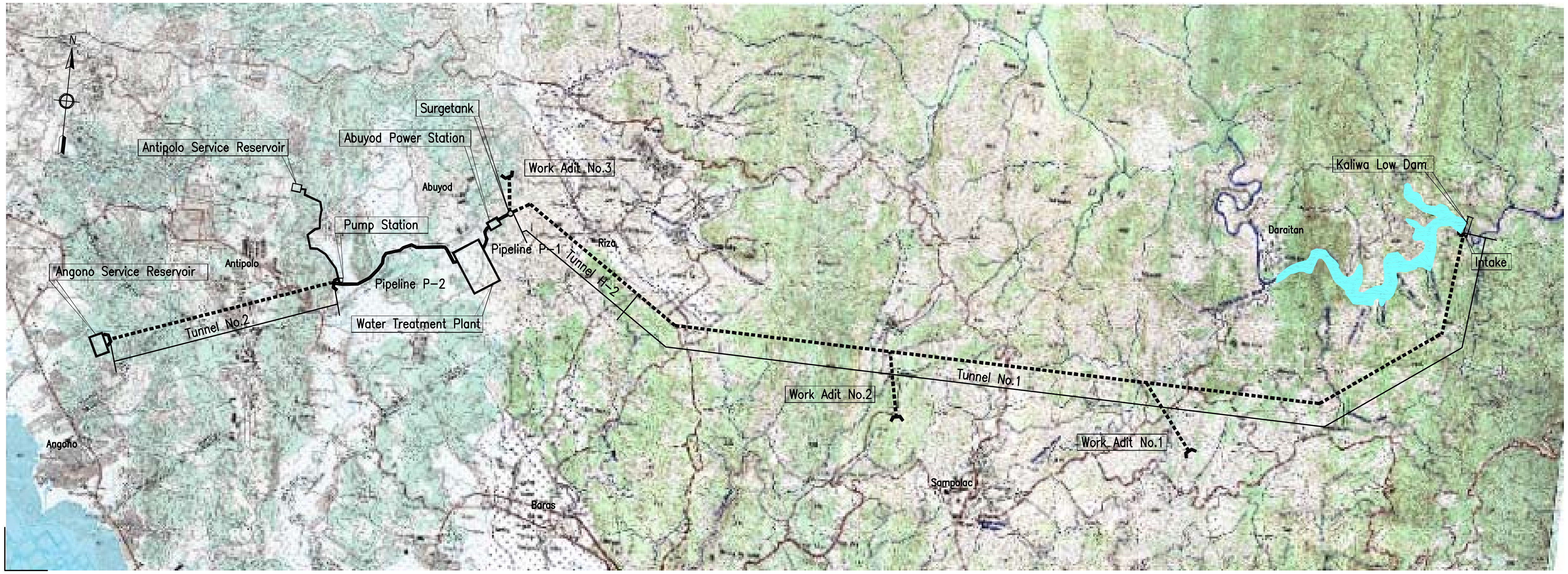
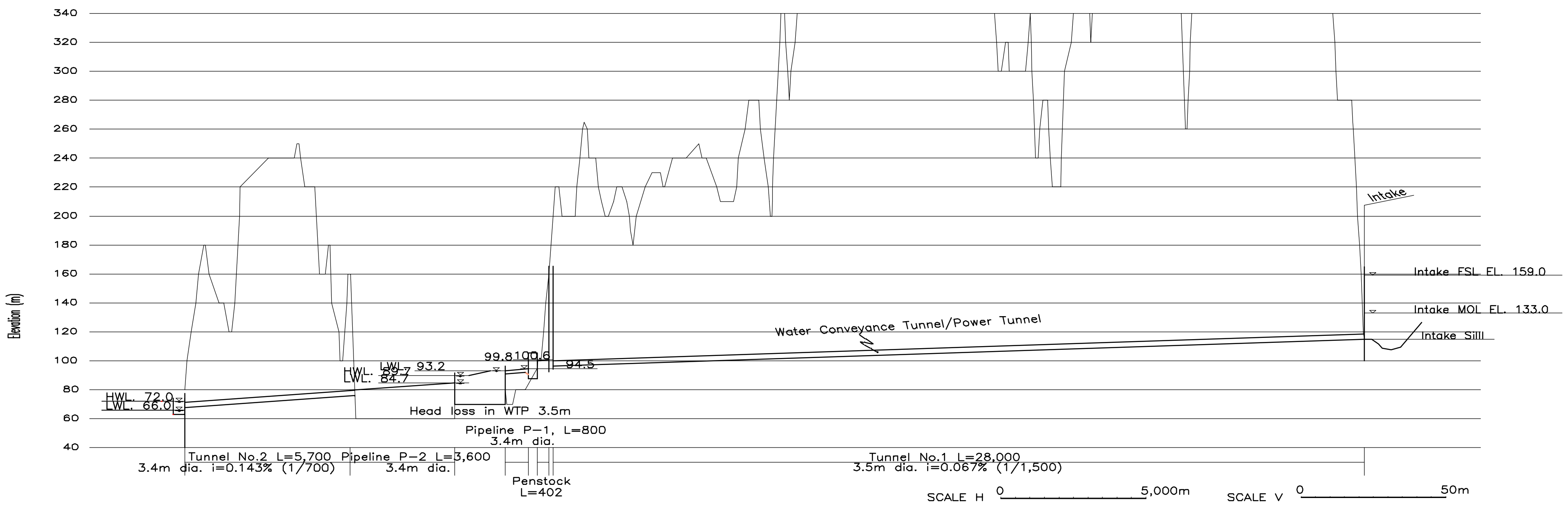


General Layout of Selected Kaliwa–Angono Water Conveyance Route



Profile of Selected Kaliwa–Angono Water Conveyance Route

Figure 6.2 General Layout and Profile of Selected Kaliwa-Angono Water Conveyance Route

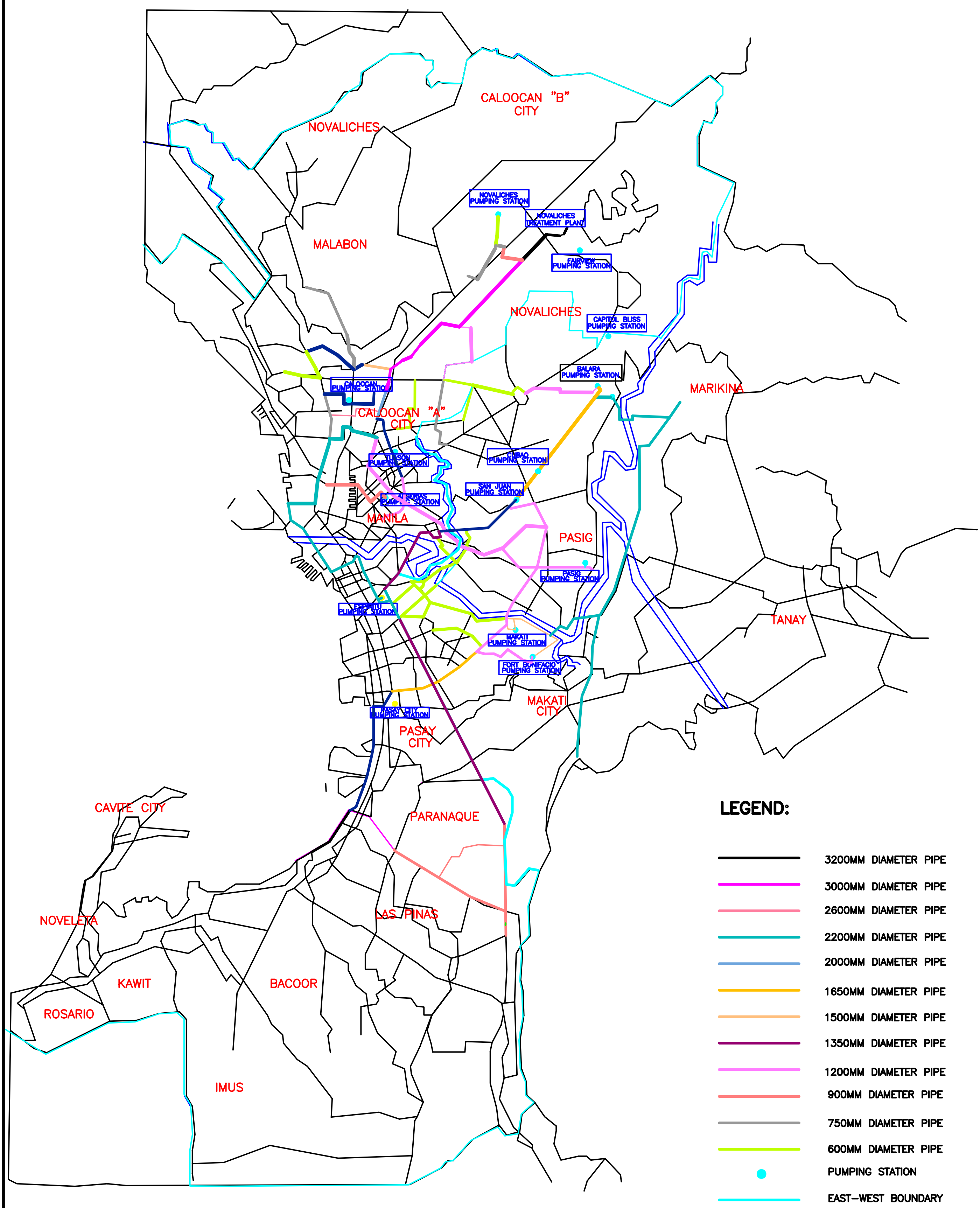


Figure 6.3 Existing Primary Main

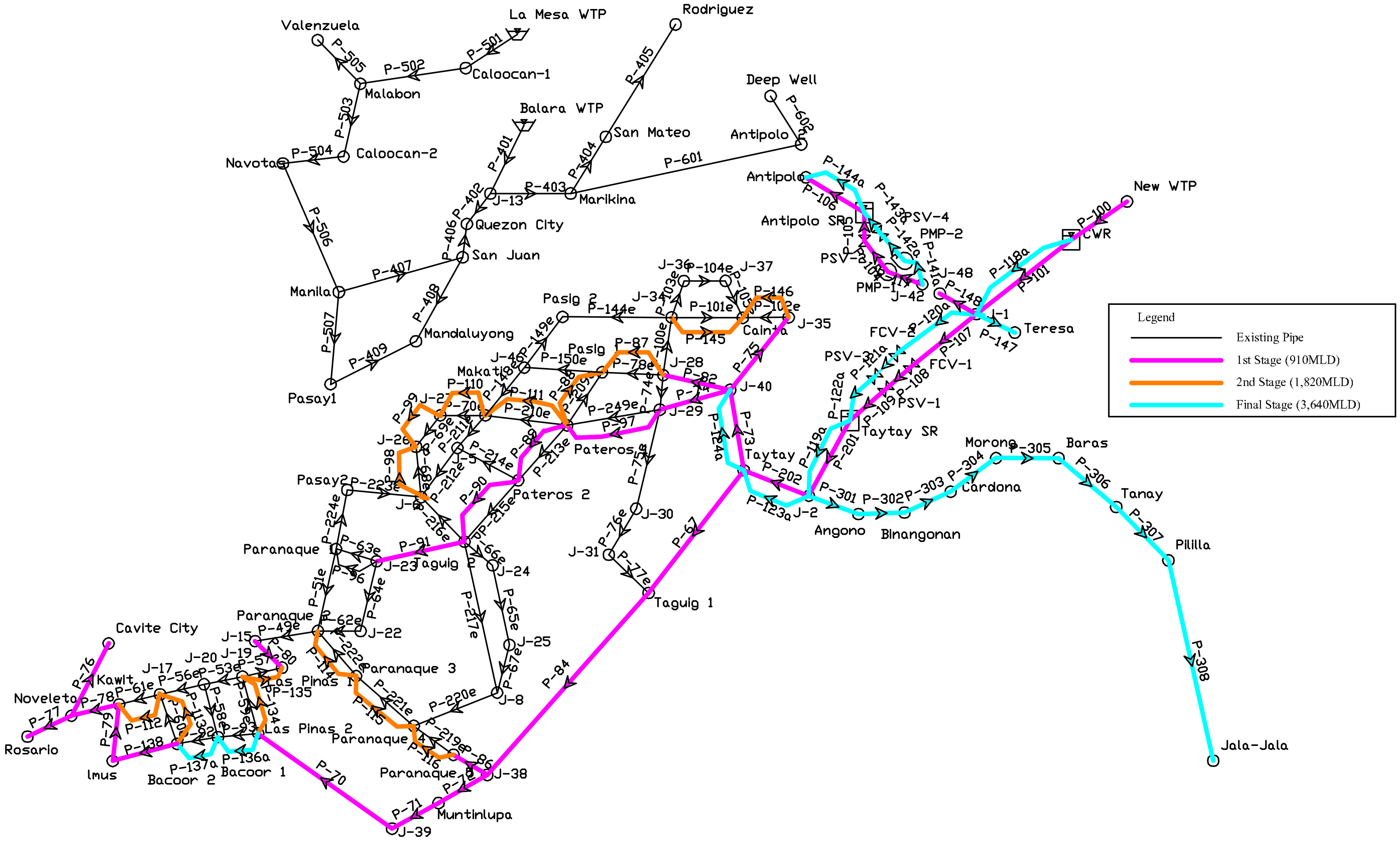


Figure 6.4 Preliminary Layout Plan of Distribution Trunk Mains

CHAPTER VII COMPARISON ON PRIORITY OF ALTERNATIVE DEVELOPMENT SCHEMES

7.1 General

The eight (8) alternative development scenarios, Development Scenario A to H, have been developed by combining the water resources development schemes in the Agos River Basin and water transfer schemes for conveying water from the Agos River Basin to Metro Manila as discussed in the foregoing Chapters V and VI.

For the comparison of alternative development scenarios, this Study introduces a concept of "unit water cost index", which is defined as a water cost to equalize the present worth of cost and revenue streams for a given evaluation horizon.

This Chapter describes the preliminary design of the proposed facilities and also summarizes the results of preliminary cost estimate and the assumed implementation schedule for each of the development scenarios, based on which the unit water cost is assessed for each development scenario in order finally to select the priority development scenario.

7.2 Preliminary Design of Proposed Structures

7.2.1 Dam in Reservoir Type Scheme

This Study contemplated three (3) dams, Agos Dam, Kanan No.2 Dam and Laiban Dam, to work out the development scenarios. As described in Chapter V, a Concrete Face Rockfill Dam (CFRD) has been selected for both the Agos Dam and Kanan No.2 Dam. Laiban Dam was also designed to be a CFRD in the detailed design under the MWSP III. Hence, all the dams are proposed as CFRD.

The preliminary design of each dam is carried out in accordance with the following design standards and criteria:

- Upstream and downstream surface slopes of main dam are set at 1:1.5 with reference to those adopted for Laiban Dam in MWSP III.
- Diversion tunnels combined with cofferdams are adopted as the diversion method in order to discharge a 20-year probable flood during construction of the main dam.
- Design discharge for spillway is 1.2 times the 200-year probable flood. Besides, spillway has a capacity to pass probable maximum flood with a freeboard of 1 m at least.

The main design features of each dam are described below.

(1) Agos Dam

A preliminary layout design for the Agos Dam with FSL 159.0 m is shown in Figure 7.1. The proposed spillway of Agos dam is a combination of gated and non-gated spillways. With the provision of a non-gated overflow weir, the spillway can regulate the peak discharges of less than 1.2-year probable flood without the operation of gates. An afterbay weir is proposed to re-regulate power discharges released from the powerhouse planned for peak-power generation. The further study on Agos Dam and its appurtenant structures will be carried out in the next Feasibility Study stage.

(2) Kanan No.2 Dam

FSL of Kanan No.2 Dam is set at EL. 310.0 m. Minimum operation level (MOL) varies by the development scenario, namely MOL 278m in the Development Scenario A (Plan A-2), Scenario D (Plan D-2) and Scenario H (Plan H-2), and MOL 225m in the Development Scenario E (Plan E-2) with a powerhouse installed at the toe of the Dam. Preliminary design of Kanan No.2 Dam in the Development Scenario E is illustrated in Figures 7.2.

(3) Laiban Dam

As for the Laiban Dam, this Study adopted the layout plan and dimensions of main structures as proposed in the 1984 detailed design prepared under MWSP III.

7.2.2 Low Dam in Run-of-River Scheme

Three (3) run-of-river schemes were proposed to evaluate the alternative development scenarios. These are Kaliwa Low Dam and Laiban Low Dam on the Kaliwa River, and Kanan Low Dam on the Kanan River.

(1) Kaliwa Low Dam

For Kaliwa Low Dam, two types of development, a temporary structure to be submerged by Agos Dam and a permanent structure, are preliminarily designed as mentioned below.

(a) Temporary Kaliwa Low Dam

The Kaliwa Low Dam is designed as a temporary structure (Development Scenarios B and G). The temporary Kaliwa Low Dam is constructed using random fill material quarried and/or produced from excavation of the dam and waterway tunnel. The upstream face of the dam is covered with impervious fill to avoid seepage through the dam body. The downstream face is protected with wood cribs filled with rocks to allow the overtopping of flood flow.

The Kaliwa Low Dam is planned to function for three years and then to be partially removed on the completion of the Agos Dam. Taking into consideration a relatively short-time operation period, no spillway is provided. A sand flush gate is provided on right side close to the intake structure for the Kaliwa-Angono waterways, so as to periodically discharge sediments accumulated in front of the intake structure.

A preliminary plan of the temporary Kaliwa Low Dam is shown in Figure 7.3.

(b) Permanent Kaliwa Low Dam

The permanent Kaliwa Low Dam (Development Scenarios D and E) is a concrete dam of about 35m high. The permanent Kaliwa Low Dam is equipped with 5 spillway gates and 4 sand flush gates. Sands deposited in the upstream pond are discharged downstream through operation of sand flush gates. In addition, a sand settling basin is provided in the intake channel. Large-size sands contained in the water will settle and be flushed out from there before flowing into the tunnel for the Kaliwa-Angono waterway.

(2) Laiban Low Dam

The site selected for the Laiban Low Dam is almost the same as that of the Laiban High Dam. At the site, two diversion tunnels are already built on the right bank.

The Kaliwa River water stored in a pond created by Laiban Low Dam is conveyed to Metro Manila through the Laiban-Angono waterway. The same design concepts as those on the permanent Kaliwa Low Dam are applied to the preliminary design. An intake is provided on the right bank side of Laiban Low Dam. The tunnels are aligned to pass over the existing diversion tunnels built under MWSP III project.

Figure 7.4 shows a preliminary plan of Laiban Low Dam. The similar layout plan is contemplated for the other permanent low dams.

(3) Kanan Low Dam

Kanan Low Dam is designed to be a 36.0 m high concrete dam provided with five spillway gates and four sand flush gates. A pond to be created by Kanan Low Dam is connected to the permanent Kaliwa Low Dam through a 16.5 km long Kaliwa-Kanan inter-basin tunnel of 5.1 m diameter. The intake structure for the interbasin tunnel is provided on the right bank. The design discharge for intake structure and interbasin tunnel is 43.6 m^3/sec.

7.2.3 Waterways

The conveyance waterway for supply of water to Metro Manila consists of tunnels and pipelines. This Study examined preliminary plans for the three (3) waterways, namely Kaliwa-Angono, Laiban-Angono and Laiban-Taytay waterways, as explained hereinafter.

(1) Kaliwa-Angono Waterway

Water is taken at an intake on the Kaliwa River (or Agos Reservoir) and conveyed through a 28.0-km long tunnel. After a larger head becomes available by realization of Agos Dam, a powerhouse will be built at the end of the tunnel. Two by-pass hollow–jet valves will also be installed at the tunnel outlet. Water is conveyed, either through water turbines or hollow-jet valves, to a water treatment plant and further to a main service reservoir through a combination of pipelines and tunnels.

(2) Laiban-Angono Waterway

In the case of the Laiban-Angono waterway, water taken at Laiban Low Dam is conveyed to the water treatment near Kalan Batu through a 14.3 km long tunnel, 2.5 km pipelines and 2.6 km tunnel. To harness a relatively large head available between Laiban Low Dam and the outlet of the first tunnel, a powerhouse will be built at the outlet site. Thereafter, the waterway takes the same route as the Waterway B-1b described in Section 6.2 before.

(3) Laiban-Taytay Waterway

This waterway route is same as that designed under MWSP III.

7.3 Preliminary Cost Estimate and Implementation Schedule

7.3.1 Preliminary Cost Estimate for Each Development Scenario

The project cost is estimated in accordance with project components and implementation plan for meeting the water demand up to the year 2025 for each scenario.

A summary of the estimated cost for alternative development scenarios and a cost breakdown of Scenario B are presented in Table 7.1 and 7.2, respectively.

Basis of the cost estimate is summarized as follows:

(1) Composition of Project Cost

The project cost comprises construction cost, land acquisition/resettlement cost, engineering and administration cost, and physical contingencies, while tax and price contingencies are not taken into account in the cost estimate in Table 7.1.

(2) Condition and Assumption for the Cost Estimate

The cost estimate is based on the following conditions and assumptions:

(a) Project execution method

All the proposed scenarios are assumed to be executed on the contract basis by competent contractors selected through international competitive bidding (ICB) and local competitive bidding (LBC).

(b) Price Level

The cost was estimated at June 2001 price level and the exchange rate applied is 1 US$ = 52 Pesos.

(c) Foreign and Local Currency Portion

The project cost includes Foreign Currency (F.C.) portion and Local Currency (L.C.) portion. The allocation of F.C. and L.C. is determined applying the assumed percentages for each work as shown below. Both currencies are estimated in terms of US Dollar equivalent.

Estimated Ratio of F.C. and L.C.

Work Category	F.C.	L.C.	Total
Land Acquisition/Resettlement	-	100%	100%
Dam	60%	40%	100%
Waterway	70%	30%	100%
Water Treatment Plant	80%	20%	100%
Power House	80%	20%	100%
Inter-basin Tunnel	70%	30%	100%
Engineering & Administration	70%	30%	100%

Foreign Currency portion covers the costs of imported materials and supplies, machinery for mechanical and electrical works, construction equipment and other foreign-based expenditures, while the Local Currency portion covers the costs of locally available materials including cement, reinforcing bars, fuel and explosives, local labors, lands and compensation.

(3) Cost Estimate Method

(a) Construction Cost

The construction cost is estimated based on 5 categories, i.e. dam, waterway, water treatment plant, power house, and inter-basin tunnel.

The construction cost for the dams and the main structures for waterway/inter-basin tunnel is estimated based on the unit price for major work quantities, while empirical cost formulae are applied to the cost estimate of the plant works (power plant, water treatment plant and service reservoir).

(b) Land Acquisition/Resettlement Cost

Land acquisition is required for the construction of access roads, dams, waterways, water treatment plants, and inter-basin tunnels.

For the resettlement, number of affected houses was counted on air photos. The estimated quantities and costs are shown in Chapter IV.

(c) Engineering and Administration Cost

The cost for engineering and administration is estimated at 7% of the total of construction cost and land acquisition/resettlement cost.

The cost of the engineering services covers basic design, detailed design, preparation of tender documents, and construction supervision.

(d) Physical Contingency

Physical contingency is estimated at 15% of the total of construction cost, land acquisition/resettlement cost and engineering/administration cost.

(4) Project Cost for Each Scenario

Taking into account the above (1) to (3), the project cost for the respective development scenarios is estimated as summarized in a table below:

Cost Summary for Alternative Development Scenarios

Scenario	Land Acquisition /Resettlement (10^3USD)	Construction Cost (10^3US$)	Engineering & Administration (10^3US$)	Physical Contingency (10^3US$)	Total (10^3US$)
A	151,154	1,682,547	128,359	294,309	2,256,368
B	67,257	1,416,548	103,866	238,151	1,825,821
C	61,488	1,417,807	103,551	237,427	1,820,272
D	69,077	1,462,025	107,177	245,742	1,884,021
E	78,377	1,709,698	125,165	286,986	2,200,227
F	134,234	1,543,370	117,432	269,255	2,064,292
G	130,662	1,725,815	129,953	297,965	2,284,395
H	65,141	1,379,588	101,131	231,879	1,777,740

7.3.2 Implementation Schedule

For each of the eight (8) alternative development scenarios, a preliminary implementation schedule of the first and second development schemes is worked out as shown in Figure 7.5. Timing of the implementation is determined so as to meet the water demand growth up to the year 2025.

In preparing the implementation schedule, the following were taken into account:

- Scenario A: A constraint in the implementation of Laiban Dam is the resettlement issue. This Study tentatively assumes that the dialogue with the project-affected people will take around three years and, due to this, the completion of the project will be delayed till 2013.
- Scenario B: The 1st stage project, Kaliwa Low Dam with 1st Waterway, aims at completing towards year 2010. For enabling this, a crush program is required to achieve the earliest finalization of pre-construction activities, with the immediate financing for the design from MWSS own budget source.
- Scenario C: Implementation of Agos Dam will require an 11-year time period. Hence, its completion will be attainable only in the year 2012.
- Scenario D: Implementation of Kanan No.2 Dam constitutes the critical path of this development scenario and the earliest attainable completion is estimated to be the year 2015. In relation to this, the 1st stage project, Kaliwa Low Dam with 1st Waterway, should be deferred by two years, i.e. completion in 2012, since the Kaliwa Low Dam can only meet the water demand growth for a three-year period before the commissioning of the Kanan No.2 Dam.
- Scenario E: In this Scenario, construction of Kanan Low Dam is on the critical path. The completion is scheduled in 2014. By the similar reason to that stated for Scenario D, the completion of the 1st stage project can be deferred by one year, i.e. completion in 2011.

- Scenario F: Completion of Laiban Dam will be in 2013 with the same reason as stated for Scenario A.
- Scenario G: Same consideration as for Scenario B.
- Scenario H: Completion of the 1st stage project could be deferred till 2013 with the same reason as stated for Scenario D. Laiban Low Dam can only meet the water demand growth for a two-year period before the Kanan No.2 Dam is commissioned.

7.4 Comparison of Alternative Development Scenarios in Terms of Unit Water Cost Index

7.4.1 Methodology and Procedure Adopted

As noted above, the relative attractiveness of the eight (8) development scenarios was compared in terms of the index of "unit water cost" per m^3 of water. Each development scenario contains the future plans as the Third Stage development program, which are mostly hydropower development schemes. The comparison of unit water cost was, however, made for the First Stage and Second Stage development plans that are relevant to the water supply for Metro Manila towards 2025. To estimate the unit water cost for each development scenario, a cash flow for each of the project cost and revenue was prepared in accordance with the following procedures:

(1) Evaluation Horizon and Base Year

In the present Master Plan study, the cost index was evaluated for an evaluation horizon of 40 years (2011-50). Base year for assessing the present worth of cost and revenue streams is set to be Year 2001.

(2) Components of Project Cost

The project cost estimated at this stage covers those for water source exploitation works (dam/reservoir), water treatment plant, and water conveyance facilities up to a main service reservoir planned at Taytay in the Laiban-Taytay Waterway (Development Scenarios A and F) or at Angono in the Kaliwa-Angono Waterway (Development Scenarios B to G) and Laiban-Angono Waterway (Development Scenario H). Hence, the "unit water cost" evaluated herein represents the cost at the main service reservoir, which is regarded as the off-take point for distribution to the supply network of Metro Manila.

The project cost, estimated on financial cost basis, covers the base cost estimated at 2001 price (consisting of construction cost, land acquisition and compensation costs, engineering and administration costs, physical contingency), price contingency, Value Added Tax (VAT) for the construction works, and interest during construction. Operation and maintenance cost incurred for water and energy supply operations is also taken into account.

(3) Financial Condition

It is assumed at this study stage that the project would be implemented as a government project using ODA and other concessional loans. The following conditions are set forth:

(a) Base cost

As described in Subsection 7.3.1, the base cost is estimated at the June 2001 price level (exchange rate of US$1=Peso 52). The base cost is divided into F/C and L/C portions by applying the ratios described in Subsection 7.3.1.

(b) Disbursement schedule

The construction costs are disbursed in accordance with the implementation schedules shown in Figure 7.5.

(c) Price contingency

The price escalation rates adopted are 2.0% per annum for F/C, and 5.2% for 2001-2004 and 3.0% for 2005 onward for L/C. The rates for L/C were derived from the forecast given in the Philippines National Development Plan, 1998, NEDA.

(d) Value added tax

An amount equivalent to 10% of both F/C and L/C of construction cost is adopted as the value-added tax. This tax was specifically taken into account in view of its relatively large impact to the water cost. Other taxes were not considered at this study stage.

(e) Loan interest rate

The rates tentatively assumed are 4.5% per annum for F/C (mixture of loans from bilateral aid and international aid) and 14.5% for L/C (local bank loan).

(f) Electricity selling price

Peso 2.5/kWh (US$ 0.0481/kWh) is adopted as the price in the base year, escalated at 3% per annum.

(4) Operation and Maintenance Cost

The annual operation and maintenance costs are estimated applying the following rates:

- Water treatment cost: Peso 0.25 per m^3 (US$ 0.005) of water produced
- Maintenance of facilities: 0.5 % of initial capital cost of the facilities

(5) Cost Stream and Water Supply Quantity Stream

Disbursement schedule of the implementation costs was prepared based on assumptions of financial condition set forth above. Discounting this cost stream by applying a rate of 12%, present worth of the investment cost was calculated at 2001 price. O&M cost is also discounted by the same manner.

(6) Revenue Stream and Derivation of Unit Water Cost

Soon after the commissioning of the 1st stage scheme, the scheme supplies water to meet the water demand in the respective years until the demand reaches the full supply capacity of the scheme. Thereafter, the 1st stage scheme supplies water at its full capacity towards the end of the evaluation horizon. After the 2nd stage scheme is commissioned, it will supply water to meet the growing portion of the demand exceeding the supply capacity of the 1st stage project. The supply by the 2nd stage scheme will continue till the end of the evaluation horizon. On this basis, the stream of water supply quantity was constructed.

Most of the development scenarios involve hydropower development as a component of the proposed projects. Sale of electricity energy is therefore taken into account in the cash flow analysis.

The "unit water cost" is calculated in a manner of comparing the present worth of total incurred costs and the present worth of expected water/energy sale, which are discounted to 2001 price at a discount rate of 12 % per annum. It was considered that a part of the invested cost is recovered by energy sale and the remainder should be recovered by water sale. A trial calculation was attempted to find an equalizing unit water cost that would equalize the present worth of the cost to be recovered by water sale and the present worth of water sale amount.

The unit water cost for each development scenario is estimated under the following three (3) conditions to compare the eight (8) development scenarios:

i) Indexes on the basis of the same time-frame

ii) Indexes on the basis of assumed implementation schedule

iii) Indexes on the basis of assumed implementation schedule with consideration of penalty for delay in completion

The results of the comparison study under the above three (3) different conditions are described in the following Subsections 7.4.2 to 7.4.4.

7.4.2 Comparison of Indexes on the Basis of Same Time-Frame

The evaluation assumes a fixed time frame common to all Scenarios: that is, disregarding the anticipated completion schedule shown in Figure 7.5, the comparison assumed that the 1st stage project of all the Scenarios would be completed in 2010 and commissioned in 2011. The results of the evaluation are shown as 'Case-A' in Table 7.3 and summarized below.

Summary of Comparison of Unit Water Cost Index

(Comparison on the Basis of Same Time-Frame)

Develop. Scenario	Scheme	Project Cost/*1 (US$ Mil)	Present Worth		Equalizing Unit Water Cost /*2 (US$/ m^3)
			Water Volume Supplied (Mil m^3)	Cost to be Recovered (US$ Mil)	
A	Laiban + Kanan No.2 Dam	2,256	1,650	1,429	0.400
B	Kaliwa Low Dam + Agos Dam	1,826	1,449	1,129	0.379
C	Agos Dam w/o Kaliwa Low Dam	1,820	1,449	1,171	0.391
D	Kaliwa Low Dam + Kanan No.No.2 Dam	1,884	1,531	1,248	0.389
E	Kaliwa Low Dam + Kanan Low Dam + Kanan No.2 Dam	2,200	1,580	1,411	0.421
F	Laiban Dam + Agos Dam	2,064	1,498	1,236	0.390
G	Kaliwa Low Dam + Laiban Dam + Agos Dam	2,284	1,513	1,337	0.424
H	Laiban Low Dam + Kanan No.2 Dam + Agos Dam	1,778	1,511	1,254	0.398

Notes: /*1 Base cost estimate at 2001 price, comprising construction cost, land/compensation, engineering/administration (7%) and physical contingency (15%)

/*2 Unit water cost at 2001 price, which equalizes the present worth of costs and the present worth of water sale amount, discounted at 12% per annum. The water sale price is escalated at 3% per annum.

The above table shows that the Development Scenario B is the lowest among the eight (8) development scenarios in terms of the unit water cost. The indexes of Scenarios C, D, F, and H are evaluated to be next favorably and almost comparable equally among them. The difference of the unit water cost between the Development Scenario B and Development Scenario D, ranked the second lowest, is as small as at US$ 0.010/m^3 (Peso 0.52/m^3).

Table 7.3 shows that the cost index of the Laiban Dam is assessed at a low value, which is almost same as that of Development Scenario B. This would be taken into account in the subsequent studies.

7.4.3 Evaluation of Indexes on the Basis of Assumed Implementation Schedule

Figure 7.5 shows the earliest attainable completion schedule of each Development Scenario. Among the eight scenarios, only the Scenario B and G are assumed to complete in year 2010 (1st stage project), while the other six Development Scenarios (A, C, D, E, F and H) be completed in 2012-2013 due to reasons stated in Subsection 7.3.2 before.

The column of ‘Case- B’ in Table 7.3 shows the cost indexes evaluated on this basis for the Scenarios A, C, D, E, F, and H. The indexes calculated were found to be almost equal to those evaluated for the ‘Case-A’. This is because the relative composition of cost-revenue streams is almost similar between ‘Case-A’ and ‘Case-B’, where the stream of ‘Case-B’ lags by two to three yeas from that of ‘Case-A’.

7.4.4 Evaluation of Indexes on the Basis of Assumed Implementation Schedule with Consideration of Penalty for Delay in Completion

A bold assumption was made to evaluate quantitatively the effect of delay in the completion of Scenarios A, C, D, E, F, and H. In the evaluation, the following concepts were introduced:

i) Scenario B produces water sale amounting to US$ 9.4 million in 2011, US$ 17.2 million in 2012, and US$ 23.8 million in 2013, in terms of yearly total amount

ii) This production is not possible in the case of Scenarios A, C, D, E, F, and H due to delay in completion, which is regarded as a loss of national economic production

iii) As a penalty for the delayed completion, the corresponding amount of production of Scenario B is applied to Scenarios A, C, D, E, F, and H to be the negative benefit (loss of water sale)

Based on this bold assumption, unit water cost index for the Scenarios A, C, D, E, F, and H are evaluated just for reference purpose. The result is shown as 'Case-C' in Table 7.3. If this concept is included in the comparison of Scenarios, relative position of the index of Scenario B becomes much more favorable compared with the others.

7.4.5 Conclusion of Unit Water Cost Comparison

As evaluated in Subsections 7.4.2 to 7.4.4 above, the unit water cost index of Development Scenario B was most favorably evaluated. In other words, the Development Scenario B is the least cost development program of water supply schemes. Hence, this Study proposes to take up the Development Scenario B for further study.

On one hand, the unit water cost index of Laiban Dam project was also evaluated favorably. Further consideration would be given to this project in formulating a master development plan in subsequent Chapter VIII.

7.5 Technical Assessment of Development Scenario B

7.5.1 Overall Technical Comparison with Other Scenarios

Table 7.4 shows a summary of comparison of technical aspects involved in each Development Scenario. The following describe the relative merits of Development Scenario B, compared with the other Scenarios.

(1) Water Source Facilities

Scenario B requires to construct only one dam, Agos Dam. The reservoir impounding area is 18.0 km^2, which is the smallest area among the Scenarios. This minimizes the production foregone due to the loss of lands and also the possible natural environmental impacts.

The index of reservoir water circulation was assessed to compare the performance characteristics of the three reservoirs. The results are shown below.

Index of Reservoir Water Circulation

Reservoir	Reservoir Effective Capacity (Million m^3)	Annual Runoff Inflow (Million m^3)	Reservoir Water Yield (Water Use) (Million m^3)	Indexes	
				Per Annual Runoff Inflow	Per Reservoir Water Use
	(A)	(B)	(C)	(D)=(B)/(A)	(E)=(C)/(A)
Laiban	470	738	671	1.57	1.43
Kanan No.2	607	1,728	1,198	2.84	1.97
Agos	356	3,573	1,898	10.03	5.33

As indicated above, the frequency of water circulation of the Agos reservoir is much more than the other two dams. This will contribute to minimizing the deterioration of quality of the stored water, which is regarded as one of merit accorded to the Agos Dam scheme.

Construction of water source facilities (high dam and run-of-river low dam) involves various technical difficulties and problems inherent to each site. Among others, seismicity and faults are major issues to be carefully looked into, which are however the problems common to all the proposed facilities. A concern particular to the Agos Dam is watertightness of the reservoir due to the existence of Daraitan limestone mass. This issue requires a careful study in the subsequent investigation, but seems not to be a critically negative factor denying the feasibility of the scheme at this moment.

(2) Water Conveyance Facilities

Kaliwa-Angono waterway involves the construction of a long tunnel of 28 km in length. However, this is not a difficulty for the scheme in view of recent levels of tunneling technology and cost.

Open-air pipeline length is minimal in the case of Kaliwa-Angono Waterway. This will minimize the anticipated problems relating to natural environments and households relocation.

(3) Construction Cost

In terms of base cost estimate at 2001 price, Scenario B requires the second lowest capital cost (US$ 1,826 million), next to Scenario H (US$ 1,778 million) with a difference of US$ 48 million (2.6%). Nevertheless, “unit water cost index” evaluated in Section 7.4 is lesser in the case of Scenario B. This is because of contribution by larger hydropower revenue and milder cost streams due to possible deferment of the completion of dam (Agos Dam in 2013 in the case of Scenario B, while Kanan No.2 Dam in 2012 in the case of Scenario H).

Another disadvantage of Scenario H is to deprive of the future development potential of the Laiban High Dam. The Laiban Dam is a valuable water development source to be preferably retained on a long-term basis for future water supply need of Metro Manila.

A factor to be noted is that the cost index may change if the power benefit is not as anticipated in the present index calculation. However, this is very unlikely, since the present calculation assumes a relatively low power revenue rate of Peso 2.5/kWh, compared with the Meralco's power purchase cost of Peso 3.41/kWh in the year 2000.

(4) Hydrological Impacts to Agos River Downstream Reaches

Owing to water transfer to Metro Manila, the dry season flow (e.g. 90%-discharge) in the Agos River downstream reaches will be reduced in all the Scenarios. The availability of the dry season flow is the largest in the case of Scenario B, since the Agos reservoir will release water for power generation at a rate of 25.5 m^3/sec constantly throughout the seasons (present 90%-discharge is 30.2 m^3/sec).

The 90%-discharge in the other Scenarios is less than the case of Scenario B. Hence, the Scenario B gives the minimal impact to the river discharges in the downstream reaches. Table 7.5 shows the low flow rate (90 % discharge) available in the river reach downstream of Agos Dam site at each development stage of the eight Alternative Development Scenarios.

On one hand, the reduction of sediment release to the downstream reaches is heaviest in the case of Scenario B, since the Agos Dam will trap almost all the sediments transported from the upstream. Present sediment transport through the Agos Dam site is estimated as 860,000 m^3 per year.

Reduction of the sediment yield would certainly give a large impact to the morphology of the river mouth and coastlines in the Lower Agos Plain. The degree of impact is not known at present and, hence, is subject to further studies. In the extreme case, there may be the necessity of coastal protection works. This issue is a nature of serious concern, but seems not to be a decisive factor denying the proposed project at this stage, since some countermeasures are still conceivable.

(5) Socio-Environmental Aspects

It is conservatively estimated in the present study that construction of Agos reservoir will require the relocation of about 300 households. However, this relocation issue could be minimized with a lower reservoir water level plan, if social acceptance for the relocation is found difficult.

As noted above, most section of the waterway is planned to be tunnel and hence the anticipated sociological problems will be minimal. Land acquisition for water treatment plant site, about 70 ha in area, will need a careful approach. However, this issue is common to all the Scenarios.

Construction of the Agos reservoir will bring about a certain extent of impact to the natural environment. Also, due compensation plans will be needed for the inundation of the housings, cultural sites and livelihood areas of Indigenous People (IPs). Nevertheless, these are the issues of manageable extent by proper planning of the project.

7.5.2 Water Resources Potential Exploitable for Water Demand After Year 2025

Water supply development plans proposed in each Development Scenario can meet the water demand up to the year 2025 or longer. Although the water demand will continue to grow thenceforward, water resources in the Agos River basin is abundant and could meet such demand occurring after the year 2025.

Table 7.6 shows the water resources exploitable for meeting water demand after the year 2025 by each Development Scenario. Total water resources development potential is maximized when three major dams, i.e. Laiban Dam, Kanan No.2 Dam and Agos Dam, are built. This will be possible in the cases of Scenarios A. B, C, F and G.

In the Development Scenario B, Agos Dam is built first, but the Scenario allows further development of both the Laiban Dam (for water supply) and Kanan No.2 Dam (mainly for hydropower) in the upstream basins. With the flow regulation of the two upstream dams, the Agos dam will have a water yield potential of about 4,800 MLD in terms of daily average supply quantity. This is also regarded as merit accorded to the proposed Scenario B.

Table 7.1 Cost Summary for Alternative Development Scenarios

(Exchange Rate: 1US$ =52.0 PhP)

Senario	Plan	Name of Scheme	Average Capacity (MLD)	Land Acquisition /Resettlement (x 10^3US$)	Construction Cost (x 10^3US$)	TOTAL Cost (x 10^3US$)	Foreign Currency (x 10^3US$)	Local Currency (x 10^3US$)	TOTAL Cost (x 10^3US$)	Engineering & Administration 7%	Physical Contingencies 15%	**Grand Total** (x 10^3US$)
A	A-1	Laiban Dam with 1st Waterway	1,830	96,055	611,660	707,715	433,338	274,377	707,715	49,540	113,588	870,843
	A-2	Kanan No.2 Dam with 2nd Waterway	3,280	55,099	1,070,887	1,125,985	762,302	363,683	1,125,985	78,819	180,721	1,385,525
		Senario Total	5,110	151,154	1,682,547	1,833,700	1,195,640	638,060	1,833,700	128,359	294,309	**2,256,368**
B	B-1	Kaliwa Low Dam with 1st waterway	550/0 *2	20,135	413,683	433,819	298,643	135,176	433,819	30,367	69,628	533,814
	B-2-1	Agos Dam + WTP #2	3,000	18,044	485,265	503,309	324,132	179,177	503,309	35,232	80,781	619,322
	B-2-2	Kaliwa-Angono 2nd Waterway + WTP #3 + 4		29,077	517,600	546,677	379,248	167,429	546,677	38,267	87,742	672,686
		Senario Total	3,000	67,257	1,416,548	1,483,804	1,002,023	481,782	1,483,804	103,866	238,151	**1,825,821**
C	C-1	Agos Dam with 1st Waterway	1,500	38,179	904,503	942,682	627,196	315,486	942,682	65,988	151,301	1,159,971
	C-2	Kaliwa-Angono 2nd Waterway	1,500	23,308	513,304	536,612	376,242	160,371	536,612	37,563	86,126	660,302
		Senario Total	3,000	61,488	1,417,807	1,479,295	1,003,437	475,857	1,479,295	103,551	237,427	**1,820,272**
D	D-1	Kaliwa Low Dam with 1st waterway	550/290 *2	20,505	447,731	468,236	322,476	145,760	468,236	32,777	75,152	576,164
	D-2-1	Kanan No.2 Dam + WTP #2	1,210	15,585	380,300	395,885	252,892	142,993	395,885	27,712	63,540	487,136
	D-2-2	Kaliwa-Angono 2nd Waterway + WTP #3 +4	2,100	32,987	633,995	666,982	466,226	200,756	666,982	46,689	107,051	820,721
		Senario Total	3,600	69,077	1,462,025	1,531,102	1,041,594	489,509	1,531,102	107,177	245,742	**1,884,021**
E	E-1	Kaliwa Low Dam with 1st waterway	550/290 *2	20,505	441,999	462,505	318,464	144,041	462,505	32,375	74,232	569,112
	E-2-1	Kanan Low Dam with tunnel	770/0 *2	6,749	265,078	271,827	190,443	81,384	271,827	19,028	43,628	334,484
	E-2-2	Kanan No.2 Dam with 2nd Waterway	3,770	51,123	1,002,621	1,053,744	715,542	338,202	1,053,744	73,762	169,126	1,296,632
		Senario Total	4,060	78,377	1,709,698	1,788,076	1,224,449	563,627	1,788,076	125,165	286,986	**2,200,227**
F	F-1	Laiban Dam with 1st Waterway	1,830	96,055	614,671	710,726	436,115	274,612	710,726	49,751	114,072	874,549
	F-2	Agos Dam with 1st Waterway	1,500	38,179	928,699	966,878	645,163	321,715	966,878	67,681	155,184	1,189,743
		Senario Total	3,330	134,234	1,543,370	1,677,604	1,081,277	596,327	1,677,604	117,432	269,255	**2,064,292**
G	G-1	Kaliwa Low Dam with 1st waterway	550/0 *2	23,045	486,821	509,866	351,772	158,094	509,866	35,691	81,833	627,390
	G-2-1	Laiban Dam + WTP #2	1,930	71,872	302,253	374,124	207,394	166,731	374,124	26,189	60,047	460,360
	G-2-2	Agos Dam with 2nd Waterway	1,500	35,745	936,741	972,487	652,114	320,373	972,487	68,074	156,084	1,196,645
		Senario Total	3,430	130,662	1,725,815	1,856,477	1,211,279	645,198	1,856,477	129,953	297,965	**2,284,395**
H	H-1	Laiban low dam with 1st Waterway	340/140 *2	29,073	427,455	456,528	304,124	152,404	456,528	31,957	73,273	561,758
	H-2-1	Kanan No.2 Dam + WTP #2	3,280	15,585	396,749	412,334	264,407	147,928	412,334	28,863	66,180	507,378
	H-2-2	2nd Waterway + WTP #3 & #4		20,483	555,384	575,867	371,098	204,768	575,867	40,311	92,427	708,604
		Senario Total	3,420	65,141	1,379,588	1,444,730	939,630	505,100	1,444,730	101,131	231,879	**1,777,740**

Notes: Total Cost = Land Acquisition/Resettlement Cost + Construction Cost
Engineering/Administration Cost = Total Cost x 7%
Physical Contingencies = (Total Cost + Engineering/Administration Cost) x 15%
Grand Total = Total Cost + Engineering/Administration Cost + Physical Contingencies

Table 7.2 Summary of Project Cost for Scenario B (1/2)

Description	Foreign Currency (US$)	Local Currency (US$)	Total Const. Cost (US$)
Stage B-1; Kaliwa Low Dam (Temporary) and Kaliwa-Angono 1st Waterway			
Engineering & Administration	21,257,071	9,110,173	30,367,245
Physical Contingency	47,985,145	21,642,608	69,627,754
Land Acquisition and Resettlement			
Waterway	0	9,220,440	9,220,440
Water Treatment Plant	0	10,912,200	10,912,200
Preparatory Works			
New access road	1,680,000	720,000	2,400,000
Improvement of existing roads	630,000	270,000	900,000
Preparatory works	30,419,992	13,037,139	43,457,131
Hydropower Facilities			
Kaliwa Low Dam (Temporary)	5,751,823	2,465,067	8,216,890
Intake Structure	582,400	249,600	832,000
Headrace Tunnel			
Headrace Tunnel: Tunnel No.H1-1	76,067,908	32,600,532	108,668,440
Headrace Tunnel: Tunnel No.H1-2 (Steel Lined)	23,541,471	10,089,202	33,630,673
Surge Tank	1,130,500	484,500	1,615,000
Pressure Shaft	2,016,700	864,300	2,881,000
Powerhouse	165,200	70,800	236,000
Hydromechanical Works	3,591,000	1,539,000	5,130,000
Water Conveyance Facilities			
Pipeline No.P-1 (Dia=3.4m, L=800m)	2,671,918	1,145,108	3,817,025
Tunnel No.T-1 (Steel-lined)	32,167,356	13,786,010	45,953,366
Pipeline No.P-2 (Dia=3.4m, L=3,600m)	12,023,630	5,152,984	17,176,614
Water Supply Facilities for Antipolo	7,851,550	3,364,950	11,216,500
Angono Service Reservoir	25,838,050	11,073,450	36,911,500
Water Treatment Plant #1 (750mld)	72,514,400	18,128,600	90,643,000
StageB-1 Total	**367,886,114**	**165,926,663**	**533,812,777**
Stage B-2-1; Agos Dam + WTP #2			
Engineering & Administration	24,662,125	10,569,482	35,231,608
Physical Contingency	52,318,923	28,462,120	80,781,043
Land Acquisition and Resettlement	0	18,044,055	18,044,055
Preparatory Works			
Improvement of existing roads	2,340,000	1,560,000	3,900,000
Preparatory works	17,263,910	11,509,274	28,773,184
Dam Works			
River Diversion Works	12,204,078	8,136,052	20,340,130
Main Dam & Afterbay	107,662,352	71,774,902	179,437,254
Spillway	42,328,787	28,219,191	70,547,978
Hydromechanical Works	10,443,888	6,962,592	17,406,480

Table 7.2 Summary of Project Cost for Scenario B (2/2)

Description	Foreign Currency (US$)	Local Currency (US$)	Total Const. Cost (US$)
Agos Power Station			
Preparatory Works	7,066,640	1,766,660	8,833,300
Interbasin tunnel/Waterway for Hydropower			
Intake Structure	2,729,600	682,400	3,412,000
Interbasin Tunnel (Headrace Tunnel)	2,596,800	649,200	3,246,000
Pressure Shaft	1,860,800	465,200	2,326,000
Powerhouse	12,013,600	3,003,400	15,017,000
Switchyard	563,200	140,800	704,000
Hydromechanical Works	7,692,800	1,923,200	9,616,000
Power Equipment	38,089,600	9,522,400	47,612,000
Transmission Line	5,160,000	1,290,000	6,450,000
Water Treatment Plant #2	54,114,640	13,528,660	67,643,300
Stage B2-1 Total	401,111,744	218,209,588	**619,321,332**
Stage B-2-2; Kaliwa-Angono 2nd Waterway			
Engineering & Administration	26,787,216	11,480,235	38,267,451
Physical Contingency	60,905,488	26,836,310	87,741,799
Land Acquisition and Resettlement	0	29,076,740	29,076,740
Preparatory Works	32,940,799	14,117,485	47,058,285
Hydropower Facilities			
Headrace Tunnel			
Headrace Tunnel: Tunnel No.H1-1	76,066,459	32,599,911	108,666,370
Headrace Tunnel: Tunnel No.H1-2 (Steel Lined)	23,541,471	10,089,202	33,630,673
Surge Tank	1,130,500	484,500	1,615,000
Pressure Shaft	2,016,700	864,300	2,881,000
Powerhouse	1,710,100	732,900	2,443,000
Switchyard	492,800	211,200	704,000
Hydromechanical Works	2,929,500	1,255,500	4,185,000
Power Equipment	4,454,100	1,908,900	6,363,000
Transmission Line	280,000	120,000	400,000
Water Conveyance Facilities			
Pipeline No.P-1 (Dia=3,400, L=800m)	2,671,918	1,145,108	3,817,025
Tunnel No.T-1 (Steel-lined)	32,167,356	13,786,010	45,953,366
Pipeline No.P-2 (Dia=3,400, L=3,600m)	12,023,630	5,152,984	17,176,614
Water Supply Facilities for Antipolo	25,557,350	10,953,150	36,510,500
Angono Service Reservoir	25,838,050	11,073,450	36,911,500
Water Treatment Plant #3	81,314,640	20,328,660	101,643,300
Water Treatment Plant #4	54,114,000	13,528,500	67,642,500
Stage B2-2 Total	466,942,077	205,745,045	**672,687,123**

Table 7.3 Unit Water Cost Index for Comparison of Alternative Development Scenarios

Evaluation Horizon: 40 Years (2011-2050)

Scenario	Development Scheme	Proposed Supply Capacity (MLD)	Total Project Cost *1 (US$ M)	Present Worth of Cost or Q'ty Value: Cost (US$ M)	Water Supplied (M. m3)	Energy produced (GWh)	Present Worth of Revenue: Etimated Energy Sale *2 (US$ M)	Water Sale Required (US$ M)	Marginal Unit Water Cost *3 ($/m3)
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Case-A: Comparison on a Basis of Same Time Framework									
	(Assumed that 1st Stage Project of All Scenarios would be Completed in Year 2010)								
A	Laiban Dam + Kanan No.2 dam	5,110	2,256	1,490	1,650	756	62	1,429	0.400
B	Kaliwa Low Dam + Agos Dam (FSL 159m)	3,000	1,826	1,215	1,449	1,071	88	1,129	0.379
C	Agos Dam (FSL 159m) w/o Kaliwa Low Dam	3,000	1,820	1,285	1,449	1,596	114	1,171	0.391
D	Kaliwa Low Dam + Kanan No.2 Dam	3,600	1,884	1,252	1,531	45	4	1,248	0.389
E	Kaliwa Low Dam + Kanan Low Dam + Kanan Dam	4,060	2,200	1,459	1,580	534	50	1,411	0.421
F	Laiban Dam + Agos Dam	3,330	2,064	1,313	1,498	897	78	1,236	0.390
G	Kaliwa Low Dam + Laiban Dam + Agos Dam	3,430	2,284	1,393	1,513	588	58	1,337	0.424
H	Laiban Low Dam + Kanan No.2 Dam	3,420	1,778	1,289	1,511	393	36	1,254	0.398
	(For Reference)								
A & F	Laiban Dam w/1st Waterway+WTP #1 - #3	1,830	871	907	1,166	532	40	868	0.380
Case-B: Comparison according to Assumed Schedule									
	(Assumed that Project would be Implemented according to Most Likely Schedule. See Figure 7.3)								
A	Laiban Dam + Kanan No.2 dam	5,110	2,256	1,154	1,213	534	48	1,108	0.393
	(Completion of 1st Stage Project in 2013)								
C	Agos Dam (FSL 159m) w/o Kaliwa Low Dam	3,000	1,820	1,099	1,174	1,266	101	1,002	0.394
	(Completion of 1st Stage Project in 2012)								
D	Kaliwa Low Dam + Kanan No.2 Dam	3,600	1,884	1,077	1,244	40	4	1,076	0.393
	(Completion of 1st Stage Project in 2012)								
E	Kaliwa Low Dam + Kanan Low Dam + Kanan Dam	4,060	2,200	1,331	1,426	475	46	1,287	0.415
	(Completion of 1st Stage Project in 2011)								
F	Laiban Dam + Agos Dam	3,330	2,064	1,017	1,111	636	60	939	0.378
	(Completion of 1st Stage Project in 2013)								
H	Laiban Low Dam + Kanan No.2 Dam	3,420	1,778	1,016	1,108	327	32	987	0.397
	(Completion of 1st Stage Project in 2012)								
	(For Reference)								
A & F	Laiban Dam w/1st Waterway+WTP #1 - #3	1,830	871	702	844	383	32	671	0.376
	(Completion in 2013)								
Case-C: Assessment of Effect of Delayed Completion									
	(In Consideration of Production Loss for Delayed Completion Compared with Scenario B)								
A	Laiban Dam + Kanan No.2 dam	5,110	2,256	1,154	1,213	534	48	1,106	0.410
	(Completion of 1st Stage Project in 2013)								
C	Agos Dam (FSL 159m) w/o Kaliwa Low Dam	3,000	1,820	1,099	1,174	1,266	101	1,004	0.405
	(Completion of 1st Stage Project in 2012)								
D	Kaliwa Low Dam + Kanan No.2 Dam	3,600	1,884	1,077	1,244	40	4	1,074	0.402
	(Completion of 1st Stage Project in 2012)								
E	Kaliwa Low Dam + Kanan Low Dam + Kanan Dam	4,060	2,200	1,331	1,426	475	46	1,287	0.418
	(Completion of 1st Stage Project in 2011)								
F	Laiban Dam + Agos Dam	3,330	2,064	1,017	1,111	636	15	986	0.397
	(Completion of 1st Stage Project in 2013)								
H	Laiban Low Dam + Kanan No.2 Dam	3,420	1,778	1,016	1,108	277	29	989	0.398
	(Completion of 1st Stage Project in 2012)								
	(For Reference)								
A & F	Laiban Dam w/1st Waterway+WTP #1 - #3	1,830	871	702	844	383	32	671	0.404
	(Completion in 2013)								

Notes: *1 Project Cost represents Base Cost at 2001 price including Physical Contingency (15%) and Engineering/Administration Cost (7%)

*2 Eledctricity selling price is assumed to be Peso 2.5/kWh (US$ 0.0481/kWh) at 2001 price, with escalation at 3% per annum

*3 Marginal unit water cost at 2001 price level which equalizes the present worths of cost and water sale. Water cost assumed to escalate at a rate of 3% per annum.

Table 7.4 Summary of Technical Comparison of Alternative Development Scenarios (1/2)

Development Scenario	Water Source Facilities	Water Conveyance Facilities *1	Construction Cost *2	Hydrological Impact to Agos Downstream Reaches	Socio-Environmental Impact (See Table 4.3 for more detailed descriptions)
Development Scenario A - Laiban Dam - Kanan No.2 Dam (5,110 MLD)	- Reservoir inundation area: 46 km2 - Laiban Dam: Need of further investigation on reservoir watertightness - Kanan No.2 Dam: Dam to be a 160 m class high dam to convey water to Laiban Dam (FSL 270m)	- Laiban-Taytay Waterway: 23.3 km Tunnel: 14.3 km (3 tunnels) Pipeline: 9.0 km (2 pipelines) - Waterway length is shortest - Relatively long open-air pipeline construction, requiring socio-environmental consideration	- US$ 2,256 million	- Due to water transfer from both the Laiban and Kanan No.2 Dams, future 90%-discharge in the Agos downstream reaches will be reduced to 12.4 m3/sec, which is about 40 % of the present 90%-discharge of 30.2 m3/sec - Sediment yield to Agos reaches will be about 34 % of present yield rate estimated as 860,000 per year	- Resettlement requirements: Laiban Dam: 3,000 families Kanan No.2 Dam: 100 families Waterway: 330 families - People of San Ysilo not welcome the relocatees from 7 Barangays in the reservoir area (Laiban Dam) - Need for protection of rare and endangered species, such as Philippine eagle, Philippine deer, etc. (Kanan No.2 Dam)
Development Scenario B - Kaliwa Low Dam (Temporary) - Agos Dam (3,000 MLD)	- Reservoir inundation area: 18 km2 - Agos Dam: Need of further investigation for reservoir watertightness at Daraitan limestone gorge	- Kaliwa-AngonoWaterway:38.1km Tunnel: 33.7 km (2 tunnels) Pipeline: 4.4 km (2 pipelines) - Pipeline length is shortest, requiring minimum socio-environmental consideration	- US$ 1,826 million	- Average constant dry season flow released fro Agos Dam is 25.5 m3/sec, which is slightly less than present 90%-discharge (30.2 m3/sec) - Agos Dam will stop almost all of sediment yield to the downstream reaches, which may give a large impact to downstream riverine environments	- Resettlement requirements: Kaliwa Low Dam: None Agos Dam: 300 families Waterway: 50 families - People of Barangay Daraitan oppose to inundation of their village (Agos Dam) - Inundation of Tinipak/limestone caves, IPs worship places in Kaliwa basin and Ips cultural sites, such as Tigbak, 12 burial site in Kanan basin (Agos Dam) - Need for protection of rare and endangered species, such as Philippine eagle, Philippine deer, etc.
Development Scenario C - Agos Dam (3,000 MLD)	- Reservoir inundation area: 18 km2 - Agos Dam: Sam as for Scenario C	- Kaliwa-AngonoWaterway:38.1km Tunnel: 33.7 km (2 tunnels) Pipeline: 4.4 km (2 pipelines) - Other comments are same as for Scenario B	- US$ 1,820 million	- Anticipated conditions are same as for Scenario B	- Resettlement requirements: Agos Dam: 300 families Waterway: 50 families - Other Comments are identical to those given for Scenario B
Development Scenario D - Kaliwa Low Dam - Kanan No.2 Dam (3,600 MLD)	- Reservoir inundation area: 26 km2 - Kanan No.2 Dam: Dam to be a high dam to yield water of more than 3,000 MLD	- Kaliwa-AngonoWaterway:38.1km Tunnel: 33.7 km (2 tunnels) Pipeline: 4.4 km (2 pipelines) - Other comments are same as for Scenario B	- US$ 1,884 million	- Future 90%-discharge is estimated as about 17.0 m3/sec, 56 % of the present discharge - Sediment yield to Agos reaches will be about 65 % of present yield rate	- Resettlement requirements: Kaliwa Low Dam: None Kanan No.2 Dam: 100 families Waterway: 50 families - Inundation of Tinipak/limestone caves, IPs worship places (Kaliwa Low Dam) - Need for protection of rare and endangered species, such as Philippine eagle, Philippine deer, etc. (Kanan No.2 Dam)
Development Scenario E - Kaliwa Low Dam - Kanan Low Dam - Kanan No.2 Dam (4,060 MLD)	- Reservoir inundation area: 26 km2 - Kanan No.2 Dam: Can be slightly low dam, but it reduces the economic viability in terms of cost per m3 of water	- Kaliwa-Angono Waterway: 38.1km Tunnel: 33.7 km (2 tunnels) Pipeline: 4.4 km (2 pipelines) - Other comments are same as for Scenario B	- US$ 2,200 million	- Future 90%-discharge is estimated as about 16.2 m3/sec, about 54 % of the present discharge	- Resettlement requirements: Kaliwa Low Dam: None Kanan Low Dam: None Kanan No.2 Dam: 100 families Waterway: 50 families - Other Comments are identical to those given for Scenario D

Notes: *1 Waterway length excluding the portion of water treatment plant *2 Base cost estimate at 2001 price

Table 7.4 Summary of Technical Comparison of Alternative Development Scenarios (2/2)

Development Scenario	Water Source Facilities	Water Conveyance Facilities *1	Construction Cost *2	Hydrological Impact to Agos Downstream Reaches	Socio-Environmental Impact (See Table 4.3 for more detailed descriptions)
Development Scenario F - Laiban Dam - Agos Dam (3,330 MLD)	- Reservoir inundation area: 38 km2 - Laiban Dam: Same as for Scenario A - Agos Dam: Same as for Scenario B	- Laiban-Taytay Waterway: 23.3 km Tunnel: 14.3 km (3 tunnels) Pipeline: 9.0 km (2 pipelines) - Kaliwa-AngonoWaterway:38.1km Tunnel: 33.7 km (2 tunnels) Pipeline: 4.4 km (2 pipelines) - Other comments are same as for Scenarios A and B	- US$ 2,064 million	- Flow regime in the Agos downstream reaches is almost similar to the case of Scenario B, where Agos Dam will release about 25.5 m3/sec - Condition of sediment release is also identical to the case of Scenario B	- Resettlement requirements: Laiban Dam: 3,000 families Agos Dam: 300 families Waterway: 330+50 families - Other Comments are identical to those given for Scenarios A and B
Development Scenario G - Kaliwa Low Dam - Laiban Dam - Agos Dam (3,430 MLD)	- Reservoir inundation area: 38 km2 - Laiban Dam: Same as for Scenario A - Agos Dam: Same as for Scenario B	- Kaliwa-AngonoWaterway:38.1km Tunnel: 33.7 km (2 tunnels) Pipeline: 4.4 km (2 pipelines) - Other comments are same as for Scenario B	- US$ 2,284 million	- Anticipated conditions are same as for Scenario F	- Resettlement requirements: Kaliwa Low Dam: None Laiban Dam: 3,000 families Agos Dam: 300 families Waterway: 330+50 families - Other Comments are identical to those given for Scenarios A and B
Development Scenario H - Laiban Low Dam - Kanan No.2 Dam (3,420 MLD)	- Reservoir inundation area: 26 km2 - Kanan No.2 Dam: Dam to be a high dam to yield water of more than 3,000 MLD	- Laiban-Angono Waterway: 32.5 km Tunnel: 23.1 km (4 tunnels) Pipeline: 9.4 km (4 pipelines) - Relatively long open-air pipeline construction, requiring socio-environmental consideration	- US$ 1,778 million - Least capital requirement, but unit water cost index is slightly less favorable than Scenario B	- Future 90%-discharge is estimated as about 18.6 m3/sec, about 62 % of the present discharge	- Resettlement requirements: Laiban Low Dam: None Kanan No.2 Dam: 100 families Waterway: 70 families - Other Comments are identical to those given for Scenario D

Notes: *1 Waterway length excluding the portion of water treatment plant *2 Base cost estimate at 2001 price

Table 7.5 90 % Discharge Available in River Reach Downstream of Agos Damsite at Each Development Stage

Scenario	Stage 1 Development		Stage 2 Development			
A	Laiban Dam	21.2 m^3/sec	Kanan No.2 Dam	12.4 m^3/sec		
B	Kaliwa Low Dam	18.4 m^3/sec	Agos Dam	25.5 m^3/sec		
C	Agos Dam	25.5 m^3/sec				
D	Kaliwa Low Dam	18.4 m^3/sec	Kanan No.2 Dam	17.0 m^3/sec		
E	Kaliwa Low Dam	18.4 m^3/sec	Kanan Low Dam	7.5 m^3/sec	Kanan No.2 Dam	16.2 m^3/sec
F	Laiban Dam	21.2 m^3/sec	Agos Dam	25.5 m^3/sec		
G	Kaliwa Low Dam	18.4 m^3/sec	Laiban Dam	20.1 m^3/sec	Agos Dam	25.5 m^3/sec
H	Laiban Low Dam	21.2 m^3/sec	Kanan No.2 Dam	18.6 m^3/sec		

Notes:
1. Present 90 % discharge is 30.2 m^3/sec at Agos Dam site.
2. The above figures represent the available flow after each water source facility delivers the water for Metro Manila at its full capacity.
3. Some of the above figures are approximate, subject to further review in subsequent study.

Table 7.6 Water Resources Exploitable for Water Demand after 2025

Scenario	Development Plan up to Year 2025 – at Ultimate Stage (MLD)		Supply Period (Year)	Future Water Resources Exploitable for Future Demand Growth after Year 2025 *1 (MLD)	
A	- Laiban Dam - Kanan No.2 Dam	1,830 3,280		- New construction of Agos Dam -	2,500
	- Total	5,110	2014-2037		2,500
B	- Kaliwa Low Dam - Agos Dam	0 3,000		- Additional extraction from Agos Reservoir - New construction of Laiban Dam - Increase of Agos reservoir yield due to flow regulation of Kanan No.2 Dam	2,200 1,830 2,600
	- Total	3,000	2011-2025		4,800 *2
C	- Agos Dam -	3,000		- Same as for Scenario B -	
	- Total	3,000	2012-2027		4,800 *2
D	- Kaliwa Low Dam - Kanan No.2 Dam	290 3,310		- New construction of Laiban Dam - *3	1,800
	- Total	3,600	2013-2030		1,800
E	- Kaliwa Low Dam - Kanan Low Dam - Kanan No.2 Dam	290 0 3,770		- Same as for Scenario D - *3	1,800
	- Total	4,060	2012-2032		1,800
F	- Laiban Dam - Agos Dam	1,800 1,500		- Additional extraction from Agos Reservoir - Increase of Agos reservoir yield due to flow regulation of Kanan No.2 Dam (to be newly built)	2,200 2,600
	- Total	3,330	2014-2029		4,400 *2
G	- Kaliwa Low Dam - Laiban Dam - Agos Dam	0 1,930 1,500		- Additional extraction from Agos Reservoir - Increase of Agos reservoir yield due to flow regulation of Kanan No.2 Dam (to be newly built)	2,200 2,600
	- Total	3,430	2014-2027		4,800 *2
H	- Laiban Low Dam - Kanan No.2 Dam	140 3,280		- New construction of Agos Dam - *4	2,500
	- Total	3,420	2014-2030		2,500

Notes: Some of the figures above are approximate estimate, subject to revision by supplemental hydrological studies

*1 On a condition that all water is allocated for water supply purpose.

*2 Combined yield is less than the simple addition of the above three figures.

*3 Agos Dam cannot be built, since it submerges the permanent Kaliwa Low Dam.

*4 Laiban High Dam cannot built, since Laiban Low Dam is already built at the same site.

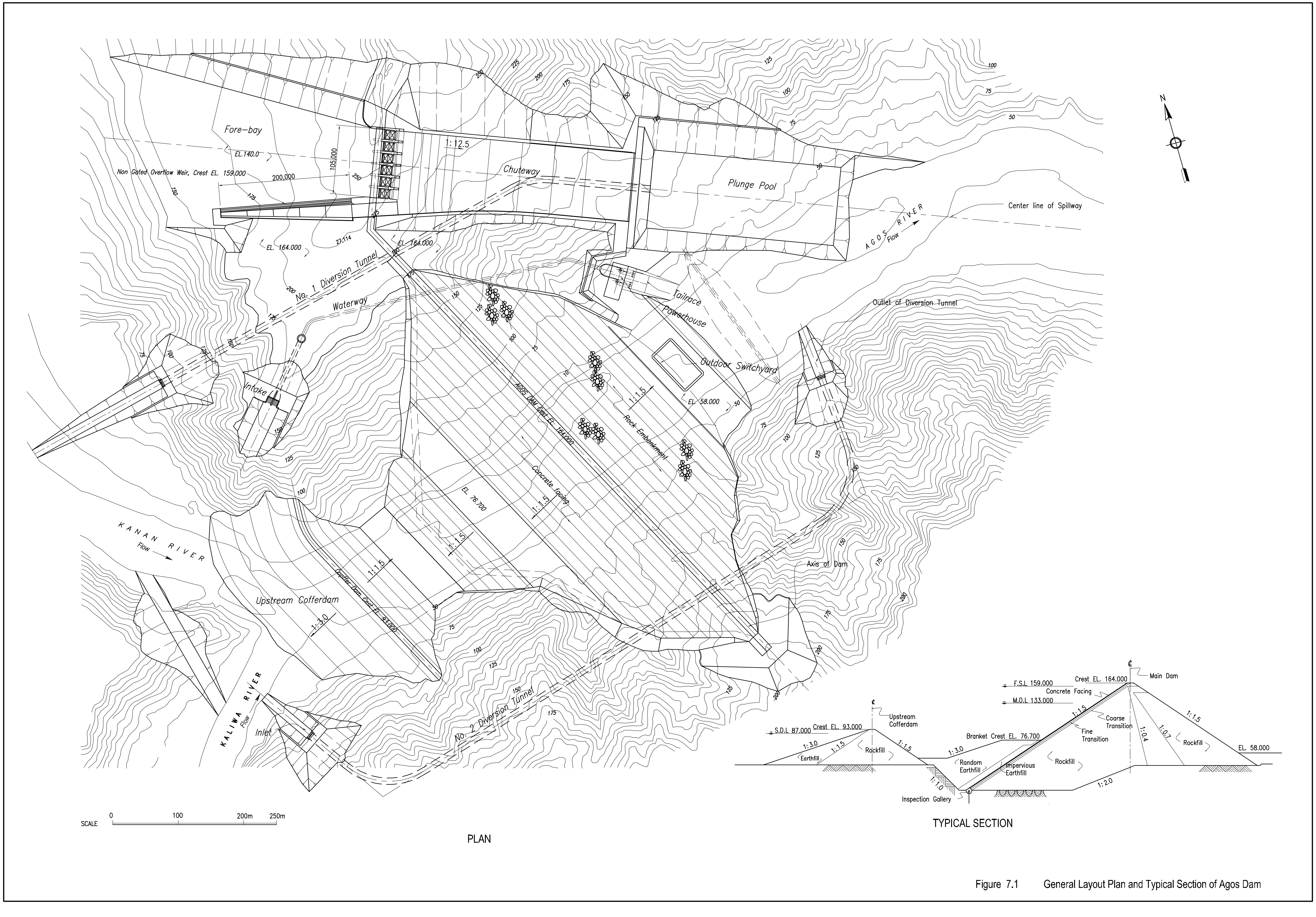
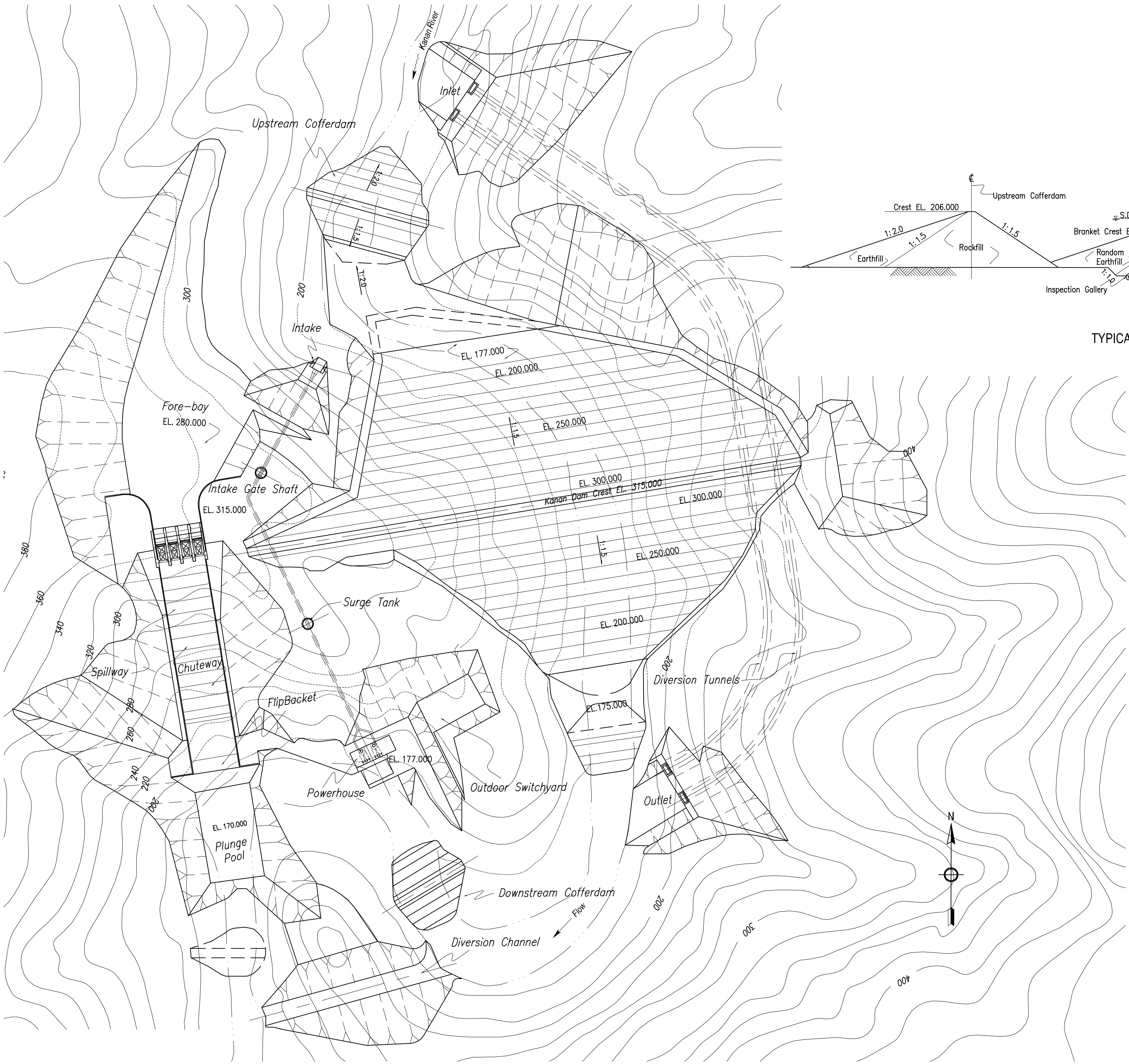
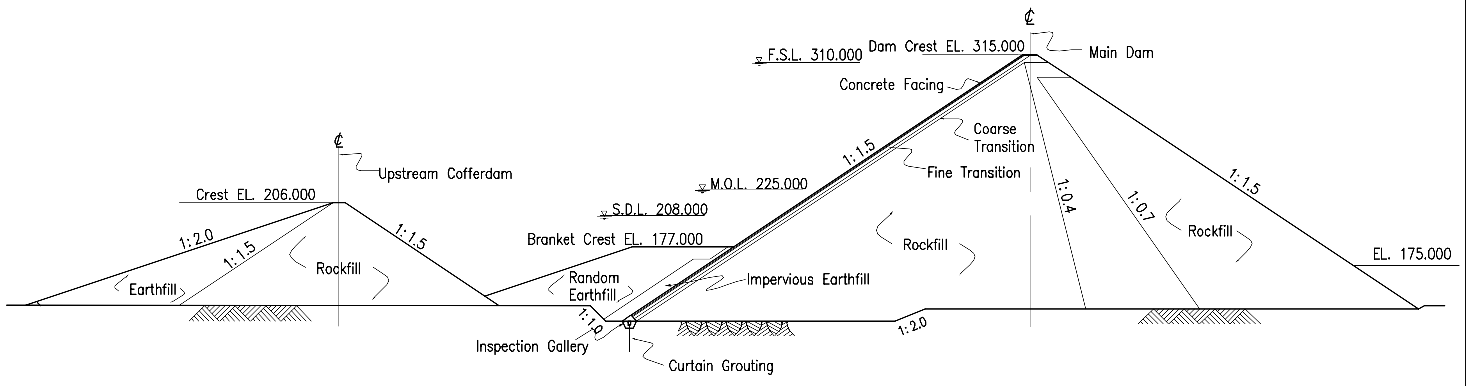


Figure 7.1 General Layout Plan and Typical Section of Agos Dam



PLAN



TYPICAL SECTION OF DAM

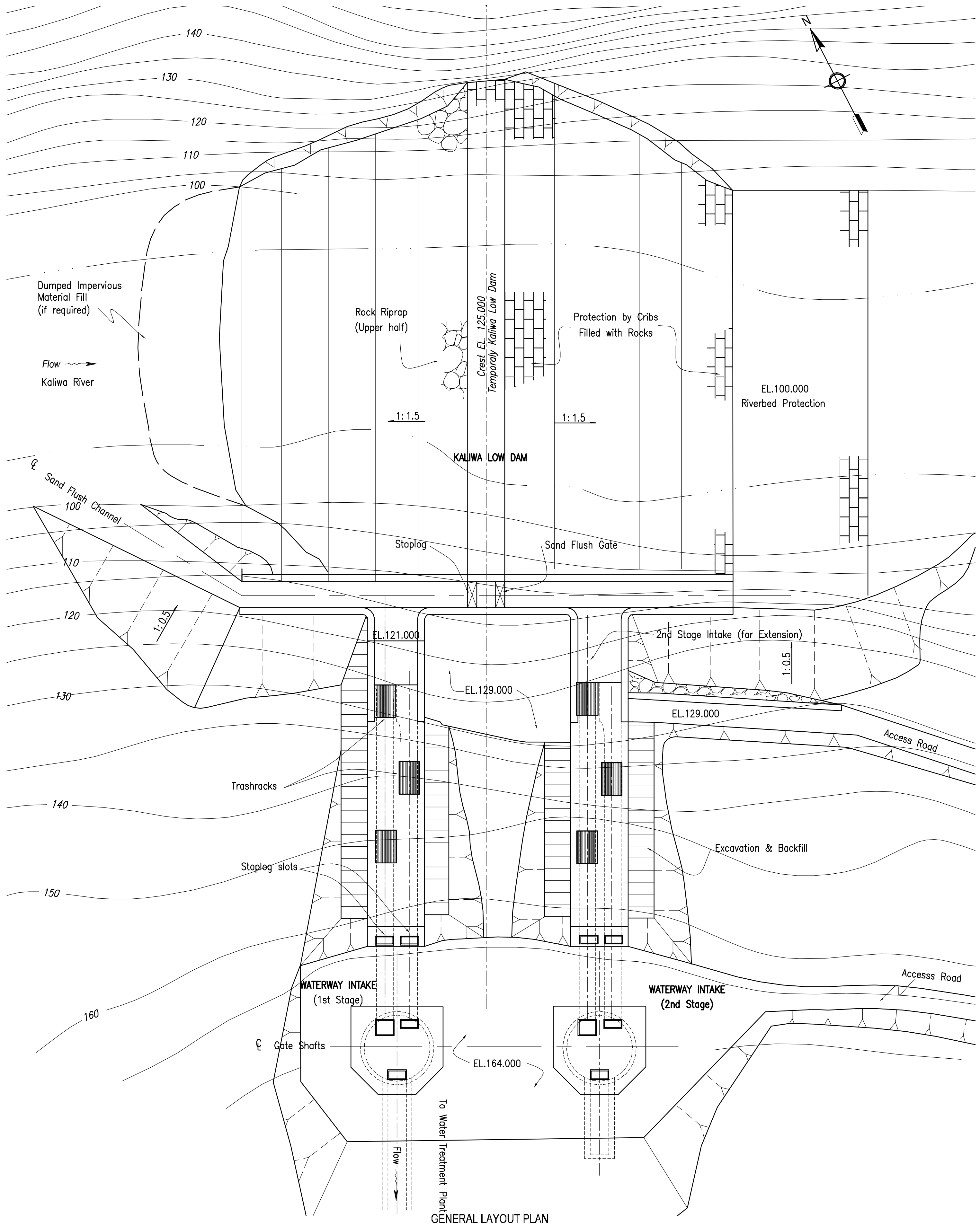
Note:

1) When the Power Station is installed just downstream of the Kanan No.2 dam site, the MOL will be set at EL. 225.000.

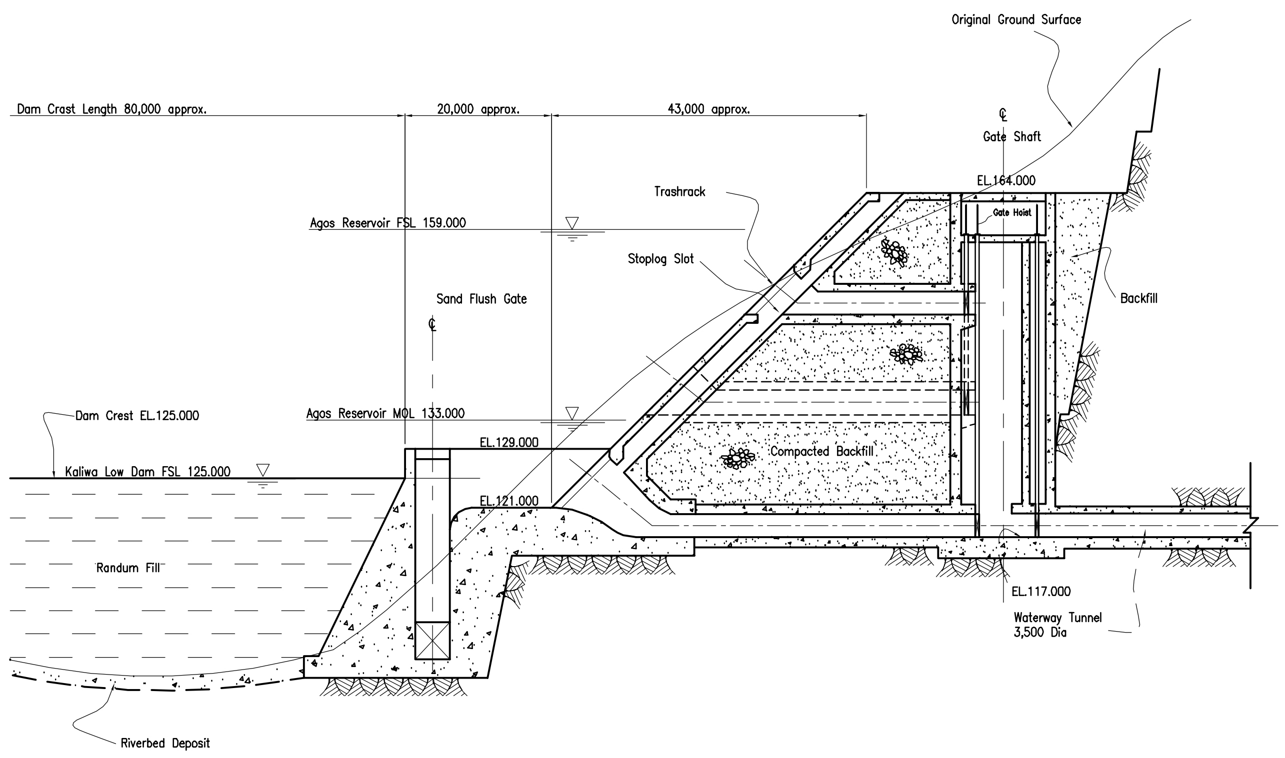
2) When inter-basin tunnel is constructed to transfer the water to the Laiban Dam, MOL will be set at EL. 278.000.

SCALE 0 250M

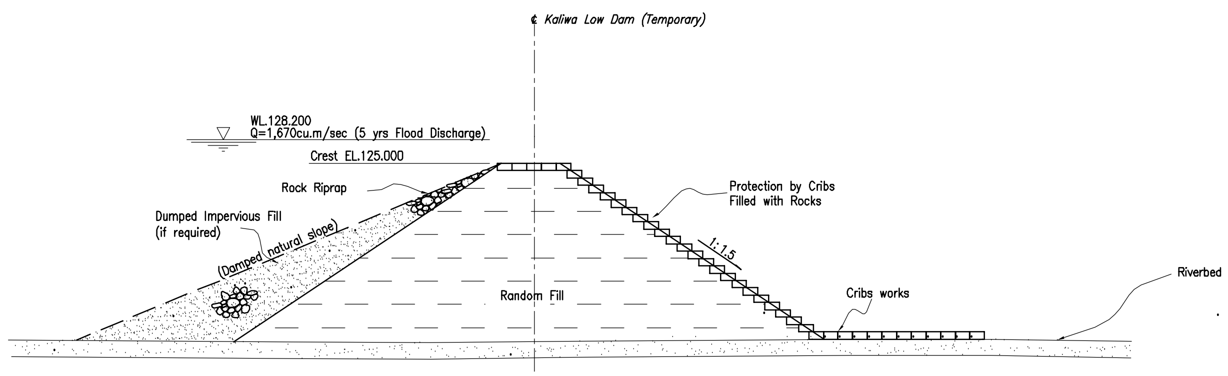
Figure 7.2 General Layout Plan and Typical Section of Kanan No.2 Dam



GENERAL LAYOUT PLAN



PROFILE ALONG DAM AXIS AND INTAKE- 1st STAGE



TYPICAL CROSS SECTION OF DAM

SCALE 0 20m 40m

Figure 7.3 General Layout Plan and Typical Section of Kaliwa Low Dam (Temporary Type)

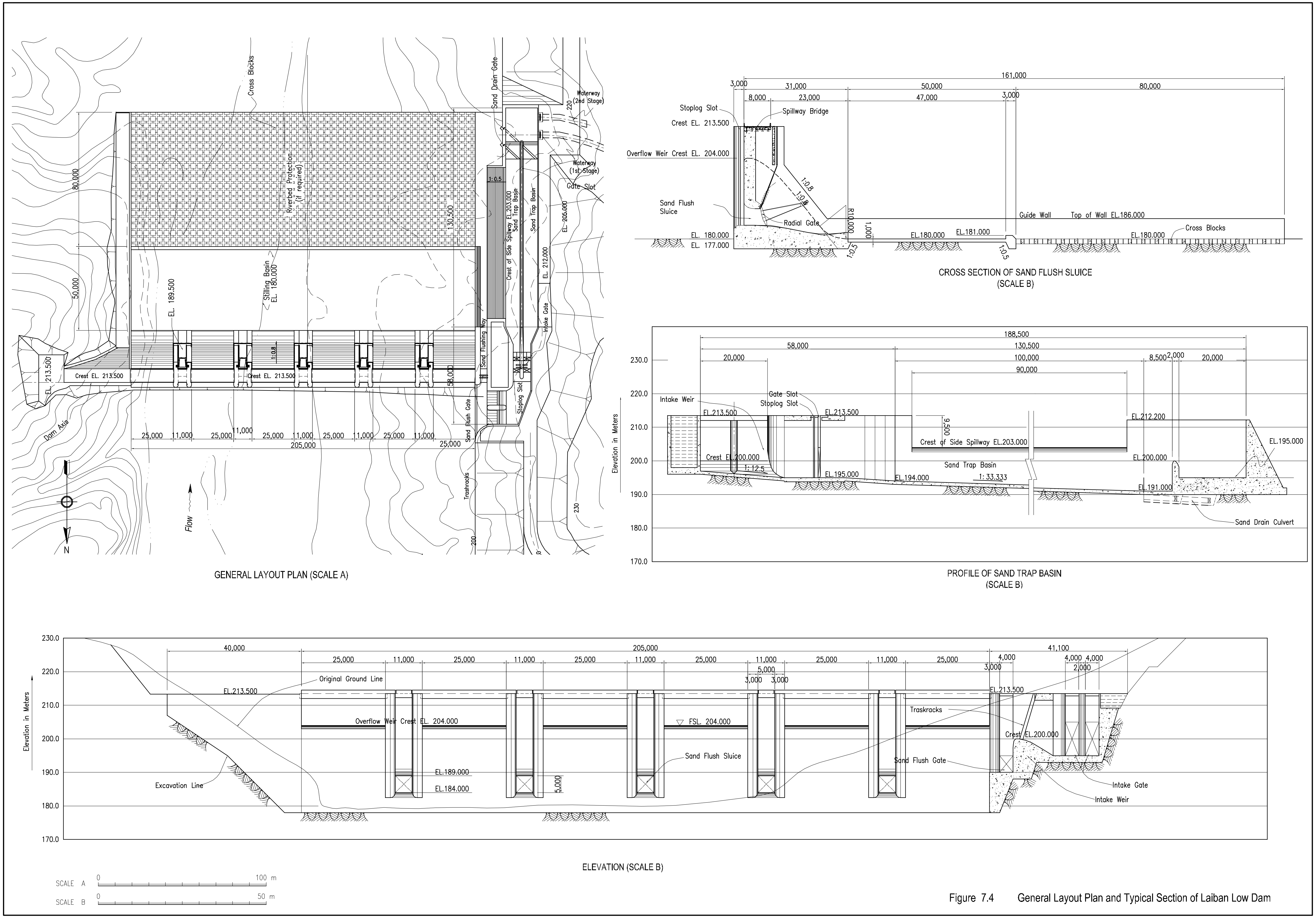


Figure 7.4 General Layout Plan and Typical Section of Laiban Low Dam

Scenario	Plan	Name of Scheme	Average Capacity *1 (MLD)	Const. Cost (US$ Mil)	Year (01–35)
A	A-1	**Laiban Dam w/Laiban-Taytay 1st Waterway**	**1,830**	**871**	(1st Waterway: 1830 MLD average)
		Mobilization of Resettlement Team within MWSS			
		Dialogue with Project Affected People by MWss			
		Land Acquisition and Compensation by MWSS			
		Resettlement Site Infrastructure			Monitoring
		Resettlement of People			
		Finalization of BOT Tender Documents			
		Tender/Evaluation/Negotiation			
		Design Review by BOT Contractors			
		Construction Works (All works by BOT as prently envisaged)			1st Waterway + WTP #1
		- Laiban Dam + 1st Waterway + WTP #1Unit	610		WTP #2
		- WTP #2 Unit	610		WTP #3
		- WTP #3 Unit	610		
	A-2	**Kanan No.2 Dam w/Laiban-Taytay 2nd Waterway**	**3,280**	**1,385**	(2nd Waterway: 3280 MLD average)
		Feasibility Study			
		Financing for Detailed Design			
		Detailed Design and Tender Documents			
		Financing for ODA Portion (Dam)			
		Land Acquisition and Compensation			
		Resettlement of People			
		Tender/Evaluation/Negotiation			
		Main Construction Works			
		- Access Roads (via. Laiban Damsite) (ODA)			2nd Waterway + WTP #4
		- Kanan Dam & Kanan-Laiban Interbasin Tunnel (ODA)			
		- 2nd Waterway + WTP #4 Unit (ODA+BOT)	1,090		WTP #5
		- WTP #5 Unit (BOT)	1,090		WTP #6
		- WTP #6 Unit (BOT)	1,090		
	Total		**5,110**	**2,256**	
B	B-1	**Kaliwa Low Dam w/Kaliwa-Angono 1st waterway**	**550/ 0 *2**	**534**	(1st Waterway: 1500 MLD average)
		Feasibility Study			
		Basic Design and Tender Documents (Financing by MWSS)			
		Land Acquisition and Compensation			
		Resettlemnt of People			
		Financing for ODA Portion (Low Dam & Waterway Tunnel)			
		Tender/Evaluation/Negotiation			
		Main Construction Works (ODA+BOT)			1st Waterway + WTP #1
		- Kaliwa Low Dam + 1st Waterway + WTP #1 Unit	750		
	B-2-1	**Agos Dam + WTP #2**	**3,000**	**619**	
		Financing for Detailed Design			
		Detailed Design and Tender Documents			
		Financing for ODA Portion (Dam)			
		Land Acquisition and Compensation			
		Resettlement of People			
		Tender/Evaluation/Negotiation (ODA+BOT)			
		Main Construction Works			WTP #2
		- Agos Dam (ODA)			
		- WTP #2 Unit (BOT)	750		
	B-2-2	**Kaliwa-Angono 2nd Waterway + WTP #3 & 4**		**673**	(2nd Waterway: 1500 MLD average)
		Basic Design and Tender Documents (Financing by MWSS)			
		Land Acquisition and Compensation			
		Resettlemnt of People			
		Financing for ODA Portion (Waterway Tunnel)			
		Tender/Evaluation/Negotiation			
		Main Construction Works			WTP #3
		- 2nd Waterway + WTP #3 Unit (ODA+BOT)	750		WTP #4
		- WTP #4 Unit (BOT)	750		
	Total		**3,000**	**1,826**	
C	C-1	**Agos Dam w/Kaliwa-Angono 1st Waterway**	**1,500**	**1,166**	(1st Waterway: 1500 MLD average) 1st Waterway + WTP #1
		Feasibility Study			
		Financing for Detailed Design			
		Detailed Design and Tender Documents			
		Financing for ODA Portion (Dam & Waterway Tunnel)			
		Land Acquisition and Compensation			
		Resettlement of People			
		Tender/Evaluation/Negotiation			
		Main Construction Works			
		- Agos Dam (ODA)			1st Waterway+WTP #1
		- 1st Waterway + WTP #1 Unit (ODA+BOT)	750		WTP #2
		- WTP #2 Unit (BOT)	750		
	C-2	**Kaliwa-Angono 2nd Waterway**	**1,500**	**660**	(2nd Waterway: 1500 MLD average)
		Basic Design and Tender Documents (Financing by MWSS)			
		Land Acquisition and Compensation			
		Resettlemnt of People			
		Financing for ODA Portion (Waterway Tunnel)			
		Tender/Evaluation/Negotiation			
		Main Construction Works (BOT)			2nd Waterway + WTP #3
		- 2nd Waterway + WTP #3 Unit (ODA+BOT)	750		WTP #4
		- WTP #4 Unit (BOT)	750		
	Total		**3,000**	**1,826**	
D	D-1	**Kaliwa Low Dam w/Kaliwa-Angono 1st Waterway**	**550/290 *2**	**576**	(1st Waterway: 1500 MLD average)
		Feasibility Study			
		Financing for Detailed Design			
		Detailed Design and Documents			
		Land Acquisition and Compensation			
		Resettlemnt of People			
		Financing for ODA Portion (Low Dam & Waterway Tunnel)			
		Tender/Evaluation/Negotiation			
		Main Construction Works			1st Waterway + WTP #1
		- Kaliwa Low Dam + 1st Waterway (ODA+BOT)			
		- WTP #1 Unit (BOT)	750		
	D-2-1	**Kanan No.2 Dam + WTP #2**	**1,210**	**487**	
		Feasibility Study			
		Financing for Detailed Design			
		Detailed Design and Tender Documents			
		Financing for ODA Portion (Dam)			
		Land Acquisition and Compensation			
		Resettlement of People			
		Tender/Evaluation/Negotiation			
		Main Construction Works			
		- Access Roads (ODA)			WTP #2
		- Kanan Dam+Kanan-Laiban Interbasin Tunnel (ODA)			
		- WTP #2 Unit (BOT)	750		
	D-2-2	**Kaliwa-Angono 2nd Waterway + WTP #3 & 4**	**2,100**	**821**	(2nd Waterway: 2100 MLD average)
		Basic Design and Tender Documents (Financing by MWSS)			
		Land Acquisition and Compensation			
		Resettlemnt of People			
		Financing for ODA Portion (Waterway Tunnel)			
		Tender/Evaluation/Negotiation			
		Main Construction Works (BOT)			2nd Waterway + WTP #3
		- 2nd Waterway + WTP #3 Unit (ODA+BOT)	1,050		WTP #4
		- WTP #4 Unit (BOT)	1,050		
	Total		**3,600**	**1,884**	

Note: Scheme A-1 is on the critical path. Earliest completion should be pursued by solving the resettlement issue at the earliest.

Note: Scheme B-1 is on the critical path. A rushed program is proposed for pre-construction activities.

Note: Scheme C-1 can only be completed in 2011 due to a longer lead time required.

Note: Completion of Scheme D-1 can be deferred till 2012, since it can meet only the demand growth for 3 years before Scheme D-2-1 is commissioned.

Note: Implementation of D-2-1 constitutes the critical path of overall program. Its completion is attainable only in 2015.

Notes: *1 The figures show average water supply capacity at source development sites and water treatment plant
*2 550/290 : 90% discharge during run-of-river intake period (temporary design intake discharge) / once 10-year dry discharge (permanent design intake discharge).

Pre-construction Activities — Construction Work

Figure 7.5 Implementation Schedule of Alternative Development Scenarios (1/2)

Sce-nario	Plan	Name of Scheme	Average Capacity *1 (MLD)	Const. Cost (US$ Mil)	Year (01–35)
E	**E-1**	**Kaliwa Low Dam w/Kaliwa-Angono 1st Waterway**	**550/290 *2**	**569**	(1st Waterway: 1500 MLD average)
		Feasibility Study			
		Basic Design and Tender Documents (Financing by MWSS)			Note: Completion of Scheme E-1 can be dedferred till 2010, since it can meet only the demand growth for 3 years before Scheme D-2-1 is commissioned.
		Land Acquisition and Compensation			
		Resettlemnt of People			
		Financing for ODA Portion (Low Dam +Waterway Tunnel)			
		Tender/Evaluation/Negotiation			
		Main Construction Works			1st Waterway + WTP #1
		- Kaliwa Low Dam+1st Waterway+WTP #1 Unit (ODA+BOT)	750		
	E-2-1	**Kanan Low Dam w/Kanan-Kaliwa Trans Basin Tunnel**	**770/ 0 *2**	**334**	
		Feasibility Study			
		Financing for Detailed Design			Note: Implementation of E-2-1 constitutes the critical path of overall program. Its completion is attainable only in 2014.
		Basic Design and Tender Documents			
		Land Acquisition and Compensation			
		Resettlemnt of People			
		Financing for ODA Portion (Low Dam & Interbasin Tunnel)			
		Tender/Evaluation/Negotiation			
		Main Construction Works			
		- Access Roads (along Kanan River) (ODA)			WTP #2
		- Kanan Low Dam+Interbasin Tunnel+WTP #2 Unit (ODA+BOT	750		
	E-2-2	**Kanan No.2 Dam w/Kaliwa-Angono 2nd Waterway**	**3,770**	**1,297**	(2nd Waterway: 2560 MLD average)
		Feasibility Study			
		Financing for Detailed Design			
		Detailed Design and Tender Documents			
		Financing for ODA Portion (Kanan Dam & Waterway Tunnel)			
		Land Acquisition and Compensation			
		Resettlement of People			
		Tender/Evaluation/Negotiation			
		Main Construction Works			
		- Access Roads (along Kanan River) (ODA)			2nd Waterway + WTP #3
		- Kanan Dam + 2nd Waterway + WTP #3 Unit (ODA+BOT)	855		WTP #4
		- WTP #4 Unit (BOT)	855		WTP #5
		- WTP #5 Unit (BOT)	855		
	Total		**4,060**	**2,200**	
F	**F-1**	**Laiban Dam w/Laiban-Taytay 1st Waterway**	**1,830**	**875**	(1st Waterway: 1830 MLD average)
		Mobilization of Resettlement Team within MWSS			
		Dialogue with Project Affected People by MWss			Note: Scheme F-1 is on the critical path. Earliest completion should be pursued by soving the resettlement issue.
		Land Acquisition and Compensation			
		Resettlement Site Infrastructure			Monitoring
		Resettlement of People			
		Finalization of BOT Tender Documents			
		Tender/Evaluation/Negotiation (BOT)			
		Design Review by BOT Contractors			
		Construction Works (All works by BOT as prently envisaged)			1st Waterway + WTP #1
		- Laiban Dam + 1st Waterway + WTP #1Unit	610		WTP #2
		- WTP #2 Unit	610		WTP #3
		- WTP #3 Unit	610		
	F-2	**Agos Dam w/Kaliwa-Angono 1st Waterway**	**1,500**	**1,190**	(1st Waterway: 1500 MLD average)
		Financing for Detailed Design			
		Detailed Design and Tender Documents			
		Financing for ODA Portion (Agos Dam & Waterway Tunnel)			
		Land Acquisition and Compensation			
		Resettlement of People			
		Tender/Evaluation/Negotiation			
		Main Construction Works			
		- Agos Dam (ODA)			1st Waterway+WTP #1
		- 1st Waterway + WTP #1 Unit (ODA+BOT)	750		WTP #2
		- WTP #2 Unit (BOT)	750		
	Total		**3,330**	**2,065**	
G	**G-1**	**Kaliwa Low Dam w/Kaliwa-Angono 1st Waterway**	**550/0 *2**	**627**	(1st Waterway: 1930 MLD average)
		Feasibility Study			
		Basic Design and Tender Documents (Financing by MWSS)			Note: Scheme G-1 is on the critical path. A rushed program is proposed for pre-construction activities.
		Land Acquisition and Compensation			
		Resettlemnt of People			
		Financing for ODA Portion (Low Dam & Waterway Tunnel)			
		Tender/Evaluation/Negotiation			
		Main Construction Works (ODA+BOT)			1st Waterway + WTP #1
		- Kaliwa Low Dam+1st Waterway+WTP #1 Unit	965		
	G-2-1	**Laiban Dam + WTP #2**	**1,930**	**460**	
		Mobilization of Resettlement Team within MWSS			
		Dialogue with Project Affected People by MWss			Note: Scheme G-2-1 is also on the critical path.
		Land Acquisition and Compensation			
		Resettlement Site Infrastructure			Monitoring
		Resettlement of People			
		Finalization of BOT Tender Documents			
		Tender/Evaluation/Negotiation (BOT)			
		Design Review by BOT Contractors			
		Construction Works (All works by BOT as prently envisaged)			WTP #2
		- Laiban Dam + WTP #2 Unit	965		
	G-2-2	**Agos Dam w/Kaliwa-Angono 2nd Waterway**	**1,500**	**1,197**	(2nd Waterway: 1500 MLD average)
		Financing for Detailed Design			
		Detailed Design and Tender Documents			
		Financing for ODA Portion (Agos Dam & Waterway Tunnel)			
		Land Acquisition and Compensation			
		Resettlement of People			
		Tender/Evaluation/Negotiation (ODA+BOT)			
		Main Construction Works			
		- Agos Dam (ODA)			2nd Waterway+WTP #3
		- 2nd Waterway + WTP #3 Unit (BOT)	750		WTP #4
		- WTP #4 Unit (BOT)	750		
	Total		**3,430**	**2,284**	
H	**H-1**	**Laiban Low Dam w/Laiban-Angono 1st Waterway**	**340/140 *2**	**562**	(1st Waterway: 15070 MLD average)
		Feasibility Study			
		Basic Design and Tender Documents			Note: Completion of Scheme H-1 can be dedferred till 2013, since it can meet only the demand growth for 1 years before Scheme H-2-1 is commissioned.
		Land Acquisition and Compensation			
		Resettlemnt of People			
		Tender/Evaluation/Negotiation (BOT)			
		Main Construction Works			1st Waterway + WTP #1
		- Laiban Low Dam+1st Waterway+WTP #1 Unit (ODA+BOT)	750		
	H-2-1	**Kanan No.2 Dam + WTP #2**	**3,280**	**507**	
		Feasibility Study			
		Financing for Detailed Design			
		Detailed Design and Tender Documents			Note: Implementation of H-2-1 constitutes the critical path of overall program. Its completion is attainable only in 2015.
		Financing for ODA Portion (Dam & Interbasin Tunnel)			
		Land Acquisition and Compensation			
		Resettlement of People			
		Tender/Evaluation/Negotiation			
		Main Construction Works			
		- Access Roads (ODA)			WTP #2
		- Kanan No.2 Dam+Kanan-Laiban Interbasin Tunnel (ODA)			
		- WTP #2 Unit (BOT)	750	**709**	
	H-2-2	**Laiban-Angono 2nd Waterway + WTP #3 & 4**			(2nd Waterway: 1920 MLD average)
		Basic Design and Tender Documents (Financing by MWSS)			
		Land Acquisition and Compensation			
		Resettlemnt of People			
		Financing for ODA Portion (Waterway Tunnel)			
		Tender/Evaluation/Negotiation			
		Main Construction Works			2nd Waterway + WTP #3
		- 2nd Waterway + WTP #3 Unit (ODA+BOT)	960		WTP #4
		- WTP #4 Unit (BOT)	960		
	Total		**3,420**	**1,778**	

Notes: *1 The figures show average water supply capacity at source development sites and water treatment plant
*2 550/290 : 90% discharge during run-of-river intake period (temporary design intake discharge) / once 10-year dry discharge (permanent design intake discharge).

Pre-construction Activities / Construction Work

Figure 7.5 Implementation Schedule of Alternative Development Scenarios (2/2)