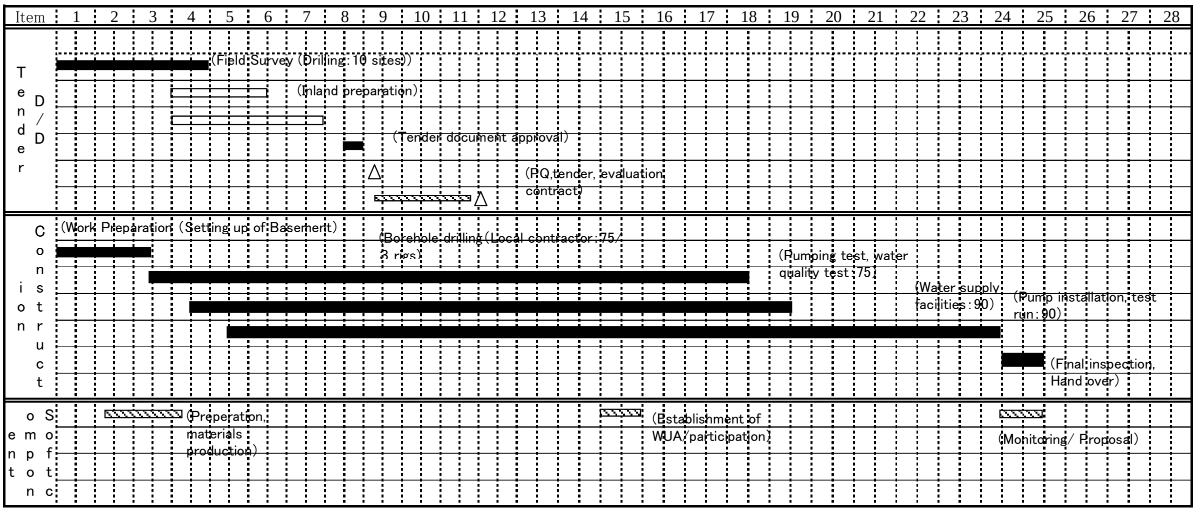



Figure 2-18 Implementation Schedule

## 2-3 Obligations of Recipient Country

(1) Preparation of Land for Borehole Drilling

The final position of a borehole shall be determined through consultation with the communities and the DWO, based on the results of electrical exploration. The decided project land shall be leveled by the community prior to the construction work.

(2) Access Path

In case the site is located far from a road, the access path to the community shall be prepared by the community.

(3) Securing Land for the Project Office, Stockyard and Warehouse

Land for the base camp for construction works needs to be provided by Kenya. A stockyard, warehouses to keep cement and aggregate as well as fuel and vehicles also need to be provided.

(4) Works of Commercial Electricity Lead-in to the Site

Commercial grid needs to be led in to the target 37 sites until the incoming panels.

(5) Placement of Project Staff and Budget

Project personnel shall be selected from DWO and RV-WSB which are in charge of coordination of the Project. Direct personnel costs such as allowance and transportation shall be budgeted prior to the commencement of construction work.

(6) Permission of Drilling and EIA Procedure

The procedures of EIA and permission for drilling shall be expeditiously processed.

(7) Coordination with Other Donors, NGOs and Other Related Agencies

MOWI shall coordinate with other donors and projects to avoid implementing overlapping activities and projects.

## 2-4 Project Operation Plan

### 2-4-1 Supporting System of the Executing Agencies

The operation and maintenance plan has the following conceptual framework: 1) promotion of communities' proactive participation in the operation and maintenance; and 2) assistance to communities bygovernment agencies.

### 2-4-2 Operation and Maintenance Plan

(1) Basic Policy on Operation and Maintenance

Operation and maintenance of water facilities is to be carried out through the proactive participation of local community organizations and the administrative support services in Kenya.

After the sector reform under the 2002 Water Act, the responsibilities of support services for rural communities were transferred to the Water Service Board (WSB). NGOs, private sector and community based organizations provide the services. In Large Baringo, a water service provider operates in Kabarnet.

For the rural areas, water users associations maintain the water facilities and, in addition, RV-WSB carries out the support services. The study team had confirmed that RV-WSB is to keep the same operation and maintenance system, whereby water users associations are established and DWO's capacity building is carried out to support the rural communities.

(2) Operation and Maintenance Plan

a) Community support by the local administration

For sustainable operation and maintenance of the water supply facilities, improvement of communities' operation and maintenance capacity is a necessity. Training and monitoring are also necessary to facilitate the process.

The following are the roles and responsibilities expected to be provided by DWO:

- Support to establish water users association (WUA)
- Technical guidance for operation and maintenance
- Training and guidance to the communities to determine water fees and fee collection system
- Training on bookkeeping and fund management
- Support for the repair and rehabilitation of the facilities
- Monitoring

The Project aims to incorporate participative operation and maintenance approach in cooperation with DWO. A soft-component program intervenes to improve the capacity for operation and maintenance.

b) Community support by the local administration

A participative operation and maintenance system puts emphasis on ownership and cost sharing by the users. The Project will request the local communities to participate in deciding the borehole drilling points and to prepare the access for rigs to enter into their communities.

c) Improvement of operation and maintenance capacity

A soft component program will be provided to assist in the set up of a WUA and propose an initial training. The WUA members are to be elected from community members at regular intervals in the future; therefore, the roles and responsibilities need to be well defined and transparent to all community members. The Project will provide an operation and maintenance manual to each village to guide and help the communities in long term operation and maintenance activities.

## 2-5 Project Cost Estimation

The breakdown of the cost charged to Kenya to implement the project through a Japanese grant aid has been estimated as presented below. Kenyan and Japanese sides are expected to bear the costs respectively. However, the amount does not show the limit of grant aid.

(1) Estimated Project Cost covered by Kenya:

Total Approx. 30.09 million Ksh (28.66 million Japanese Yen)

MOWI and RV-WSB

| Items | | Details | Qt'y | Unit | Unit Price | Price (Ks) | Remarks |
|---|---|---|---|---|---|---|---|
| 1 | Base Camp Land Preparation | | | | | | |
| | Kabarnet | 50mx50m | 2500 | $m^2$ | 100 | 250,000 | Public land, leveling |
| | Margat | 50mx50m | 2500 | $m^2$ | 100 | 250,000 | Public land, leveling |
| 2 | Service Wire | | 37 | Site | 643,405 | 23,806,000 | |
| 3 | EIA License Application | EIA report preparation | 12 | Set | 70,000 | 840,000 | Reports for areas with 90 sites divided into some groups |
| 4 | Approval of Borehole Drilling | WRMA | 40 | Site | 1,000 | 40,000 | Less than 10 $m^3$ |
| | | WRMA | 50 | Site | 5,000 | 250,000 | More than $10m^3$ |
| 5 | C/P Activity Expenses | | | | | | |
| | Allowance | | 500 | Person・Day | 3,000 | 1,500,000 | 2person×10d/M×25M |
| | Vehicle Maintenance | Fuel for 1 vehicle | 15,000 | Liter | 120 | 1,800,000 | 30L/d×20d×25M Without Soft Component |
| | | Maintenance of vehicles | 25 | Month | 15,000 | 375,000 | Price×1%/month |
| | | Fuel for 2 motorbikes | 2500 | Liter | 120 | 300,000 | 5L /day x 20days x 25months (operation and maintenance activities are not included) |
| | | Maintenance fee for motorbikes | 20 | Month | 2,900 | 58,000 | Price×1%/Month |
| 6 | Bank Charges | | | Set | | 625,000 | |
| | Total | | | | | 30,094,000 | |

| Items | | Details | Qt'y | Site | Unit Price | Price | Remarks |
|---|---|---|---|---|---|---|---|
| 1 | Project Sites | Clearance, leveling | | 90 | - | - | With community involvement |
| 2 | Access to Sites | | | 90 | - | - | With community involvement |

(2) Cost Estimation Conditions

a) Month of cost estimation: June, 2011

b) Exchange Rate: 1US$=¥ 83.480; 1Ksh=¥1.050

c) Project Period: (Detailed design, construction and procurement periods are shown in the construction schedule.)

d) Others: The cost estimation process abide with the Grant Aid Scheme of the Japanese Government.

(3) Operation and Maintenance

Operation and maintenance costs are calculated as shown in Table 5-1. The results of social survey shows that 2 to 3 Ksh per 20L on average are the appropriate water fee range consideringits sustainability. Although there are communities that pay up to 20 Ksh to water vendors, these are exceptional cases. From the viewpoint of financial viability, communities with more than 750 population are better off to operate with a generator pumping system or commercial electric power.

Table 2-2 Operation and Maintenance Cost Estimates

| Power | Parameters | Conditions | Operation and Maintenance (Ksh/year) |
|---|---|---|---|
| Solar | Size | 500 people | |
| | Fuel | ― | 0 |
| | Spare parts, replacement | Consumables, 10 years renewal | 21,000 |
| | Water vendor | volunteer | 0 |
| | Operator | | 24,000 |
| | Others (transport, stationary) | 1 set | 6,000 |
| | Total | | 51,000 |
| | 1 person per day (= per 20L) | | 0.6 |
| Generator | Size | 750 people | |
| | Fuel | Fuel per unit Ksh110/L | 0 |
| | Spare parts, replacement | Consumables, 10 years renewal | 180,600 |
| | Water vendor | volunteer | 18,000 |
| | Operator | | 72,000 |
| | Others (transport, stationary) | 1set | 6,000 |
| | Total | | 276,600 |
| | 1 person per day (= per 20L) | | 1.0 |
| Commercial grid electric power | Size | 750 people | |
| | Fuel | KPLC unit price for electricity | 449,000 |
| | Spare parts, replacement | Consumables, 10 years renewal | 231,300 |
| | Water vendor | volunteer | 18,000 |
| | Operator | | 72,000 |
| | Others (transport, stationary) | 1set | 6,000 |
| | Total | | 776,300 |
| | 1 person per day (= per 20L) | | 2.8 |

# CHAPTER 3 PROJECT EVALUATION

## 3-1 Preconditions

Many village people in the target communities use water sources such as pond water, river water, spring water, dug wells and so on. However, the quality and quantity of water sources are not adequate for drinking purposes; these water sources are contaminated by sewage and livestock excreta and, at the same time, the quantity fluctuates unstably in the dry season.

The Project will construct new boreholes and water supply facilities, and supply service water to vehicles and computers for operation and maintenance. Additionally, "soft component" is implemented such as the training of DWO personnel, capacity building of community organizations, and sanitary education at the communities.

Preconditions for the Project's implementation are as follows:

Preparation for borehole drilling sites

Preparation of access route for works

Land preparation for field office, warehouses and yard

Lead-in of commercial power lines

Securing Project Personnel and Budget

RV-WSB: Personnel in charge of the project implementation

DWO: Personnel in charge of practical works

Procedures related to the Project implementation such as borehole drilling permit and Environment Impact Assessment

## 3-2 Necessary Inputs by Recipient Country

The issues to be addressed by the Government of Kenya in order to sustain the effects of the Project are as listed below. The budget of DWO for personnel costs, transportation and others shall be secured to implement the activities.

DWO will take charge of monitoring and supervision, for sustainable operation and maintenance in the target communities.

In the target communities, support is given to form a Water Users Association (WUA)

## 3-3 Important Assumptions

External conditions for sustainable effects of the Project are as follows:

Sudden price jump does not occur and the equipment is stably procured.

No significant change in the government's relevant policies in Kenya.

Weather and road conditions do not deteriorate rapidly.

The safety conditions do not deteriorate.

## 3-4 Project Evaluation

### 3-4-1 Relevance

The target of the Project are the communities in the 4 districts of Baringo District located in Rift Valley Province (Baringo North, Marigat, Baringo Central, and East Pokot). Direct beneficiaries are approximately 60,000 in 2015, and the proportion of population with access to safe and stable water is increased from 24% to 37%.

Water sources such as lake water, river water, spring water and dug wells are primarily used as the main water sources in the area for drinking purposes without any treatment. Consequently, many people are affected by waterborne diseases. The safety of water sources is thus a serious problem, so that the improvement of water services is an urgent concern.

New boreholes with pumping facilities constructed in the Project are maintained by the WUAs to be established at each site. Water fees to cover the maintenance cost are estimated to be around 2 to 3 Ksh/20 liters. Based on the data gathered in the social survey, the estimated water price is acceptable for the local users and WUAs are advised to conduct operation and maintenance by themselves.

The National Development Plan (Vision 2030) aims at achieving universal access to water resources and hygiene. The medium-term program of the Millennium Development Goals targets the increase of the average proportion of population with access to safe and stable water from 40% to 59%. The access rate in the area is currently 24%; therefore, increasing the access rate to approximately 35.7% will contribute to the overall objectives.

The category of Environmental and Social Consideration is C (hardly have any adverse impact on environment and society), thus there is little influence on the environmental and social conditions.

## 3-4-2 Effectiveness

(1) Quantitative Effect

Table 3-1 Quantitative Project Impact

| Indicator | Base Year (2011) | Target Year (2017: 3 year after completion) |
|---|---|---|
| Proportion of the population with access to safe and stable water in the area | 24.4% | 35.7% |
| Population with access to safe and stable water in the area | 98,000 | 157,580 |

(2) Qualitative Effect

a) Waterborne diseases such as diarrhea and dysentery are expected to decrease.

b) Labour for the transportation of water is expected to decrease.

c) At 90 sites, WUAs are established to facilitate maintenance, and their capacity for maintenance as well as ownership is enhanced.

In consideration of the analysis stated above, the validity and effectiveness of the Project is high.