Annex G

Water Conveyance and Water Suppy Plans for Metro Manila

Annex G WATER CONVEYANCE AND WATER SUPPLY PLAN FOR METRO MANILA

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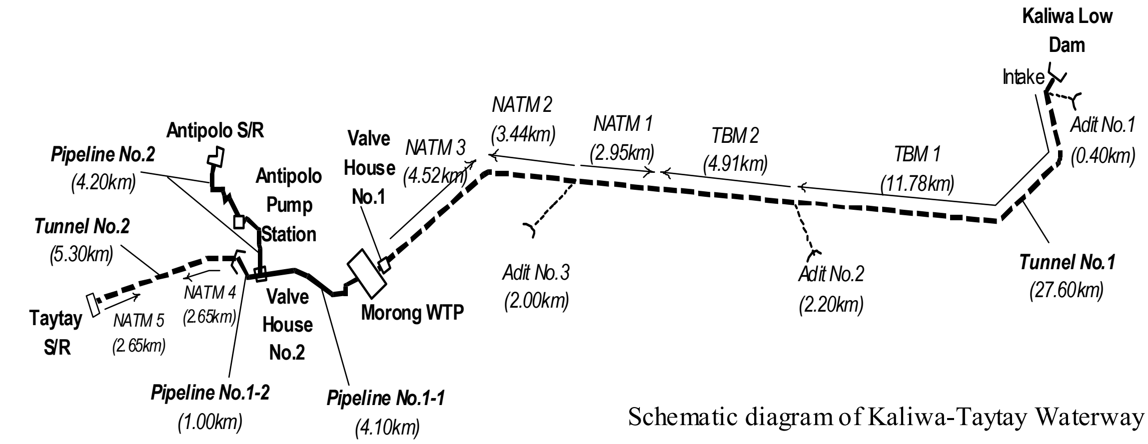
G1 General Layout of Kaliwa-Taytay Waterway

The Kaliwa-Taytay Waterway connects the Kaliwa Intake Structure to be provided on the right bank of the Kaliwa River where the Kaliwa Low Dam is provided, and the service reservoir at Taytay (Taytay Service Reservoir) as shown in the following schematic diagram:



Schematic diagram of Kaliwa-Taytay Waterway

The trunk waterway route of the Kliwa-Taytay Waterway connecting the Kaliwa Intake Structure and Taytay Service Reservoir is composed mainly of the following facilities:

i) Kaliwa Intake Structure
ii) Tunnel No.1,
iii) Valve House No.1,
iv) Morong WTP,
v) Pipeline No.1-1,
vi) Valve House No.2,
vii) Pipeline No.1-2,
viii) Tunnel No.2, and
ix) Taytay Service Reservoir.

On the above trunk waterway route, a waterway to the Antipolo Service Reservoir diverges therefrom at the Valve House No.2. The waterway to the Antipolo Service Reservoir consists of the following main facilities

a) Pipeline No.2 starting from the Valve House No.2,
b) Antipolo Pump Station,
c) Antipolo Service Reservoir.

As discussed in Annex F of this Volume V, this Study contemplates to realize the proposed Project in two stages, namely Stage 1 Development and Stage 2 Development. The 1st Stage Development comprises construction of the Kaliwa Low Dam and the 1st lane of the Kaliwa-Taytay Waterway, namely Kaliwa-Taytay 1st Waterway. The Stage 2 Development is further divided into the two stages, namely Stage 2-1 and Stage 2-2. The Agos Dam is to be constructed in Stage 2-1 and the Kaliwa 2nd Waterway will be provided in the Stage 2-2.

The staged development plan of main components of the Kaliwa-Taytay Waterway is summarized in Table G1.1. The general layout plan and profile of the Kaliwa-Taytay Waterway are shown in Figure G1.1.

G2 Water Conveyance Facilities

G2.1 Selection of Location and Route of Waterway Facilities

G2.1.1 General

In the initial part of the Feasibility Study Stage in 2002, the field reconnaissance was intensively carried out for the sites of the waterway facilities contemplated in the Master Plan Study stage in 2001 so as to determine the definite layout plan thereof. The initial field reconnaissance conducted at the Feasibility Study stage (Phase II) identified the necessity of several changes in the alignment of waterway facilities for the reasons of topographic and geological conditions observed at the sites. This Section describes the background of determination of location and route of the Kaliwa-Taytay waterway facilities.

G2.1.2 Kaliwa Intake Structure Site

The Kaliwa Intake Structure site was selected on the right bank of the Kaliwa Low Dam site on the Kaliwa River as discussed in Annex F of this Volume V.

G2.1.3 Tunnel No.1 Route

Tunnel route originally proposed was such that it would pass through the middle of chained ridges with a view to having the maximum ground cover depths and also facilitating the layout of access adits as shown in Figure G2.1. During the course of the field investigation, however, it was found that a major fault, considered an active fault ("Assumed Active Fault") by PHILVOLCS, lies at 25 km point and runs almost in parallel with the tunnel route. This has obliged to modify the tunnel route so as to cross the fault at right angle as shown in Figure G2.1. In the case of this modified route, the downstream part of the tunnel has relatively thin ground cover of 50 to 100 m, where the tunnel may encounter complicated geology. However, this could be overcome by use of proper tunneling method.

Note: The fault was originally assumed to occur at 19 km point based on information available in the existing literature. In this case, the originally aligned tunnel crosses the fault at a large angle as shown in Figure G2.1. However, the subsequent interpretation of satellite imagery by the Study Team's Geologist revealed the location of the fault at 25 km point. (See "Annex B- Geological Investigation" of this Volume V for the further detail).

G2.1.4 Valve House No.1 and Lagundi Powerhouse Sites

In the Master Plan Study stage in 2001, a powerhouse was proposed near Abuyod about 2 km northwest from the presently proposed location. In the initial stage of the Feasibility Study in 2002, the powerhouse site was changed to the site at Lagundi due to change of the location of water treatment plant site as discussed in Subsection G2.1.6 below. In the Feasibility Study, however, the Lagundi powerhouse has been finally replaced by the Valve House No.1, since the hydropower development to harness the potential head between the Agos Reservoir and the downstream end of the tunnel No.1 was found to be not economically viable as explained in Annex H of this Volume V.

G2.1.5 Waterway Alignment at Downstream Part of Tunnel No.1

The two alternative waterway routes were conceived for the downstream part of the No.1 Tunnel as shown in Figure G2.1 and below:

- Alternative 1: With Lagundi powerhouse as stated in Subsection G2.1.4 above
- Alternative 2: With Valve House No.1 (without Lagundi powerhouse)

The Lagundi powerhouse has been discarded from the Project at the final stage of the Feasibility Study as mentioned in Subsection G2.1.4 above. Accordingly, the Alternative 2 is selected as the downstream route for the Tunnel No.1.

G2.1.6 Water Treatment Plant (WTP) Site

The WTP site contemplated at the time of the Master Plan Study in 2001 was the area adjacent to the presently proposed area to the north. The Initial field reconnaissance conducted in this Feasibility Study phase revealed that the area has already been occupied by a farm factory project (Coral Farm Co.). This has obliged to shift the WTP area southeast by about 1.5 km as shown in Figure G2.2. Hydraulic head loss calculation revealed the WTP area to be built at EL.90 to 100 m. In view of the size of the WTP requiring as a large area as 100 to 120 ha, the site must be a large area of flat topography. The proposed site in the Feasibility Study is considered to be only the area meeting these topographic requirements.

G2.1.7 Tunnel No.2 Route

In the Master Plan Study Stage, the tunnel was planned to have its inlet at the foot of limestone hill with a view to minimizing the relocation of housings as shown in Figure G2.2. However, the field reconnaissance conducted at the beginning of the Feasibility Study found that the limestone hill was under the final process of authorization for limestone quarrying by an aggregate production company (Island Quarry and Aggregates Corp.).

This necessitated to relocate the inlet site southward. The site so selected was at a valley situated between the limestone hill and Teresa town as shown in Figure G2.2. It was thought that, in general term, the site might not be so favorable from the geological and constructional aspects in view of the valley topography, but there was no other choice.

G2.1.8 Antipolo Pump Station

The pump station is proposed at a location nearer to the Antipolo Service Reservoir in order to reduce the loss head for pumping by a shorter pipeline as shown in Figure G2.2. The site is relatively close to the existing residential area, but the noise during pump operation (electrically driven pumps) is supposed not to be intolerable nuisance to the residents. An alternative site is found at a location of some 200 m north (opposite to a small stream). However, a constraint at this site is the existence of about 15 housings. Hence, the proposed site shown in Figure G2.2 was selected.

G2.1.9 Antipolo Service Reservoir

The selected site is virtually same as that proposed in the MWSP III (Laiban Dam). The site is situated at EL. 260 m, which is almost the highest place in the Antipolo area enabling the supply of water by gravity to most area of Antipolo City.

G2.1.10 Taytay Service Reservoir

The site is at the same location as envisaged in the Master Plan Study stage (2001). A vital requirement for selection of the site was that the area should be situated at around EL.70 m to construct the reservoirs having HWL 72 m and LWL 66 m on a NAMRIA datum basis. Judging from the topographic features and land use conditions in the area, the proposed site is only the area suitable for building the reservoirs meeting this altitude requirement.

G2.2 Preliminary Design of the Water Conveyance and Water Supply Facilities

G2.2.1 Kaliwa Intake Structure

In the Stage 1 Development, the two Kaliwa Intake structures, one for each of the two lanes of waterway, need to be constructed on the right bank of the Kaliwa River as shown in Figure G2.3.

G2.2.2 Tunnel No.1

Two lanes of Tunnel No.1 will be constructed in two stages. The first lane and most upstream 30 m long section of the second lane, and the remaining second lane of Tunnel No.1 will be constructed in the Stage 1 and Stage 2-2 Development, respectively. Plan and profile of the Tunnel No.1 are shown in Figure G2.4. Typical cross sections of the waterway tunnels and pipelines are shown in Figure G2.5.

G2.2.3 Valve House No.1

Three main valves, two for 1st lane of the Tunnel No.1 and remaining one for its by-pass way, are planned to be installed in the Stage 1 Development. In addition, two main valves for 2nd lane of the Tunnel No.1 are planned to be installed in 2nd Stage Development. The preliminary structural design including alignment of required pipes and valves is presented in Figures G2.6.

Four types of valves consisting of high pressure slide gate, jet flow gate, hollow jet valve and sleeve type valve are studied for the comparison to select the appropriate valve type for the waterway. The comparison results are presented in Table G2.1. As a result, the sleeve type valve is selected in consideration of its technical features and because of its lower cost.

G2.2.4 Morong Water Treatment Plant

In the Stage 1 Development, the WTP with the nominal design capacity of 1,820 MLD out of the ultimate 3,640 MLD will be planned in 2 stages, each with 910 MLD, as shown in Figure G2.7. Figure G2.8 gives the flow diagram required to compute and determine the capacity of each process unit in the system. Preliminary design drawings of major facilities (receiving well, flocculation and sedimentation basin, rapid sand filter, clear water reservoir, backwash wastes returning tank, sludge thickening tank, sludge drying bed and administration building) to meet first 910 MLD are presented in Figures G2.9 to G2.22.

The design of unit process needs to be reviewed in the next detailed design stage. As for filter back washing, in particular, air-water back washing may be a subject to be examined as the alternative, taking account of characteristics of filter media (anthracite and sand).

G2.2.5 Pipeline No.1

Two lanes of Pipeline No.1 will be constructed in two stages. The first lane and the second lane of Pipeline No.1 will be constructed in the Stage 1 and Stage 2-2, respectively. Plan and profile of the Pipleline No.1 are shown in Figure G2.23.

G2.2.6 Valve House No.2

The construction of Valve House No.2 is planned to meet the ultimate stage in order to avoid intricate works such as installation of additional pipes and valves as well as troublesome operation of water supply system in expansion of Pipeline No.1 and No.2. The preliminary structural design including alignments of required pipes and valves is presented in Figures G2.24.

G2.2.7 Antipolo Pump Station

As mentioned in Subsection G3.2.3, pump equipment of Antipolo Pump Station is planned to be developed in 3 stages in accordance with water demand growth in the Antipolo area and the structure of sump and pump house will be constructed in 2 stages. Figure G2.25 presents a general layout of the Antipolo Pump Station at the full development stage (Stage 2 Development). The preliminary structural design of pump station for the first stage is presented in Figure G2.26.

G2.2.8 Pipeline No.2

Two lanes of Pipeline No.2 will be constructed in two stages. The plan and profile of the Pipeline No.2 are shown in Figure G2.27.

G2.2.9 Antipolo Service Reservoir

The Antipolo Service Reservoir is planned to be constructed in 3 stages. Figure G2.28 shows a general layout plan of the Antipolo Service Reservoir at the full development stage. The plan and section of the Antipolo Service Reservoir are presented in Figures G2.29 and G2.30, respectively.

G2.2.10 Tunnel No.2

Two lanes of Tunnel No.2 will be constructed in two stages. The plan and profile of the Tunnel No.2 are shown in Figure G2.31.

G2.2.11 Taytay Service Reservoir

The Taytay Service Reservoir is planned to be constructed in 4 stages with a total effective storage capacity of 720,000 m^3 at the ultimate stage (180,000 m^3 x 4=72,000 m^3). Figure G2.32 shows a general layout plan of the Taytay Service

Reservoir at the full stage development. The plan and section of the Taytay Service Reservoir for the first 180,000 m^3 in effective storage volume are presented in Figures G2.33 and G2.34, respectively.

G3 Water Supply Plan for Metro Manila

G3.1 Matters to be Considered in Water Supply Plan

G3.1.1 Suppressed Water Demand

Although there is no change in projected water demand of the Master Plan Study (M/P) in 2001, it is anticipated that the demand-supply balance will still continue critical under the conditions of insufficient scale of water source development in the interim schemes and uncertainty of implementation of the projects including Laiban Dam until water source from the Agos River Basin becomes available. Since it is assumed that growth of water demand may be delayed, in this connection, the suppressed water demand was examined for reference as explained below. Described are service area of water supply for Metro Manila, methodology of water demand projection in the M/P and the conceivable suppressed water demand.

(1) Service area of water supply for Metro Manila

The targeted service area of water supply for Metro Manila is defined to be as same as cities/municipalities stipulated in the Concession Agreement. Thus, Rizal towns presently not being supplied by the Concessionaires are included therein. These are Angono, Baras, Binangonan, Cardona, Jala-Jala, Morong, Pililla, Tanay and Teresa.

(2) Methodology of water demand projection in M/P

Water demand was projected by such water use sector as domestic, commercial and industrial ones by city and municipality of the service area.

1) Domestic water

As for assumption of per capita consumption, the JICA master plan (1995) was basically adopted with some modification referring to the latest figures obtained during the course of this Study. The future population by city/municipality was projected in this Study as follows and the target service coverage was determined referring to the Concession Agreement.

Domestic water by city/municipality = (Per capita consumption) x (Future population) x (Service coverage)

2) Commercial water

The total water volume of commercial water was assumed by using correlation between past record of commercial water and GRDP and distributed to respective city/municipality based on the ratio of current composition of commercial water to the total billed water of concerned city/municipality.

3) Industrial water

The demand was estimated by the same manner as adopted for the estimate of commercial water demand. Recycling ratio which was proposed in the JICA master plan (Water Resources Management in the Philippines, 1998) was also considered to project total water volume of industrial water.

4) Non-Revenue Water (NRW)

The NRW ratios were assumed to be improved from the present 61% to 30% in the target year of 2025. The bases for assuming the NRW ratios are actual performance of previous rehabilitation projects, various study reports, NRW reduction plans of the Concessionaires and comparison of the NRW ratios of other cities in Asia.

5) Peak factor

The peak factor used in the previous study (MWSP III) was adopted, where the maximum daily water demand/Average daily water demand is 1.21.

(3) Conceivable suppressed water demand

The conceivable factors for holding back water demand growth are delay of improving water service level including water availability as well as achieving target service coverage. In projecting the suppressed water demand, on the other hand, it is assumed that unit consumption by the water use sector will not be changed from those in the Master Plan, since they are related to GRDP. Likewise, available water produced from the improvement of NRW will not be a factor to suppress water demand, since it will be directly counted as the billed water. The conceivable situation of holding back of water demand growth in each 5-year period is assumed as presented below.

1) Year 2001 - 2005

Due to limitation of water source, it is rather difficult to expand water supply. Thus, only the existing service coverage is maintained as a whole. Specially, it covers areas of Taguig, Pasig, Paranaque, Muntinlupa, Las Pinas, Cainta, Taytay, Cavite, Bacoor, Imus, Kawit, Noveleta, Rosario, Rodrigues and San Mateo, where low water pressure and/or intermittent water supply are experienced. Therefore, water availability is considered not to be improved. In these areas, water supply is assumed to decrease by 10% as compared with the current situation.

2) Year 2006 - 2010

Generally, service coverage by city/municipality is assumed to be still 5 years behind the schedule assumed in the Master Plan. However, service coverage in the areas such as Las Pinas, Muntinlupa, Paranaque, Bacoor and Rosario may be improved moderately with the 300 MLD Laguna project if implemented.

3) Year 2011 - 2015

Due to commencement of water supply from the Agos River Basin, service coverage in the municipalities such as Taguig, Cainta and Taytay, where distribution trunk main from the proposed Taytay Service Reservoir passes through, may be improved. However, service coverage of other cities/municipalities is assumed to be still 5 years behind that assumed in the Master Plan. Particularly, bulk water supply for towns in the Rizal Province is assumed to be deferred.

Based on the above assumptions, service coverage and the suppressed water demand by city/municipality are assumed as shown in Tables G3.1 and G3.2, respectively. The table below summarizes the comparison between water demand growth projected in the Mater Plan and the suppressed case examined herein. The water volume of 300 to 500 MLD is assumed to be held back in the medium term.

Comparison of Water Demand Growth (Maximum daily base)

Year	2000	2005	2010	2015	2020	2025
Water Demand in M/P	4,090	4,577	5,143	6,090	7,097	8,446
Suppressed Water Demand	4,090	4,140	4,640	5,760	7,097	8,446
Difference	-	440	500	330	-	-

In the water supply plan for Metro Manila, growth of service coverage and improvement of water availability will be held back. The commencement of bulk water supply for towns in the Rizal Province, in particular, will be delayed.

G3.1.2 Water Distribution System for the Farthest Areas

This Study defines that the Taytay Service Reservoir is an off-take point for delivering water to the two Concessionaires. The Taytay Service Reservoir is a base facility to distribute water to main service areas of Metro Manila such as the southwestern part (Cavite area), southern part (Muntinlupa area) and southeastern part (Rizal area) and staged expansion of the reservoir is planned according to increase of water demand. However, taking account of hydraulic condition to supply to the farthest part of Cavite and Muntinlupa area, the construction of an additional service reservoir at an appropriate site will be an alternative in order to maintain properly the difference of water pressure in peak flow and night flow in the said service areas in the long term. The proposed site of the reservoir will be at an elevated area in Muntinlupa, about 45 m in ground elevation. As for storage capacity, some 130,000 m^3 of effective volume will be recommended considering the combined operation with the proposed Taytay Service Reservoir.

G3.1.3 Water Supply for in Rizal Province Towns

With regard to water and sewerage systems in the Province of Rizal, MWSS Memorandum Circular No. 010-92, which prescribes the guideline for the takeover of MWSS of the water supply systems in the Province of Rizal, MWSS may not inhibit the LWUA from developing and operating water and sewerage systems in the Province of Rizal as long as waiver is secured from MWSS.

The Water Districts (WD) of the municipalities organized “Rizal Water Districts Association (RIZWADA)”.

Since 1994, MWSS recognized the rights of RIZWADA and its member local water districts to remain and continue as independent-locally controlled water districts that will have direct control, supervision, administration and management of the operation of the waterworks and sewerage systems within their respective municipalities and territorial boundaries.

On August 1, 1997, MWCI, as contractor/concessionaire, took over the management and operation of the water supply and sewerage facilities in the

Service Area East which includes, among others, the municipalities covered by RIZWADA, pursuant to the Concession Agreement executed by and between MWSS and MWCI.

MWCI has made known to the RIZWADA that, as MWSS contractor and concessionaire for the service area, it will perform its functions as contractor and exercise its rights as agent to manage and operate the water supply and sewerage facilities of the service area, including the right to bill and collect for water services supplied therein.

On November 6, 1996, the RIZWADA passed the Resolution expressing its decision to remain as independent, and locally controlled water districts that manage and operate the waterworks and sewerage systems within their respective municipalities.

The parties cognizant of foregoing premises and of the aforesaid laws, agreements and resolutions, agree that MWCI will recognize and honor past agreements with the MWSS and the water districts represented by the RIZWADA to continue to manage and operate their respective waterworks and sewerage system, subject to the exclusive rights of MWCI under the MWSS-MWCI Concession Agreement to provide bulk water, sewer and sanitation services, through the RIZWADA and its member local water districts, to the municipalities covered by the RIZWADA once the Laiban Dam Project and/or other similar source of water supply become available and are implemented by MWSS.

G3.1.4 Water Supply for Antipolo Area

Considering the water demand projection in the Antipolo area as well as the Antipolo Water Supply Project (Phase II, 120 MLD from Balara WTP) which is planned to be completed in 2006, the required water supply from the Project is estimated to be 43 MLD in 2010 and 680 MLD in 2025. The water demand projection made in this Study reveals that the water demand of Antipolo area will increase rapidly between year 2020 and 2025 so that the projected water demand in 2025 becomes almost double of that in 2020. On the other hand, in projecting the alternative water demand using projected population in low case, the maximum daily water demand in 2025 was assumed to decrease to 575.5 MLD, which corresponds to 70% of original water demand (824.0 MLD). Thus, the actual water supply program for the Antipolo area is subject to alteration based on the actual growth of water demand.

With regard to water supply to Antipolo area, it is fact that cost of pumping operation will affect the water tariff to a certain extent. As for the power cost, for instance, 4.17 Pesos/m^3 is estimated for the proposed Antipolo Pump Station (Pump unit: 0.99 m^3/min x 205m head x 2,500 kWh) by adopting the MERALCO's current unit price of 5.0 Pesos/kWh. While, 3.30 Pesos/m^3 is estimated for pump station under Laiban Dam Project (Pump unit: 1.1 m^3/min x 155 m Head x 2,200 kWH), which is lower by 0.87 Pesos/m^3 (or 20%) as compared with that in the proposed pump station in the Study. However, the water supply to Antipolo (680 MLD in

2025) is only a part of the total supply (3,000 MLD in 2025), about 22 %, which will reduce the influence to the overall tariff rate.

G3.2 General Features of Proposed Water Supply Facilities

G3.2.1 Minimizing Water Use at Morong WTP

To determine the design capacity of the water treatment facilities, water loss within the yard of water treatment plant is planned to be as minimal as possible. Wash water from the filters is planned to be returned to receiving well, and sludge from sedimentation basin is thickened and supernatant water also returned to receiving well through backwash wastes returning tank.

Under the above condition, the required water and discharge volume in water treatment process were assumed as shown in Table G3.3. Total volume of water loss at plant arrives at only 0.76 MLD or 0.08 % out of assumed intake water volume, which consists of thickened sludge (0.36 MLD or 0.04 %), office/laboratory use (0.04 MLD or 0.004 %) and occasional tank cleaning (0.36 MLD or 0.04 %). Since the total water loss is estimated to be quite small at 0.76 MLD, the design capacity for each unit of water treatment plant is adopted to be 910 MLD that is same as the unit capacity for the maximum daily demand.

G3.2.2 Design Criteria of JWWA and AWWA

The design of unit process was prepared referring to the Japan Waterworks Association (JWWA) “Design Standard of Water Supply Facility” and/or American Waterworks Association (AWWA) “Water Treatment Plant Design, Third Edition” that are shown in Table G3.4.

G3.2.3 Staged Development Plan of Water Supply for Antipolo Area

To avoid the excessive initial investment for the Antipolo Pump Station, the pump station including sump and pump house is planned to be constructed in 2 stages to meet the ultimate supply volume, and a total of ten (10) pump units including 2 stand-by units to be installed in 3 stages in accordance with water demand increase. Thus, the 1st pump house to be constructed at the initial stage will accommodate the number of pump units to meet the water demand up to year 2020. The construction of 2nd pump house will be needed after year 2020. The service reservoir with a capacity of 30,000 m^3 will be enough to meet the water demand until year 2015, and additional two units (30,000 m^3 x 2) and other three units (30,000 m^3 x 3) are required to meet rapid increase of water demand growth up to 2020 and 2025, respectively.

G3.2.4 Storage Capacity of Taytay Service Reservoir

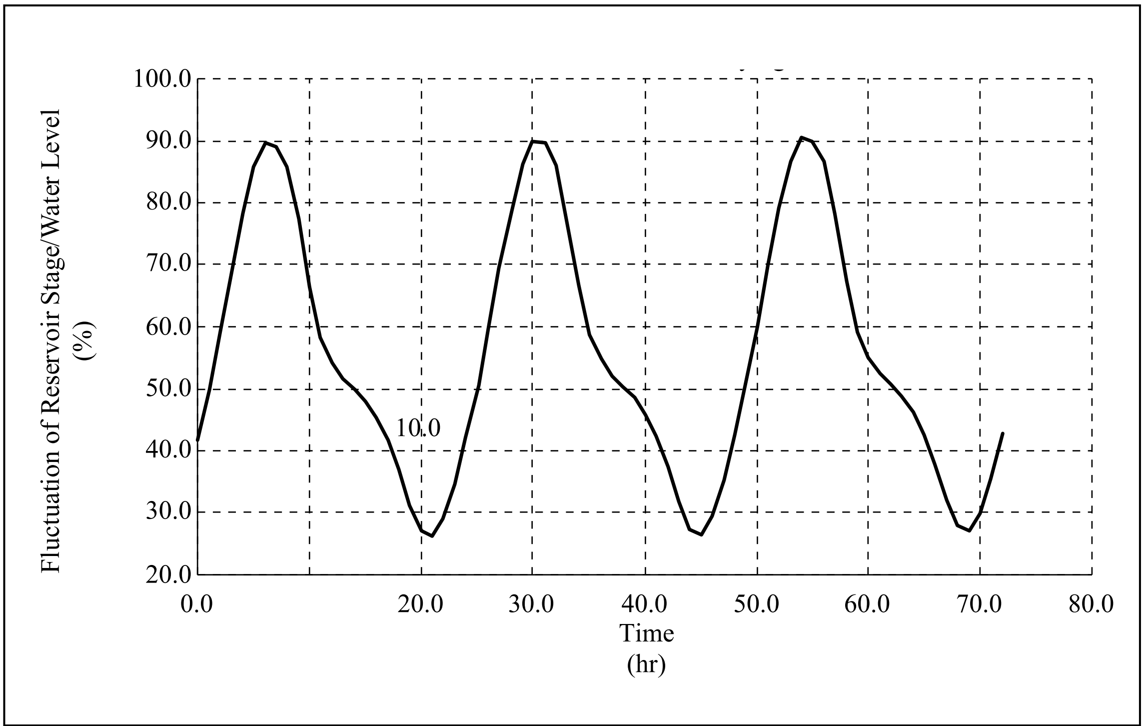
It is desirable that the reservoir has a larger water storage capacity to ensure the stable water supply in case of stoppage of water supply from the upstream facilities. On the other hand, the determination of the reservoir capacity shall also take into account the topographic and geological conditions of the site, available space for construction thereof, as well as the magnitude of increase of water demand in the service area. In determining the storage capacity, the following matters were taken into consideration:

(i) Storage capacity of the existing service reservoirs

The total storage capacity of the existing service reservoirs in Metro Manila is 740,000 m^3, while the production capacity of existing water treatment plants is 4,000,000 m^3/day (4,000 MLD). The total storage capacity of the existing service reservoirs is roughly estimated to be equivalent to 4.4-hour supply volume of the maximum daily water demand, although some of them are not fully filled with water due to lack of proper operation of water supply. On the other hand, the "MWSS design standards for Water Supply" specifies the service reservoir to have a capacity equivalent to a half-day supply volume.

(ii) Simulation of storage capacity

The storage capacity of the proposed service reservoir was simulated taking account of hourly fluctuation of water demand. As a result, a storage capacity equivalent to 6-hour supply volume of the maximum daily water demand would ensure the stable water supply as shown in the figure below:



Thus, the effective volume of the Taytay Service Reservoir is proposed to be 720,000 m^3 at the ultimate stage. The Taytay Service Reservoir will be developed in 4 stages with 180,000 m^3 each in accordance with the expantion of the Morong water treatment plant.

G3.2.5 Factors to be Considered in Determining the Water Rate

Other than the factors of the project construction cost and financial return (Return on Equity (ROE) in the financial analysis in Chapter XII of Volume IV), another factor to be considered in determining the water rates is the quantity of water actually supplied from the Project. For instance, during the initial period after the project is commissioned, the quantity of water supplied from the Project may remain at a lower level as compared with the full supply capacity of the Project completed at each stage. This aspect should be taken into consideration in the agreement of water rates to be discussed among MWSS, BOTw proponent and the existing concessionaires.

The concept of the ‘minimum take-off’ is not incorporated in the present Study, on an understanding that the projection of water demand can be made with certain accuracy and hence there would be no major risk in the aspect of saleable water quantity. The water rate could be agreed among the concerned bodies based on cashflow analysis incorporating the projected supply quantity and the agreed rate of ROE.

The Study considers that, in the case of Stage 1 and 2-1 projects, the quantity of water supply by the Project will grow rapidly since the staged projects are commissioned under a demand-suppressed condition (see Figure 11.7 of Volume IV). In this case, the issue of ‘minimum take-off’will not be a major subject of arguments.

The concept of ‘minimum take-off’, if it were to be introduced at the request of the Concessionaires, would be a subject of discussion among the concerned bodies. In case the concept is introduced, a specific agreement on this subject will be required.

The other factor influencing the water rates is the difference in water cost at each stage of the Project. The Study contemplates that, subject to the consent of MWSS, a higher water rate is to be assumed during the initial period when only the Stage 1 project is commissioned. For example, water rate at Service Reservoirs is assessed as Peso 17.7/m3 at the Stage 1 (550-750 MLD), which is higher than the rate at ultimate stage estimated as Peso 15.9/m3 for supply of 3,000 MLD (see Section 12.3 and 12.4 of Volume IV). This aspect will also have to be discussed in determining the water rates at each stage of the project.

Tables

Table G1.1 Staged Development Plan of Main Components of Waterway Facilities

Name of Facility	1st Stage	2nd Stage		Total
		Stage 2-1	Stage 2-2	
1. Water Resources Facility and Hydropower Facility in the Agos Basin				
(1) Kaliwa Low Dam	Fully constructed.	-	-	-
(2) Agos Dam	-	Fully constructed.	-	-
(3) Agos Powerstation	-	Fully constructed.	-	-
2. Kaliwa Taytay 1st Waterway Facility				
(1) Kaliwa Intake Structure[1]	1st intake structure	-	-	
(2) Tunnel No.1[2]	1st lane	-	2nd lane	2 lanes
(3) Valve House No.1 (main valve)	3 valves	-	2 valves	5 valves
(4) Morong Water Treatment Plant	1st unit	2nd unit	3rd and 4th unit	4 units
(5) Pipeline No.1	1st lane	-	2nd lane	2 lanes
(6) Valve House No.2 (main valve)	2 valves	-	2 valves	4 valves
(7) Pipeline No.2	1st lane	-	2nd lane	2 lanes
(8) Antipolo Pump Station	2 pump units	-	8 pump units	10 units
(9) Antipolo Service Reservoir	1st unit	2nd and 3rd unit	4th and 6th unit	6 units
(10) Tunnel No.2	1st lane	-	2nd lane	2 lanes
(11) Taytay Service Reservoir	1st unit	2nd unit	3rd and 4th unit	4 units

Note: 1) 1st intake structure and civil works for 2nd one
2) 1st lane and most upstream 30 m long section for the 2nd lane

Table G2.1 Comparison of Valve Type for Main Valve in Valve House No.1

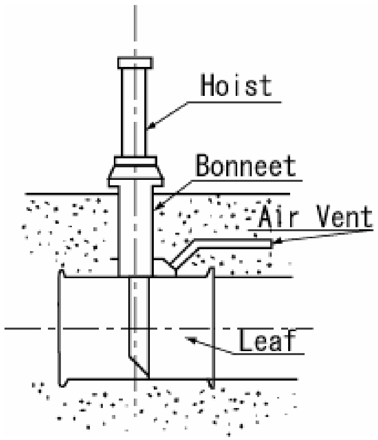
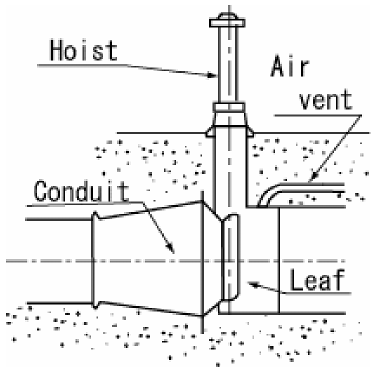
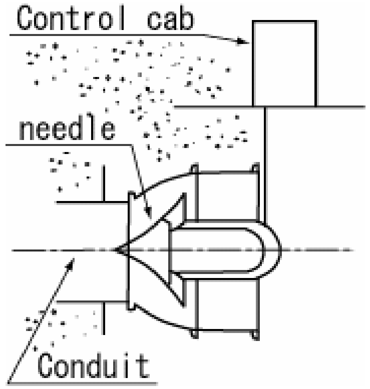
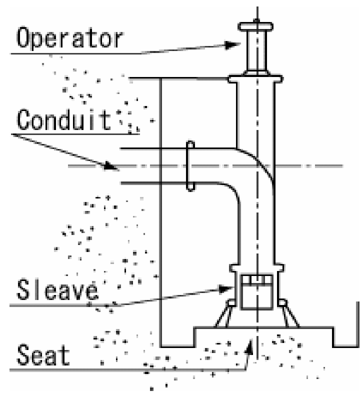
Items	High Pressure Slide Gate	Jet Flow Gate	Hollow Jet Valve	Sleeve Type Valve
General Construction				
Discharge Coefficient	0.94～0.97	0.80～0.85	0.80～0.85	0.73
Maximum Head (m)	150	150	300	120
Minimum Opening	50% of gate lip thickness	5%	5%	5%
Maximum Flow Velocity (m/s)	no limit	no limit	no limit	less than 6.0
Energy Stilling Effect	need stilling basin	need stilling basin	need stilling basin	need stilling shaft
Noise	Air discharge : big Water discharge: small	Air discharge : big Water discharge: small	Air discharge : big Water discharge: not applicable	Air discharge : not applicable Water discharge: no noise
Operation Motor Output	big	big	big	small
Fabrication limit (mm)	3,000 x 6,000	2,500	3,000	2,000
Cost	1.1	1.1	1.0	0.9

Table G3.1 Assumed Service Coverage in Case of Suppressed Water Demand

City/Municipality		Proposed Service Coverage					
		2000	2005	2010	2015	2020	2025
(West Zone)							
NCR	Pasay	83%	83%	72%	77%	91%	100%
	Callocan	52%	52%	55%	60%	85%	100%
	Las Pinas	15%	15%	36%	91%	95%	98%
	Malabon	85%	85%	91%	96%	97%	100%
	Valenzuela	66%	66%	80%	85%	93%	100%
	Montinlupa	4%	4%	29%	86%	90%	95%
	Navotas	72%	72%	74%	79%	91%	100%
	Paranaque	52%	52%	64%	100%	100%	100%
Cavite	Cavite City	82%	82%	100%	100%	100%	100%
	Bacoor	16%	16%	37%	90%	93%	95%
	Imus	6%	6%	36%	61%	65%	72%
	Kawit	75%	75%	93%	98%	98%	100%
	Noveleta	28%	28%	52%	57%	84%	100%
	Rosario	24%	24%	50%	80%	77%	90%
(East Zone)							
NCR	Mandaluyong	100%	100%	100%	100%	100%	100%
	Marukina	100%	100%	100%	100%	100%	100%
	Pasig	100%	100%	100%	100%	100%	100%
	Pateros	100%	100%	100%	100%	100%	100%
	San Juan	100%	100%	100%	100%	100%	100%
	Taguig	21%	21%	25%	53%	75%	100%
RIZAL	Antipolo	15%	15%	20%	25%	71%	97%
	Cainta	30%	30%	34%	52%	64%	79%
	Angono					67%	100%
	Baras					39%	58%
	Binangonan					58%	87%
	Cardona					39%	58%
	Jala-Jala					39%	58%
	Morong					39%	58%
	Pililla					39%	58%
	Rodoriguez	22%	22%	34%	39%	77%	98%
	San Mateo	24%	24%	41%	46%	80%	100%
	Tanay					51%	76%
	Taytay	21%	21%	33%	38%	78%	100%
	Teresa					41%	61%
(Common Concession Area)							
NCR	Quezon City	100%	100%	100%	100%	100%	100%
	East	100%	100%	100%	100%	100%	100%
	West	100%	100%	100%	100%	100%	100%
	Manila	100%	100%	100%	100%	100%	100%
	East	100%	100%	100%	100%	100%	100%
	West	100%	100%	100%	100%	100%	100%
	Makati	100%	100%	100%	100%	100%	100%
	East	100%	100%	100%	100%	100%	100%
	West	100%	100%	100%	100%	100%	100%
	Total	69%	69%	71%	75%	88%	97%
	East	72%	72%	63%	61%	82%	95%
	West	67%	67%	77%	86%	93%	98%

Table G3.2 Comparison of Water Demand between Master Plan and Suppressed Demand

City/Municipality		2000 (NRW 61%) Max. Daily Demand (MLD)	2005 (NRW 54%) Max. Daily Demand (MLD)			2010 (NRW 48%) Max. Daily Demand (MLD)			2015 (NRW 42%) Max. Daily Demand (MLD)		
			M/P	Suppressed	Difference	M/P	Suppressed	Difference	M/P	Suppressed	Difference
(West Zone)											
NCR	Pasay	116.9	117.6	117.3	0	123	117	-6	131.8	123.5	-8
	Caloocan	259.2	327.2	314.2	-13	371	348	-23	486.5	416.5	-70
	Las Pinas	25.9	119.7	31.1	-89	231	94	-137	296.5	290.2	-6
	Malabon	124.9	154.1	146.4	-8	166	160	-6	178.7	177.0	-2
	Valenzuela	137.8	193.5	168.4	-25	219	209	-10	257.4	246.2	-11
	Muntinlupa	5.2	81.8	6.8	-75	158	53	-104	185.6	181.4	-4
	Navotas	70.7	82.8	81.0	-2	89	85	-4	100.2	94.3	-6
	Paranaque	90.8	151.5	100.4	-51	209	143	-65	240.2	240.2	0
Cavite	Cavite City	29.7	37.3	28.3	-9	35	35	0	34.0	34.0	0
	Bacoor	18.3	72.3	20.4	-52	122	52	-70	139.1	136.1	-3
	Imus	4.1	29.1	4.7	-24	56	33	-22	63.6	61.6	-2
	Kawit	16.9	23.1	17.2	-6	25	24	-1	25.4	25.3	0
	Noveleta	3.2	6.3	3.2	-3	7	6	-1	9.1	7.3	-2
	Rosario	6.5	21.3	6.8	-15	23	15	-8	27.1	26.1	-1
(East Zone)											
NCR	Mandaluyong	243.9	205.3	205.3	0	213	213	0	229.2	229.2	0
	Marikina	204.4	183.2	183.2	0	197	197	0	220.2	220.2	0
	Pasig	244.4	239.4	239.4	0	254	254	0	280.8	280.8	0
	Pateros	20.9	22.0	22.0	0	22	22	0	22.5	22.5	0
	San Juan	103.8	83.9	83.9	0	84	84	0	88.9	88.9	0
	Taguig	34.5	53.8	41.4	-12	75	64	-12	162.1	161.1	-1
Rizal	Antipolo	22.4	48.9	37.7	-11	84	68	-16	226.4	117.6	-109
	Cainta	28.3	42.3	34.1	-8	62	55	-7	106.6	105.9	-1
	Angono	0.0	-	-	0	-	-	0	13.7	0.0	-14
	Baras	0.0	-	-	0	-	-	0	2.3	0.0	-2
	Binangonan	0.0	-	-	0	-	-	0	25.7	0.0	-26
	Cardona	0.0	-	-	0	-	-	0	3.0	0.0	-3
	Jala-Jala	0.0	-	-	0	-	-	0	2.0	0.0	-2
	Morong	0.0	-	-	0	-	-	0	3.0	0.0	-3
	Pililla	0.0	-	-	0	-	-	0	3.7	0.0	-4
	Rodoriguez	10.1	16.1	9.8	-6	19	17	-2	32.3	22.1	-10
	San Mateo	13.0	23.4	13.2	-10	28	25	-3	44.5	32.7	-12
	Tanay	0.0	-	0.0	0	-	0	0	9.3	0.0	-9
	Taytay	16.2	27.2	10.8	-16	33	29	-4	56.6	37.7	-19
	Teresa	0.0	-	-	0	-	-	0	2.7	0.0	-3
(Common Concession Area)											
NCR	Quezon City	1,076.6	1,087.6	1,087.6	0	1,127	1,127	0	1,227.3	1,227.3	0
	East	569.2	544.1	544.1	0	566	566	0	617.9	617.9	0
	West	507.3	543.5	543.5	0	561	561	0	609.4	609.4	0
	Manila	804.6	800.1	800.1	0	775	775	0	792.2	792.2	0
	East	123.7	116.8	116.8	0	115	115	0	119.9	119.9	0
	West	680.9	683.3	683.3	0	659	659	0	672.2	672.2	0
	Makati	357.0	326.8	326.8	0	337	337	0	359.1	359.1	0
	East	315.3	291.5	291.5	0	301	301	0	320.7	320.7	0
	West	41.7	35.3	35.3	0	36	36	0	38.4	38.4	0
(Total Service Area)											
	Total	4,090.0	4,577.6	4,141.6	-436	5,144	4,642	-502	6,089.3	5,757.1	-332
	East	1,950.0	1,897.9	1,833.3	-65	2,054	2,010	-44	2,594.1	2,377.4	-217
	West	2,140.0	2,679.7	2,308.3	-371	3,090	2,631	-458	3,495.2	3,379.6	-116

Table G3.3 Water to be Discharged/Used at WTP*

Type		Purpose of Water Use/Discharge	Water Volume to be Required/Discharged (m3/day)	Use/Loss	Remarks
Routine (Daily use)	Water to be Discharged	(a) Back wash water	26,595	a part of production (by recycling)	to be returned to receiving well, 605m3/unit x 44
		(b) Sedimentation sludge	3,604		99.8% of water content
		1) Sludge to be removed from Thickner	360	loss	96% of water content
		2) Supernant water to be returned	3,244	a part of production (by recycling)	to be returned to backwash water storage
	Water to be consumed	(c) Chemicals (for dilution, dosing)			
		1) Lime solution (10%)	28	a part of production	Lime 2,760 kg/d x 10
		2) Chlorine feeding	1,037	a part of production	Feeder:120kg/h, required water: 720 L/min (ref. JWWA design criteria)
		(d) Office+Laboratory	40	loss	Ofiice space 2,000m2 X 0.2 person x 60-100L/person (ref. JWWA design criteria)
Occasion		(e) Tank flushing/cleaning	360	loss	20-30m3/h x 6hr (Jet hose) x 2 shifts
Total	(Total required water & Loss)		31,664 3.44%		
		(Breakdown) 1) a part of production (c)	1,065 0.12%	Use	
		2) a part of production (recycling a+b_2)	29,839 3.24%	Use	
		3) Loss (b_1+d+e)	760 0.08%	Loss	

Note: 910,000 m3 + 760 m3 = 910,760 m3 = 910 MLD

*Condition

Intake water volume	920,000 m3/d	(910,000m3/d x 1.01)
Ave. turbiduty	10 NTU	
Chemicals		
PAC	15mg/L	
Lime	3mg/L	
Chlorine	4mg/L	Pre & post chlorine
Filter backwashing	once a day	44 filters

Table G3.4   Design Criteria of JWWA and AWWA (1/2)

DESCRIPTION	UNIT	Japan JWWA *)	U.S.A. AWWA **)
RECEIVING WELL			
Retention Time	min.	> 1.5	
Depth	m	3.0 to 5.0	
FLASH MIXING			
1) Mechanical Mixing			
Retention Time		1 to 5 min.	10sec to 1 min
Speed		Peripheral (>1.5 m/s)	
2) Hydraulic Mixing			
Retention Time			
G Value	s^{-1}		600 to 1,000
GT value			
Velocity of Flow	m/s		
Head Loss	m		
FLOCCULATION			
G Value	s^{-1}	10 to 75	20 to 70
GT value		23,000 to 210,000	30,000 to 75,000
1) Mechanical Mixing			
Retention Time	min.	20 to 40	18 to 25
Velocity of Flow	cm/s		
No. of Stages			
Peripheral Speed	cm/s	15 to 80	30 to 300
2) Baffled Channel			
Retention Time	min.	20 to 40	
Velocity of Flow		ave. 15 to 30	21 to 43
Head Loss	cm		
No. of Stages			
SEDIMENTATION			
1) Horizontal Flow Type			
Retention Time	h		1.5 to 2.0 with clarifier
Length/Width Ratio		3 : 1 to 8 : 1	3:1 to 5:1
Surface Loading	m/h	0.9 to 1.8	1.4 to 2.0
Mean Velocity	m/min.	< 0.4	0.6 to 1.2
Depth	m	3 to 4	4.6 to 4.9
Overflow Rate	m3/m/d	< 500 (350 to 400)	< 250
2) Sludge Contact/Sludge Blanket Type			
Retention Time	h	1.5 to 2.0	2 to 4
Flocculation	min.		> 30
Surface Loading	m/h	2.4 to 3.6	1.2 to 3.7
Overflow Rate	m3/m/d		
Raw Water			
-Turbidity		10 to 1000	Water characteristics are not variable and flow rates are uniform.
-Variation of turbidity & temperature		Small	

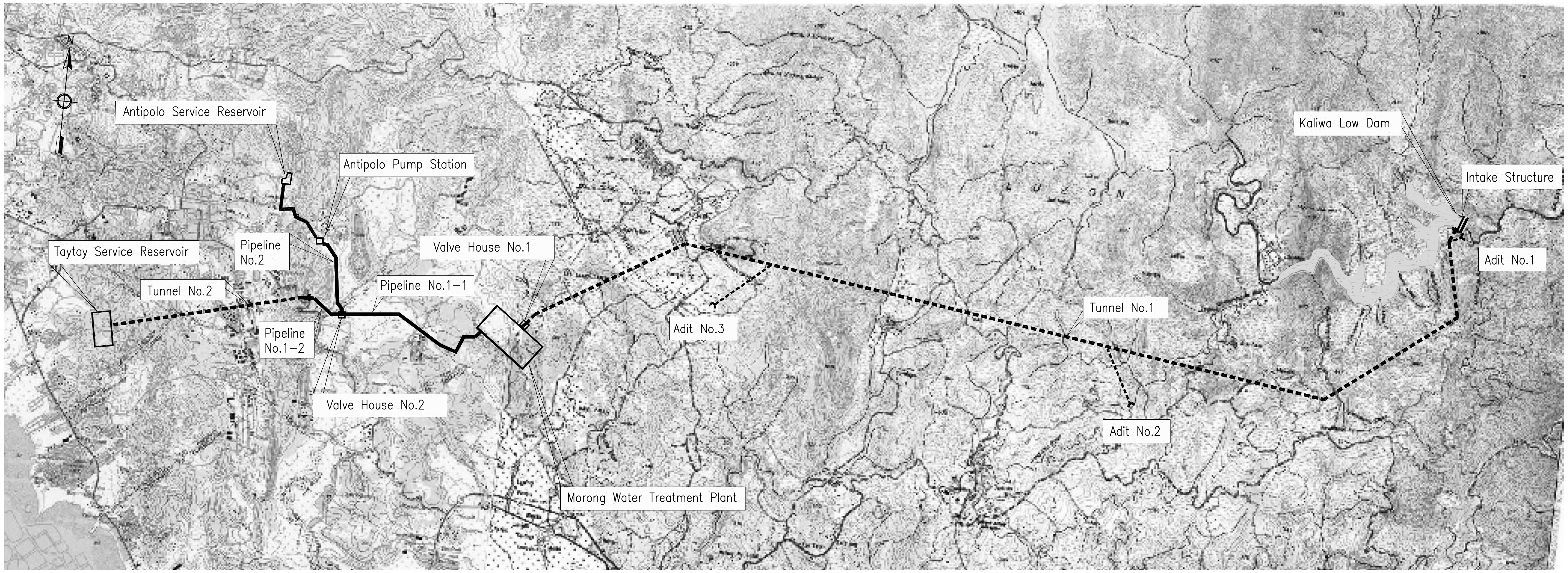
Table G3.4 Design Criteria of JWWA and AWWA (2/2)

DESCRIPTION	UNIT	Japan JWWA *)	U.S.A. AWWA **)
3) Plate/Tube Settler			
Surface Loading of Plate/Tube	m/h	0.24 to 0.54	0.7 to 1.7 for plate (5 to 15 for overall)
Inclination		60 °	
Mean Velocity	m/min.	< 0.6	
Surface Loading of Plate/Tube	m/h	0.42 to 0.84	
Inclination		60 °	
Mean Velocity		<0.08	
FILTRATION			
1) Rapid Sand Filter			
No. of Filter		> 2, 1unit of standby for each 10 units	> 2
Filter Area	m2	< 150	
Filtration Rate	m/d	120 to 150	
Sand			
-Thickness	mm	600 to 700	600 to 760
-Effective Size	mm	0.45 to 0.7 (0.6 to 0.7)	0.45 to 0.55
-Uniformity Coefficient		< 1.7	< 1.65
Gravel Layer			
-Thickness	mm	200 to 500	380 to 600
- Diameter	mm	2 to 30	4.7 to 63
Washing		Backwash + Surface Wash (or Air Scour)	Backwash + Surface Wash (or Air Scour)
Backwash			
- Rate	m/min.	0.6 to 0.9	> 0.6
- Time	min.	4 to 6	> 15
- Pressure	m	1.6 to 3.0	
Surface Wash			
Rotary type of surface wash			
- Rate	m/min.	0.05 to 0.1	0.02 to 0.08
- Time	min.	4 to 6	
- Pressure	m	30 to 40	32
Fixed type of surface wash			
- Rate	m/min.	0.15 to 0.2	0.08 to 0.17
- Time	min.	4 to 6	1 to 3
- Pressure	m	15 to 20	32
Air Scour			
- Rate (+water)	m3/m2/min	0.8 to1.5 (+0.6 to 0.8) 0.8 to 1.0 (+0.3 to 0.5) 0.8 to 1.0 (+0.2 to 0.4 +0.6 to 0.8)	0.3 to 0.6 (+0.2 to 0.3) for deep sand filter 0.6 to 1.5 (+0.6 to 0.9) for double layor
Mechanical Surface Wash			
- Revolution	rpm		

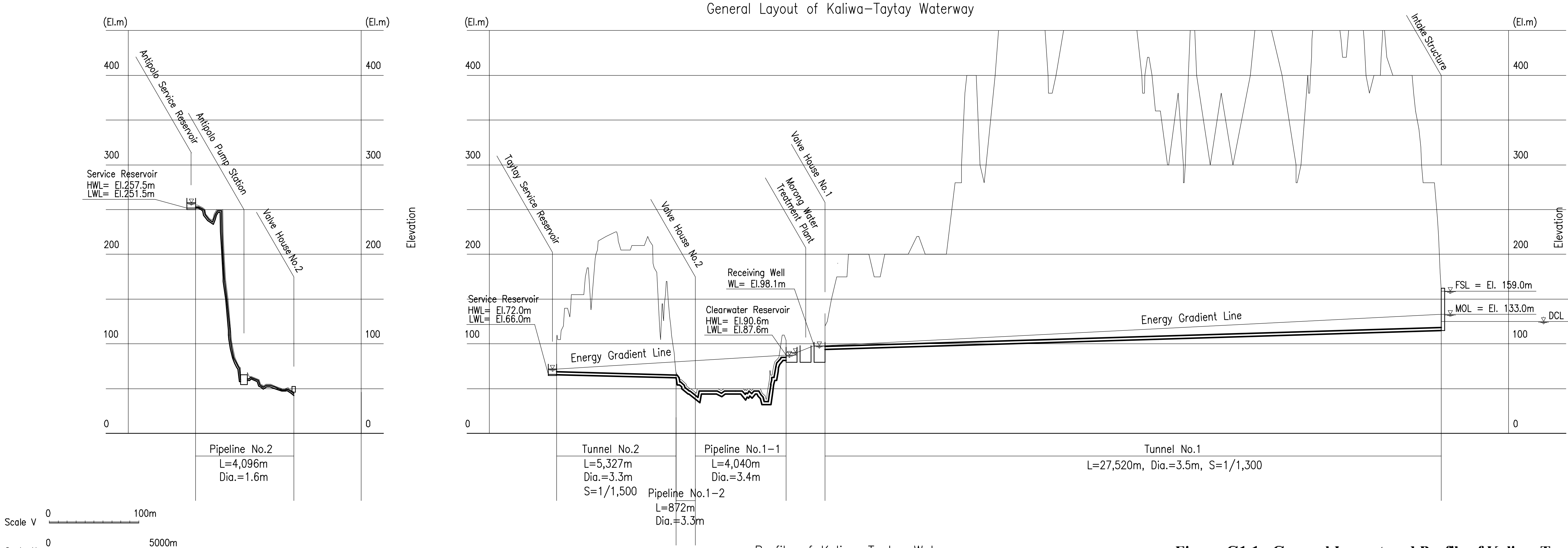
Note : *) JWWA "Design Criteria for Waterworks Facilities, 1990 Edition"

**) "Recommended Standards for Water Works (1982)" prepared by the Greater Lakes-Upper Mississippi River Board of State Sanitary Engineers and refer to AWWA "Water Treatment Plant design, Third Edition"

Figures



General Layout of Kaliwa–Taytay Waterway



Profile of Kaliwa–Taytay Watyerway

Figure G1.1 General Layout and Profile of Kaliwa-Taytay Waterway

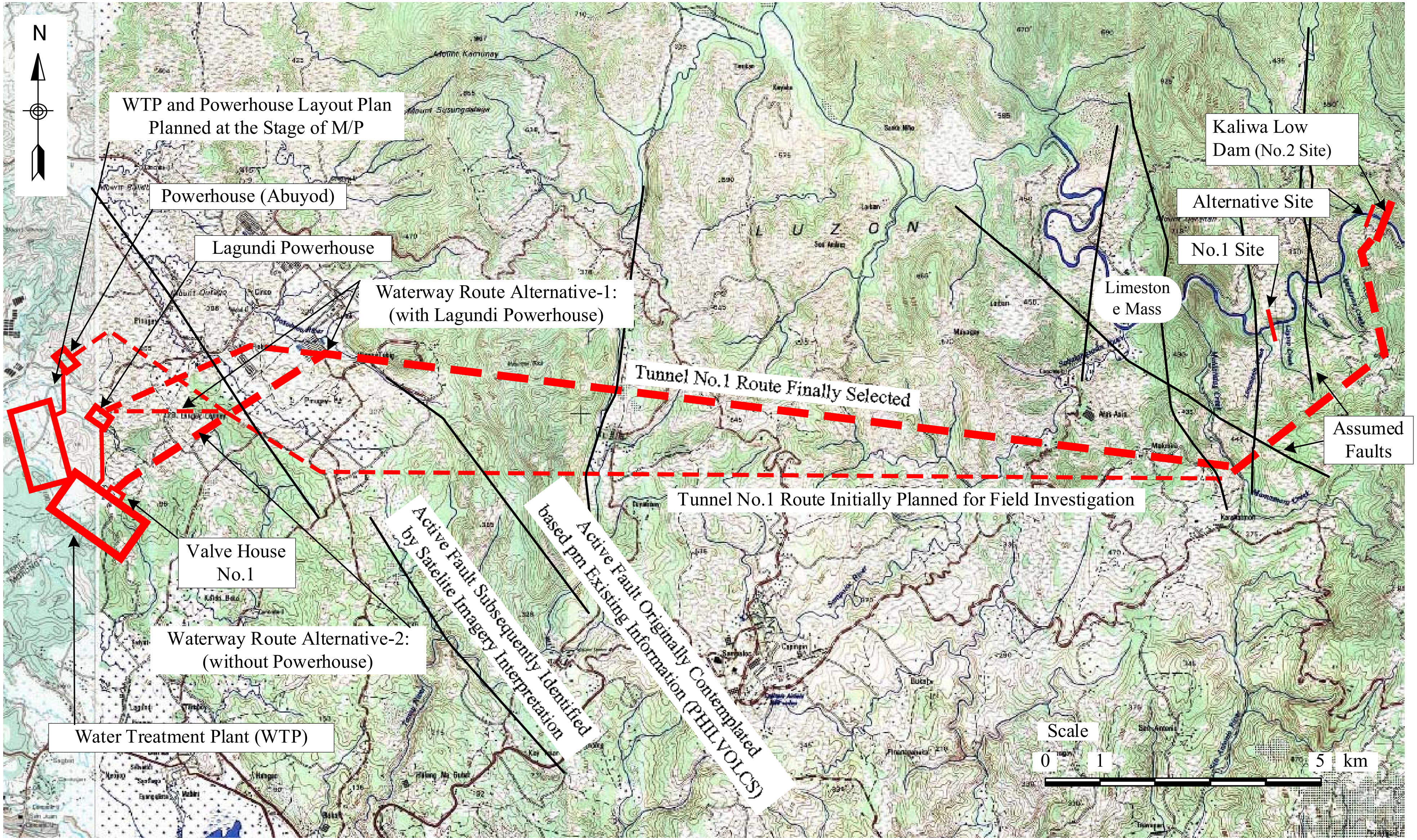


Figure G2.1 Selection of Tunnel No.1 Route

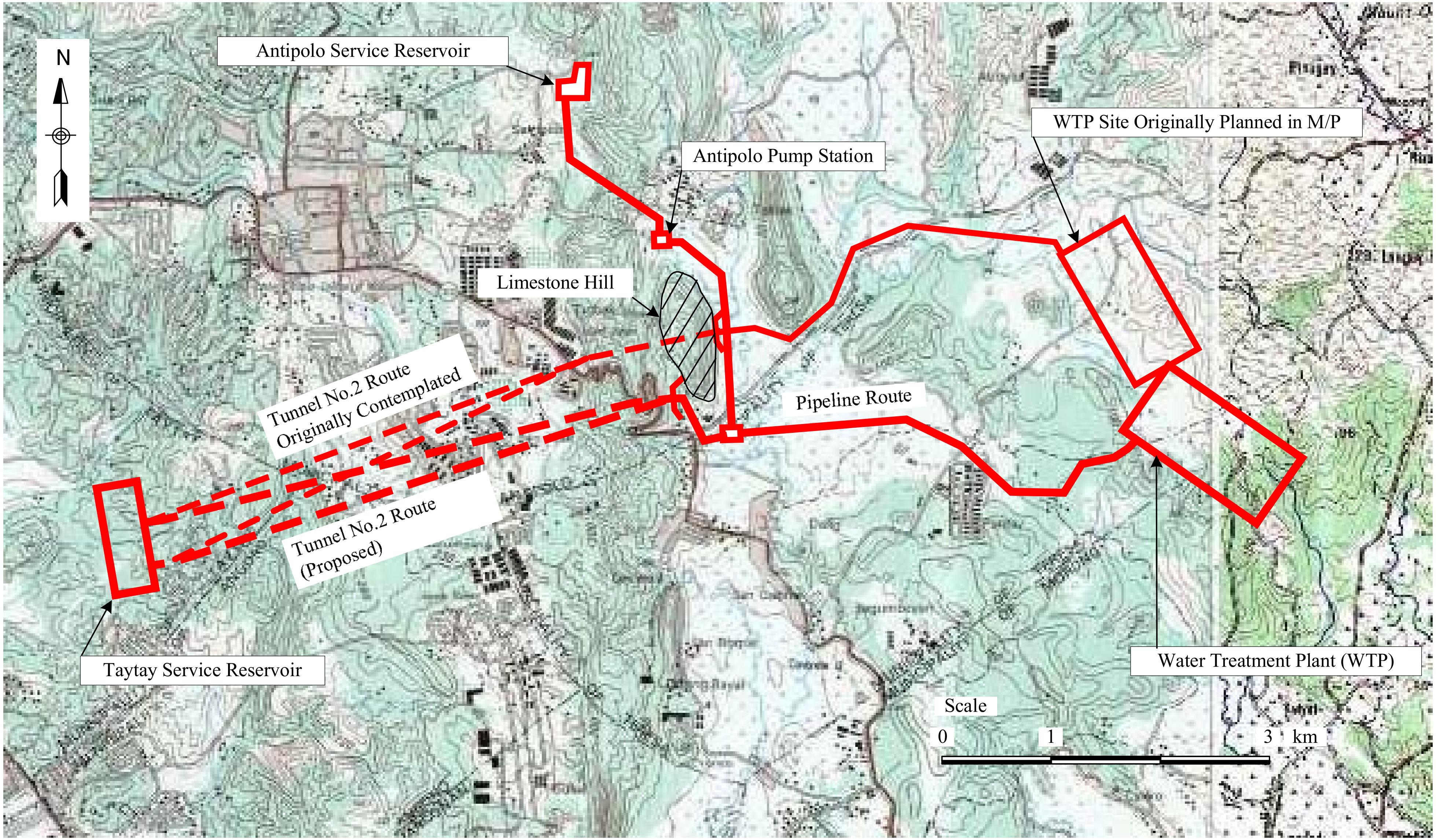


Figure G2.2 Selection of Location and Route of Waterway Facilities