Long Distance Water Transmission Pipelines and Applications for the Gobi and Steppe Regions of Mongolia

By: Mongolian National Water Programme Support Center[1], October 2007

1. Introduction

The potential of annually water resources of Mongolia is 34.6 km^3, of which 6.1 km^3 are ground water resources. While the northern part of the country has sufficient water resources, the steppe and Gobi regions, which together represent 69 percent of the country's total land area, lack a surface water network and the demand for water in those areas is mostly supplied from ground water. In addition, as these regions are part of continental saline zones, a high percentage of minerals and hardness content in the water make it less suitable for consumption.

Table 1. **Estimated Water Resource Capacity in the Gobi Regions**

Aimag	Surface water, km^3		Underground water, km^3	
	Total	Can be utilized	Total	Can be utilized
Dornogobi, Gobisumber	0.05	-	0.01	0.005
Dundgobi	0.15	-	0.08	0.01
Omnogobi	0.038	-	0.01	0.001
Tov[1]	1.91	0.20	0.59	0.20
Hentii	6.69	0.40	2.70	0.80
Total	**8.838**	**0.6**	**3.39**	**1.016**

The South and Southeastern Gobi regions are also a focus of serious interest in the development of mining prospects that could provide much needed economic boost for the region and the country if they are developed correctly.

These developments will need large amounts of water, and there is concern that increasing extraction rates from the non-renewable underground sources may cause irreversible environmental damage. This paper introduces two projects as potential alternative solutions.

[1] *The Mongolian National Water Programme Support Center (Water Center) is a Mongolian NGO whose members are professionals actively working in water-related fields for government, academia, and the private sector.*

2. Background

Water is precious in Mongolia and in many parts of the country there are severe problems with the quantity and quality of water available. Public water systems in Mongolia are typically based on wells, and in the South and Southeastern provinces (aimags) these well systems are drawing water from deep aquifers containing old water that is not replenished from precipitation. Water from these wells is typically high in minerals and hardness, and there are links between the poor water quality and health problems in the region.

Most of the water supply infrastructure of Mongolia was constructed during the 1970's and 80's, at a time when the economics of operation, maintenance and expansion of public utilities was of little concern. Many water systems that were constructed to support agriculture and other small-scale economic activities are in disrepair and there is no feasible way to rebuild and operate these systems without subsidies.

Today water utilities in Mongolia are faced with the realities of a "Market Economy", and must try to support themselves from an economically disadvantaged customer base. While there are some donor-funded programs for some of the major cities, there are still many small water systems that are in need of improvement. Many of the improvements needed are due to depletion of the deep aquifers that causes wells to fail and water quality to decrease to below legal standards. Finding new deep sources, drilling deep wells, and installing new pumps and pipelines are expensive and difficult to financially justify.

Additionally, Mongolia's electric power infrastructure dates prior to Market Economy, with one central, coal-fired power plant located in Ulaanbaatar generating most of the supply for the country. Additional power is purchased from Russia at a high cost, sometimes with intermittent delivery. Mongolia needs to increase the generating capacity and reliability it's power infrastructure in a ways that are environmentally responsible and economically sustainable.

The "Herlen-Gobi" and "Orhon-Gobi" Projects will address all of the above problems on a regional scale, based on the premise that the only way to solve these problems is to develop an alternative to underground water sources.

3. Estimate of Water Resources in the Project Area

The projects will cover the southwest portion of Hentii Aimag, southeast portion of Tov Aimag, south and west portion of Dornogobi Aimag, and the eastern portion of both Omnogobi and Dundgobi Aimags of Mongolia.

Possibility of Using Underground Water

Previous investigations have found that the regions contain some underground water resources, although they are located unevenly. Deep aquifers of underground water were documented at the intermounts of Shainshand, Balgasiin Ulaan Nuur, Choir, Galbiin Gobi, and Unegt.

Hydro-geological investigation done at a location 200 km from the proposed enrichment plant at Tavan Tolgoi estimated that the total capacity of deep aqufiers in Balgasiin Ulaan Nuur, Bulgan II, Mandah, Mandal Ovoo, Tavan Ald, Herment Tsagaan is no greater than 780 l/s^2.

Hydro-geological investigations were done in the intermountain near Choir for evaluation of deep aquifer at North Choir, Shivee Ovoo, Ovdog Hudag, Jargalant Lake, and Mort Bulag. The main structure for the Shainshand intermountain deep aquifer is Bor Hovooriin Gobi. A preliminary study estimated 500 liter/second capacity of 50 m average depth from a 780 km^2 area. There are small aquifers at Zegiin Hotol and Shanagan Mogoit.

Hydro-geological investigation at Tsagaan Suvraga identified Tsagaan Tsav deep aquifier of about 300 l/s capacity. The latest hydrological investigations done in Galbiin Gobi and Gunii Hooloi have identified deep aquifiers that could be possibly utilized.

The above assessments of groundwater resources were done in the 1970's and 1980's, and there is a low degree of certainty as to the actual groundwater exploitation potential.

4. Water Demand Assessment for 2020

Research for the project has included a detailed assessment of future water demands for the region. This assessment has included with direct contact with all potential municipal and industrial customers, and some estimates of agricultural uses that are projected to develop if water becomes available.

A summary of demands is shown in the table below. These are only the demands that can be anticipated from known data, and there is a high likelihood of additional industrial users from future mining development and economic activity resulting from the Free Trade Zone in Zamiin-Uud and new road that will parallel the existing railroad between Ulaanbaatar and the China Border.

Table 2. **Water Demand Projections for 2020**

№	Water User	Estimated Demand liter/sec	Source	
			Surface	Under-ground
Energy and Mining Industry				
1	Shivee-Ovoo	616	467	149
2	Tsagaan Suvarga	604	300	304
3	Oyu Tolgoi	1060	360	700
4	Tavan Tolgoi	951	486	465
	Subtotal	***3231***	***1613***	***1618***
Urban Water Supply				
5	Mandalgobi	50	50	0
6	Dalanzadgad	70	60	10
7	Choir	40	40	0
8	Sainshand	85	65	20
9	Zamiin-Uud	50	50	0
10	Soum Center and rural	104	52	52
	Subtotal	***399***	***317***	***82***
Agriculture and Environment				
11	Livestock	200	100	100
12	Agriculture	1750	1750	0
13	Environment	300	100	200
	Subtotal	***2250***	***1950***	***300***
14	Other	120	120	0
	TOTAL	***6000***	***4000***	***2000***

Development of potential demands into actual water sales will require a period of time after the main pipelines are completed, and the project will be developed to minimize this time by working closely with major customers to facilitate the financing and construction of connections to the project. The implementation schedule will also be made to match the needs of major customers so water can be delivered when

[2] Water source potential reported in pre-1990 studies is expressed in an average demand rate sustainable for 20 years and does not consider recharge rate.

it is needed. Part of the sensitivity analysis to be conducted for the project will include alternatives with and without some of the anticipated major customers.

The water transmission pipeline will provide water to various classifications of public and private users. Projected demands have been developed from data provided from developers of proposed mining and power station projects and from the projected year 2020 demands of towns and settlements (Table 2).

5. Herlen-Gobi Project

Project Description. The objective of the Herlen-Gobi Project is to divert water from the Herlen River and supply it to the Southeastern Gobi regions by means of a pipeline network. This would require that a dam and intake structure be constructed at Togos Ovoo, which is approximately 125 km southeast of Ulaanbaatar. Then pipelines, pump stations, and supporting facilities would be constructed to bring water south. The pipelines would branch near Sainshand, with one branch continuing South west to Tsagaan Suvarga, and the other branch turning Southeast, generally following the road and railroad to Zamin-Uud on the China border.

The Herlen-Gobi Project is serve the needs of a number of problems for beneficiaries at various levels, in a way that is comprehensive, sustainable, and environmentally responsible: The project will provide water of high quality for potable use, not only to major population centers, but also to small users along the pipeline route.

Water will be made available for agricultural users including livestock raising and farming. There will be sufficient quantity of water to support mining developments that will provide employment and needed revenue for Mongolia.

This will be done in a way that is financially self-sustaining. Because the project will supply water to various classes of users, it will be possible to have a rate structure that will allow small users with limited incomes to benefit while the major users support the cost of construction and operations.

Basic Description of the Water Supply System. There are two main parts of the system; the Dam, Reservoir and Water Intake Structure for water collection and storage, and the Pipeline, Pump Station, and Water Treatment system for transmission and distribution of water to customers.

Collection and Storage. The dam will be located at approximately 50 km downstream from the Herlen River Bridge on the Ondorhaan Highway near Baganuur, in a wide valley with mountains on either side. The dam will be 2560 meters long and have a maximum height of 25.5 meters. It will be constructed from rock and earth fill mined from the surrounding area, with an impervious core constructed of clay and/or concrete. There will be an impervious barrier constructed under than dam to a depth of 7-20 meters to block seepage under the dam. The dam design will incorporate measures for fish passage as required based on the results of the Environmental Assessment

The drainage and intake structure, which will be concrete construction, will include a 5000-kilowatt hydroelectric turbine that will generate electricity for operation of the dam facilities and first pump station. There will be buildings constructed near for the power station, security and operations support and appropriate roads and fencing.

The reservoir impoundment is estimated to be approximately 500 million cubic meters, covering an area of 62 square kilometers. The reservoir will extend approximately 30 kilometers upstream from the dam.

Transmission, Treatment, and Distribution. The piping system will begin at the dam and water will flow by gravity approximately 18 kilometers to the first pump station. The initial pipe diameter is presently set at 1200 mm and the diameter will be reduced along the way as the water is delivered to customers. The route of the pipeline, which will be finally determined in the Feasibility Study, will generally head south to town of Choir where one branch will continue south and the other will head southeast generally following the road and railroad to the China border.

There will be 2 pump stations between the dam and Choir, 5 pump stations on the southern leg, and 3 pump stations on the southeastern leg. There are no significant hills or mountains on either leg and the total pump station capacity is estimated to be 24.2 mW. The pump stations will be designed with multiple pumps and redundancy so that the system can be operated at various flow rates with high tolerance for equipment failure.

While the pump stations will be located to use the existing electrical supply network, there are some pump stations that will require new electrical lines to be installed, and others will be

needed to increase the reliability of the existing network. Current planning is for approximately 112 kilometers of high voltage power transmission lines to be constructed that will connect to the existing electric grid, with substations located at each pump station. The Feasibility Study will investigate the use of wind or solar alternatives in suitable areas.

The pipelines are planned as coated steel, installed below seasonal freezing depth. There is no known permafrost along the pipeline routes, and from the available data the soils are of low corrosion potential. There are no river crossings or major highway crossings identified for the main transmission pipelines.

Control valves will be installed at necessary locations and metering stations will be installed that are connected to a central operations control facility. Current planning is to use radio telemetry to acquire data for system operations and to remotely control the pump stations from a single location for safety and efficiency.

The water from the Herlen River will require minimal treatment before use. Disinfection with chlorine is typically used for water intended for human consumption, although it is not necessary for industrial uses and undesirable for agricultural uses. If chlorination is used it will be done close to the distribution points as required for human consumption.

Preliminary studies of the Herlen-Gobi project were done by the Water Center in 2004 and by JETRO and the Water Center in 2006. More detailed descriptions and estimated costs are presented in the reports from these studies.

6. "Orhon-Gobi" Project

The objective of the "Orhon-Gobi" Project is to divert water from the Orhon River and supply it to the South Gobi regions through Bulgan, Tuv and Dundgovi by means of a pipeline network. This would require that a dam and intake structure be constructed, at location approximately 300 km West of Ulaanbaatar and 35 km Southwest of Bulgan city. Then pipelines, pump stations, and supporting facilities would be constructed to bring water as far South as Tavan Tolgoi. The pipelines would supply water to users along the way and by three branches to Mandalgobi, Dalanzadgad, and Oyu Tolgoi.

The dam would also be constructed with a hydro-power generating station of 15-20mW capacity that would serve the Northern regions of Mongolia.

The "Orhon–Gobi" Project will address a number of problems for beneficiaries at various levels, in a way that is comprehensive, sustainable, and environmentally responsible:

- The project will provide water of high quality for potable use, not only to major population centers, but also to small users along the pipeline route.
- Water will be made available for agricultural users including livestock raising and farming.
- There will be sufficient quantity of water to support mining developments that will provide employment and needed revenue for Mongolia.
- Clean and reliable electric power will reduce dependence on foreign supplies and benefit the Mongolian economy.

This will be done in a way that is financially self-sustaining, with cost recovery from both water and power sales. Because the project will supply water to various classes of users, it will be possible to have a rate structure that will allow small users with limited incomes to benefit while the major users support the cost of construction and operations.

Orhon River Capacity. The Orhon River has been studied extensively in the past. There have been flow measurements taken nearly continuously since 1945, and there have been a number of previous studies done on the utilization of water from the Orhon River.

This information has been carefully studied in preparation of the "Orhon-Gobi" Project to date. The previous measurements show that the long-term average yearly flow is 44.1 m3/sec or approximately 1.39 billion cubic meters per year. Based on the anticipated demands from the project of between 2.0 and 2.5 m3/sec, the project would take only between 4.5 and 5.6 percent of the average flow, which will leave sufficient water to sustain downstream users. The height of the dam and volume of the reservoir have been determined to allow demands to be met under seasonal flow variations and to keep the water intake ice-free during winter.

Basic Description of the System. There are two main parts of the system; the Dam, Reservoir and the Pipeline, Pump Station, and Water

Treatment system for transmission and distribution of water to customers.

Collection and Storage. The dam will be located at approximately 20 km upstream from the "Orhon" observation station. The dam will be 300 meters long and have a maximum height of 60 meters. It will be constructed from rock and earth fill mined from the surrounding area, with an impervious core constructed of concrete. There will be an impervious barrier constructed under than dam to a depth of 10-15 meters to block seepage under the dam. The dam design will incorporate measures for fish passage as required based on the results of the Environmental Assessment

The drainage and intake structure, which will be concrete construction, will include a 15-20 megawatt hydroelectric turbine that will generate electricity for operation of the dam facilities and first pump station. The reservoir impoundment is estimated to be approximately 575 million cubic meters, covering an area of 23 square kilometers. The reservoir will extend approximately 18 kilometers upstream from the dam.

Water Transmission and Distribution. The piping system will begin at the dam and water will pumped by the first pump station. The initial pipe diameter is presently set at 1500 mm and the diameter will be reduced along the way as the water is delivered to customers. The route of the pipeline will generally head south to the Tavan tolgoi 613 km, where three branches will continue to the Mandalgovi 96 km, Dalanzadgad 85 km and to the Oyu tolgoi 123 km.

Power Generation. A power plant with power generating turbines with a capacity of 15-20 megawatts will be installed near the dam. Transmission lines will be constructed to connect to the existing 110 kilovolt system in the vicinity of the dam site.

Summary of Benefits. The Orhon-Gobi Project will bring positive benefit the people of Mongolia:

- Improved water supply for two cities and eight soum centers, affecting 50,000 people.
- Outlets at 50 locations for people and for animal watering – covering 100,000 hectares and capable of supporting 135,000 animals, providing opportunity for economic stability, settlement development, and transition from nomadic herder lifestyle.
- Irrigation water to support 2000-3000 hectares for planting vegetables, animal feeding - improving the yield and quality of harvest.

Enhanced and sustainable water supply to support mining developments and energy - both important for Mongolia's economic development. Water to support greening projects such as planting trees that can reduce desertification and improve the Gobi ecology. Hydropower will bring clean, reliable electricity supply that will contribute to making Mongolia energy self-sufficient and reduce foreign trade deficit. The Project will create recreational and tourism opportunities, with associated economic benefits.

The Water Center is presently preparing a preliminary technical and financial study of Orhon-Gobi that will be available in late 2007.

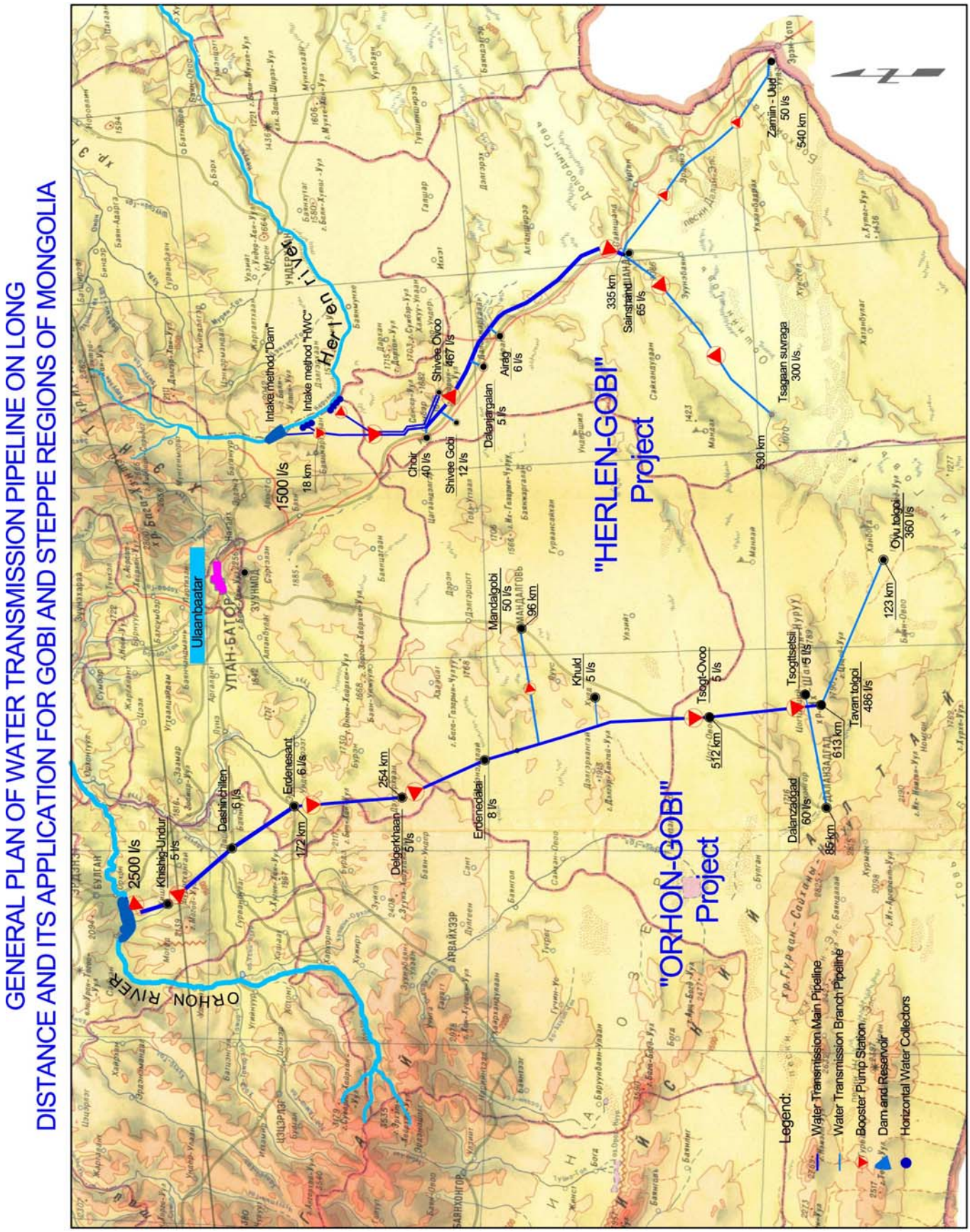
7. Conclusion

The Herlen–Gobi and Orhon-Gobi Projects will address multiple needs for Mongolia in a way that is sustainable in a market economy and sensitive to the environment.

This document was prepared by:

Mongolian National Water Programme Support Center (WATER CENTER)

Tel: +976-11-313 392, +976-99112995
Fax: +976-11-324 038
Address: #501-509, Sukbaatar Sq. #3, Ulaanbaatar 11/20 A, Mongolia
Email: watercenter@prestige.mn, centre@magicnet.mn


GENERAL PLAN OF WATER TRANSMISSION PIPELINE ON LONG DISTANCE AND ITS APPLICATION FOR GOBI AND STEPPE REGIONS OF MONGOLIA
"HERLEN-GOBI" Project
"ORHON-GOBI" Project
Herlen River
ORHON RIVER
Ulaanbaatar
УЛАН-БАТОР
Intake method "Dam"
Intake method "WC"
1500 l/s
18 km
2500 l/s
Khishig-Uridur 5 l/s
Dashinchilen 6 l/s
Erdeneesant 6 l/s
172 km
254 km
Delgerkhaan 5 l/s
Erdenedalai 8 l/s
Mandalgobi 50 l/s
96 km
Khuld 5 l/s
Tsogt-Ovoo 5 l/s
512 km
Choir 40 l/s
Shivee Gobi 12 l/s
Shivee Ovoo 467 l/s
Dalanjargalan 5 l/s
Airag 6 l/s
335 km
Sainshand 65 l/s
530 km
Tsagaan suvraga 300 l/s
Zamiin - Uud 50 l/s
540 km
Tsogttsetsii 5 l/s
Tavan tolgoi 486 l/s
613 km
Dalanzadgad 60 l/s
85 km
Oyu tolgoi 360 l/s
123 km
Legend:
Water Transmission Main Pipeline
Water Transmission Branch Pipeline
Booster Pump Station
Dam and Reservoir
Horizontal Water Collectors