Chapter 5

INTERMEDIATE WASTEWATER PUMPING STATION CONSTRUCTION (PACKAGE C)

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5.1 General

Intermediate Wastewater Pumping Station (hereinafter referred to as "IWSP") was proposed to construct at appropriate depth of interceptor or conveyance sewer to optimize the project cost consisting of construction and O/M costs and to assure easier maintenance work of the conveyance sewer. The proposed IWSP is located at swampy area having some houses in Ward 4 in District 8 as shown in Fig. 5.1.

5.2 Scope of Project

Construction of IWSP consists of the following two components:

(a) Civil works consisting of construction of lift pumping station with its future requirement (485.4m^3/min. in 2020), grit chamber with a grit removal for Phase I requirement (133.34m^3/min. in 2005), inner road, and stormwater drainage facility.
(b) Architectural works consisting of construction of pump house and O/M office, generator building, guard house, and landscape in the site
(c) Mechanical works consisting of procurement of mechanical equipment for Phase I requirement (133.34m^3/min. in 2005), and their installation
(d) Electrical works consisting of procurement of electrical equipment for Phase I requirement (133.34m^3/min. in 2005), and their installation

5.3 Civil Works

5.3.1 General

Main civil works include site preparation work, construction of sub-structure of pumping station, construction of grit chamber, and construction of inner road and storm water drainage facilities.

5.3.2 Applicable Codes and Standards

In Detail Design, concrete structures and temporary structures were designed according to following standard.

(a) Road Bridge Substructure Design Standard (Japan Road Association 1994)
(b) Standard Specification for Design and Construction of Concrete Structure (The Japan Society of Civil Engineers 1996)
(c) Structure Design Index (Japan Sewage Works Agency 1998)
(d) Specification for Highway Bridges: Part 4 (Japan Road Association 1990)
(e) Standard Specification for Design and Construction of tunneling: Open Cut Method (The Japan society of Civil Engineer 1996)
(f) Temporary Structure Index for Earth Works of Road

(Japan Road Association 1990)

(g) Temporary Structure Design Index (Japan Sewage Works Agency 1998)

5.3.3 Design Condition and Criteria

(a) Allowable Stress

Concrete

Item \ Concrete Type	Concrete Type D	Concrete Type E	Concrete Type F	Concrete Type G
28-day compressive strength by cylinder test (300mmx150mm dia.)	250	210	180	100
Bending compressive stress (σca)	83.3	70	60	-
Shearing stress (τca)	4.0	3.6	3.3	-

Note: 1. Unit: kg/cm^2

2. Concrete Type D: Precast concrete, Concrete Type E: Reinforced concrete
Concrete Type F: Plain concrete, Concrete Type G: Leveling concrete

Reinforcing Bar

Reinforcing Bar	Deformed Bar
Tensile and compressive stress (τca)	1,600 kg/cm^2

(b) Design Loads

- Design ground level: + 2.000 m
- Design ground water level: + 0.200 m
- Unit weight of soil: γ'= 1.8(t/m^3), friction angle ϕ = 30 º

Under ground water γ' = 0.8(t/m^3)

(For backfilling soil, existing soil use the result of soil investigation)

Under ground water load: Pw (unit weight is 1.0t/m^3)

Soil pressure: P = (vertical soil load) × Ko

Ko = 0.5 (Earth pressure at rest)

Horizontal load pressure: Pv = (Vertical load) × Ko

Pa = 1.0 t/m^2

Other criteria are mentioned by each structural design in Design Report.

5.3.4 Site Preparation Work

(1) Temporary Road Construction

IWSP construction site located at swampy area with some houses in Ward 4 of District 8, is about 200m far from Don Dieu Road. Very narrow local road of about 3.5 to 4.0m is connected between the project site and Don Dieu Road of 7.0m. Therefore, at the

commencement of the project, construction of temporary road along the existing local road is necessary, because during construction, it is very important to maintain the safety transportation for neighborhood.

Top elevation of the temporary road is designed at about EL.+1.30m, which is the same elevation as that of existing road. Length and width of temporary road is designed at about 200m and 6.0m respectively. Crush stone of 200mm thick is designed for the road pavement.

(2) Ground Preparation

According to the cross sectional survey conducted in August 2000, the existing ground elevations in IWSP site vary from EL.+0.90m to EL.+1,50m. There are two natural ponds at the western part of the site, of which bottom elevations are EL.-1.0m.

Accordingly, after completion of clearing and grubbing of the project site, it shall be filled up by sandy soil (locally called black sand) at the commencement of construction. Filled up area excludes around the proposed grit chamber, because open cut method is recommended for grit chamber construction. Initial filled up ground elevation around the designed pumping station is proposed to be EL.+1.70m, and reinforced concrete slab of 300mm thick is placed to prepare working space for diaphragm wall construction.

5.3.5 Design of Diaphragm Wall

(1) Introduction

IWSP is big and very deep hydraulic structure. Its designed structural dimensions are at 24.20m wide, 29.80m long and 17.70m to 20.80m depth. Accordingly, construction of rigid and strong temporary wall is necessary to protect the construction works of IWSP from big earth pressure and groundwater pressure.

In this design, the following three options are selected as a reliable construction method for deep temporary wall and comparative study is conducted.

(a) Sheet Pile Method:
Steel sheet piles of PU-32 and 24.0m long are driven around the designed pumping well. Soil improvement at the bottom is necessary

(b) Soil Mixing Wall method
Soil mixing wall of ϕ900mm with H section steel of 600 x 300 x 16 x 32 is constructed around the designed pumping well. Designed depth of wall is 42m.

(c) Diaphragm Wall Method
Diaphragm wall of 1.20m wide and 42.0m long is constructed around the designed pump well.

As the result of comparison study shown in Table 5.1, sheet pile method was omitted,

because of the following reasons:

- Rigidity of sheet pile is lowest compared with other 2 methods.
- So soil improvement under the base slab is necessary to prevent from occurrence of strong stress for sheet pile.
- It is necessary to construct a permanent wall, because sheet pile is use for only temporary wall.
- The cost is the most expensive compared with other 2 methods.

Soil mixing wall method is also more expensive than diaphragm wall method. Because soil mixing wall is generally use for only temporary wall and it is necessary to construct a permanent wall.

Diaphragm wall method has the highest rigidity and no soil improvement is conducted. It is not necessary to construct a permanent wall because diaphragm wall can use for permanent wall. The cost of diaphragm wall is the lowest cost.

From above considerations, diaphragm wall method was selected for the most appropriate temporary wall construction method for IWSP.

(2) Outline of Method

Firstly, reinforced concrete working slab and guide wall are to be constructed inside and along the designed wall. Then, trench excavation is conducted by special excavator, pouring a bentonite liquid to stabilize a surface of excavated wall. Bentonite liquid is made from clay soil and water, and specific gravity is about 1.20. After excavation is finish, insert a reinforcing cargo and replace a bentonite liquid to concrete to make a designed wall. This wall is utilized as the permanent wall. Maximum excavation depth is about 60m.

(3) Design condition and criteria

High strength concrete is used, because concrete wall of diaphragm wall method is made in the bentonite liquid. Allowable design stress is shown below.

(a) Concrete

Temporary structure (kg/cm2)

Concrete Strength		f'ck	300
Concrete Strength in the water			240
Compressive Stress	For bending moment	σ'ca	120
	For axial force		100
Shearing Stress	When a diagonal re-bar is not used	τa1	5.9
	When a diagonal re-bar is used	τa2	25.5
Bond Stress of Reinforcement Bar			18.0

Permanent structure (kg/cm2)

Concrete Strength		f'ck	300
Concrete Strength in the water			240
Compressive Stress	For bending moment	σca	80
	For axial force		65
Shearing Stress	When a diagonal re-bar is not used	τa1	3.9
	When a diagonal re-bar is used	τa2	17.0
Bond Stress of Reinforcement Bar			12.0

Reinforcement

(kg/cm2)

Type of Reinforcement					SD29A,B (JIS)
Design yield strength of reinforcement				fy	4500
In the slurry	Temporary structure			sa	2700
	When the Temporary Structure is used as the permanent structure	Temporary structure			2250
		Permanent Structure	Long Term		1600
			Short Term		2700

Ground level for construction EL.+ 2.30 m
Ground water level EL.+ 0.20 m

Concrete quality at top of diaphragm wall of about 80cm is not so good, because bentonite liquid will rise to top of the wall and concrete will be mixed with bentonite liquid. So, top of the diaphragm wall of 1.00m deep is proposed to remove and to replace the new concrete.

(4) Design of Diaphragm Wall in temporary work

(a) Soil Condition

According to the result of soil investigation, the typical subsoil condition at IWSP construction site is shown below.

+1.40 m Existing GL

OH Layer (Organic Clay)		rw = 1.40 t/m3 N = 1 C = 0.60 t/m2 E = 7 kg/cm2 -2.10m
SC Layer (Clayer Sand)		rw = 2.00 t/m3 N = 5, ϕ = 24 ˚ C = 2.20 t/m2 E = 35 kg/m2 -7.10m
SM Layer (Silty Sand)		rw = 2.00 t/m3 N = 8 ~ 28, ϕ = 30 ˚ C = 2.00 t/m2 E = 112 kg/cm2 -40.80m
CH Layer (Clay)		rw = 2.00 t/m3 N = 44 ~ 51 C = 7.00 t/m2 E = 336 kg/c

(b) Load factors
- Dead load
- Live load

A uniform traffic surcharge of 1.0 t/m2 is applied.
- Water pressure load
- Earth pressure load

* Static earth pressure
* Active earth pressure
* Passive earth pressure
- Others

* Effect of temperature: 15 degree
* Vertical load on strut: 0.5 t/m2

(c) Calculation of penetration depth of Diaphragm Wall in temporary work

Necessary penetration depth is estimated for the following 2 cases.

- Case 1: Stability analysis: Balance of moment by the active and passive earth pressure including groundwater pressure below the bottom strut.
- Case 2: Boiling analysis: Balance of weight of soil and difference of groundwater pressure at the bottom of Diaphragm Wall

Results of calculation for penetration depth are shown below.

Case		Excavation Depth (m)	Penetration Depth (m)	Length of Wall (m)
Penetration length by Earth pressure balance	Final Excavation	20.80	5.45	26.30
Check of boiling		20.80	15.70	36.50

Therefore, the necessary length of Diaphragm Wall as temporary wall is 36.50 m.

(d) Calculation of thickness of Diaphragm Wall in temporary work

Diaphragm wall in the temporary work is calculated with an Elasto-plastic analysis method. The calculations were done for each steps of excavation, each steps of removal of strut and each steps of concrete work of slab. Moments, shearing forces and displacements of Diaphragm Wall were accumulated by each calculation steps. Thickness of diaphragm wall is designed based on the maximum stress.

The result of calculation is shown below.

Maximum moment (GL - 17.56m): 272.70 t.m
Maximum shearing force (GL - 12.10m) 85.29 t
Maximum displacement (GL - 19.37m) 4.69 cm

Diaphragm wall Thickness = 1.50 m
Reinforcement: D 32 space 150mm double line arrangement

(5) Design of Diaphragm Wall as permanent wall

Diaphragm wall in the permanent condition were calculated by spring support beam method. Following factors were considered in calculation.

(a) Diaphragm wall
 * L = 36.50 m
 * Moment of inertia
 * Elastic modulus
(b) Earth pressure
 $P = K \times (rw \times h1 + rw' \times h2 + 1.0)$
 K = 0.5 (Earth pressure at rest)
(c) Water pressure
(d) Other factors
 * Spring constant of concrete slab
 * Modulus of elasticity of soil
 * Live load: A uniform traffic surcharge of 1.0 t/m2 is applied.

The result of calculation is shown below.

Maximum moment (GL - 19.90m)	192.78 t.m
Maximum shearing force(GL - 21.23m)	104.54 t

Diaphragm wall Thickness = 1.50 m
Reinforcement D 32 space 150mm double line arrangement

5.3.6 Design of Wastewater Pumping Station

After completion of excavation inside of the diaphragm wall up to the designed bottom elevation and of connection with interceptor sewer by mechanical pipe jack machine, concrete work of the wastewater pumping station will be started. Diaphragm wall is utilized for not only the temporary retaining wall but also permanent outer concrete wall for substructure of the pumping station.

The substructure of pumping station is designed to divide into three basements. Basement-3 consists of three parts, inlet pit, inflow channel and pump well. Inlet pit connected with interceptor and inflow channel is divided into two pits. One is for connection of Phase I interceptor and another one is for Phase II program. Emergency sluice gate of 1,500W x 1,500H is designed to install at the outlet to inflow channel. Internal dimension of the pit is 5.35mW x 3.00mL x 15.50mH. The pit is designed to be able to go in and out independently from the outside ground through manhole and to go down easily by ladder rungs for the maintenance work of the gate.

Inflow channel connected with inlet pit and pump well serves to make uniform flow of less than 0.5m/s to take away easily some trash, garbage and waste disposal by automatic fine screen. Four channel are provided, of which structural dimensions are 3.50mW x 8.40mL x 2.50mH. Bottom elevation is designed at EL.-14.00m. Steel stop log can be installed in front and behind of inflow channel for maintenance work of automatic trash screen. Temporary reinforced concrete wall of 300mm thick is provide at the center of inflow channel to divided into two parts, Phase I and II. Because only 2 channels will be

use in Phase I.

Pump well is key substructure to provide main pump equipment and divided into 6 small wells by bulkhead. Three wells are for ϕ700mm dia. x3 units submergible motor pump, which are installed in Phase I. Remaining three wells are for ϕ1000mm dia. x 3 units submergible motor pump, which will be installed in Phase II. Structural dimensions of pump well are 24.20mW x 12.50mL x 6.70mH and its bottom elevation is designed at EL.-17.0m, which is deeper than three times of pump bore (ϕ1000) from the emergency pump stop level of EL.-13.30m. Temporary wall of 400mm thick is also provided at the center of pump pit to divide into two pars, Phase I and II.

Basement-2 is for O/M space of mechanical equipment, such as automatic fine trash screen, conveyor to take out garbage, waste disposal, etc. and main pump equipment including stairs space. Area of Basement-2 is about 650m^2 (20.60m - 24.20m wide, 29.60m long and 6.00m high). Floor elevation is EL.-10.00m. The reinforced concrete ceiling of Basement-2 (floor of Basement-1) of 300mm thick is supported by diaphragm wall and 17 columns. Basement-2 floor has some kind of openings for installation of automatic trash screen and stop logs, and for maintenance work of main pump equipment.

Basement 1 is designed to use for electric room, storage room and stairs space. Area of Basement-1 is about 650m^2, which is the same as that of Basement-2. Wall of electric room (11.70mW x 19.30mL x 6.00mH) and storage room (3.50mW x 6.0mL x 6.0mH) including doors are constructed in architectural works. The reinforced concrete ceiling of Basement-1 (ground floor) of 300mm thick is supported by diaphragm wall and 17 columns. Basement-1 floor, of which elevation is –3.70m, has also some kind of openings for installation of inclined belt conveyor and for maintenance work of main pump equipment.

Construction of ground floor, of which elevation is EL.+2.30m, is finally conducted in concrete work. Half of the ground floor is for operation and maintenance office (A = about 255m^2) and pump house (A = about 310 m^2) for installation and maintenance of mechanical and electrical equipment.

Computer software, SAP2000 developed in USA is utilized for structural analysis (Finite Element Analysis) of substructure of wastewater pumping station. As main design load, mechanical and electrical equipment load, architectural load of pump house and O/M office and live load (500kg/ m^2) are considered. Joint conditions between diaphragm wall and ground, B-1, B-2 and base slabs are applied in hinge joint.

According to the soil investigation conducted in August 2000, bearing capacity of subsoil near the base slab is estimated at 50.6 ton/ m^2, which is almost 4 times of the design loag of 11.7 ton/ m^2. Therefore, spread foundation is recommended.

Fig.5.2 and 5.3 show plan and section of intermediate wastewater pumping station.

5.3.7 Design of Grid Chamber

In the previous study of Definitive Plan, stepwise capacity and main dimensions of grit chamber was planned as follows:

Phase	Dry Weather	Wet Weather	Main Dimension			
	Max. Daily Flow	Max. Hourly Flow	Width	Length	Height	No.of Pond
Phase 1	141,000	192,000 (133.3 m^3/min)	5.0m	19.5m	2.0m	2 chambers
Master Plan	512,000	699,000 (485.4 m^3/min)	5.0m	19.5m	2.0m	4 chambers

Since the grit chamber is very wide, flat and shallow structure, step construction is relatively easy. So, grit chamber in Phase I is designed at half size of future requirement. The grid chamber in Phase I has two chambers, of which capacity of 349,500m3/day is almost 1.8 times of Phase I requirement. However, minimum 2 chambers are required to provide for cleaning of chamber as the most important maintenance work of grit chamber.

The grit chamber consists of three parts, inlet pit to temporary storage wastewater pumped up from the pump pit, grit chamber to settle a grit to its bottom, and discharge pit to convey wastewater to the conveyance sewer. These structural dimensions are as follows:

(a) Inlet Pit: Top elevation of floor: EL.+2.30m, Bottom elevation: EL. – 0.90m
Width = 21.20m Length = 6.50m Height = 2.90m

(b) Grit Chamber: Top elevation of wall: EL.+2.30m, Bottom elevation: EL.-1.40m
Width = 5.00m x 4 chambers, Length = 24.5m Height = 3.70m

(c) Discharge Pit: Top elevation of floor: EL.+2.30m, Bottom elevation: EL.-1.30m
Width = 21.20m Length = 4.00m Height = 2.90m

Some temporary and additional wall and slab are designed for the future expansion works.

According to the foundation analysis for grit chamber based on the soil survey conducted in feasibility study in 1999 and the detailed design in August 2000, bearing capacity of subsoil under the design base slab is estimated at 8.70 t/m2, which is almost 1.9 times of design load of grit chamber. Spread foundation could be applied, however, wooden pile foundation with diameter of ϕ80 – ϕ100, length of 4.5m and 25 piles per m2 is recommended to apply, due consideration to prevent occurrence of crack in base slab from non-uniform settlement.

For excavation method of grit chamber construction, open cut method is technically and economically recommendable, because excavation depth is very shallow (maximum 3.5m) and there is enough space to provide a gentle slope of 1:2.

Plan and section of grit chamber is shown in Fig. 5.4.

5.3.8 Design of Sewer Line

Almost 70% of the IWSP site of about 0.6ha will be covered by concrete and asphalt structures, such as, pumping station, grit chamber, inner road and other related structures. So, in order to keep a good working conditions for operation and maintenance of IWSP

during heavy rainfall, construction of stormwater drainage network system should be established.

(1) Applicable Codes and Standards.

The following codes and standards are applied in this design.

- Vietnamese Design Standard 20 TCN – 51 – 84 from Ministry of Construction on "Outside Sewer Network" .
- Standard Specification for Design and Construction of Concrete Structure (The Japan Society of Civil Engineers 1996)
- Proceedings of Vietnam Construction Standards, Volume III (Ministry of Construction 1997)
- Typical Sewer Design from HCMC Urban Drainage Company for reference.
- Japanese Typical Sewer Design Sample for reference.

(2) Design Conditions and Parameters.

(a) Design Conditions:

- Design road level = EL.+2.00m.
- Design sidewalk elevation = EL.+2.05m
- Material of road: asphalt concrete pavement
- There are some small canal in the east and the southwest nearly outside the IWPS area. These are utilized for the drainage from the IWSP site.

(b) Design Parameters:

Design parameters are summarized below:

- Service Area: 6000m2.
- Flow system: Gravity flow
- Flow equation: Manning's formula
- Design velocity: v = 0.7m/s
- Design flows of stormwater: Q = 0.25m3/s.
- High water tide level on the canal: EL.+1.500m
- Dimension of U-ditch: 300mmW x 400mmH,i = 2.0‰
- Length of U ditch: L = 597.0m.
- Diameter and Length of pipe: ϕ600, L = 23.0m

(3) Design for Layout and Profile of Sewer Line:

(a) Layout Design: (refer to Fig.5.5 and 5.6)

Since the inner road has 2 side - slope, U-ditches will be installed both outsides of the curb along the inner road. The precast RC pipe of ϕ600 is constructed under the road to connect with both U-ditches.

10 manholes in total are designed to construct at the corner and crossing of the ditch. Two types of manhole are designed, Type 1 for U-ditch (7 manholes) and Type 2 for intersection of RC pipe (3 manholes).

Two outlets for the RC pipe of ϕ600 are designed to drain collected stormwater into the existing drainage channel.

(b) Profile Design:

Based on (i) the design elevation of the inner road and (ii) the result of hydraulic calculation, profiles of storm sewers are defined as follows:

- At the start point of each line: IE = EL.+1.650m
- Gradient for U ditch: 2.0‰
- Gradient for ϕ1200 sewer: 1.2‰.

(4) Design for Structure: (refer to DWG. No. PC-IWPS-221 in the Tender Drawings)

- U ditch: Cast in situ reinforced concrete Type E 210KG/cm2
- U ditch cover: Cast in situ reinforced concrete Type E 210KG/cm2
- Pipes: Precast centrifugal reinforced concrete Type D 250KG/cm2.
- Foundation of U ditch: Cast in situ concrete Type G 100KG/cm2
- Manholes: Cast in situ reinforced concrete Type E 210KG/cm2.
- Manhole cover: Cast in situ reinforced concrete Type E 210KG/cm2.
- Outlet: Cast in situ reinforced concrete Type E 210KG/cm2.

5.3.9 Design of Inner Road

In order to secure the sufficient periodical operation and maintenance work of IWSP, construction of inner road is necessary. Inner road shall be linked with outside local road constructed conveyance sewer. Moreover, stormwater drainage network in IWSP site shall be also designed simultaneously.

(1) Applicable Codes and Standard

The following Vietnamese Codes and Standards are applied for design of inner road.

- 20 TCN 104-83 "Standard for Urban Highway Design" approved by Ministry of Construction, (MOC)
- TCVN 4054-98 "Standard for Rural Highway Design" approved by Ministry of Transportation, (MOT)
- 22 TCN 211-93 "Standard for Flexible Pavement Design" approved by MOT
- TCVN 2201-1993 " Soil for Construction – Testing method for compacting index in laboratory" approved by MOC
- 22 TCN 249-98 "Specification for asphalt concrete construction, hot laid" approved by MOT
- Guide for Design of Pavement Structures – AASHTO 1986
- Standard specification for transportation materials and methods of sampling and testing. AASHTO 1990

(2) Design Conditions and Parameters

According to 20 TCN 104-83, classification of roads in IWSP is Inner Road.

(a) Basic Design Parameters.

- Design load for pavement: Axle load: 12 ton
  Tire pressure: 6 Kg/cm2
  Diameter of tire mark: 36 cm
- Design Traffic Volume (H10): 100 vehicle/Day
- Design speed 40 Km/h
- Pavement structure: Asphalt concrete Type P2

(b) Basic Design Geometric Parameters

- Existing Ground Level: 0.4 ~ 0.8 m
- Design embankment level of IWPS: 2.00 m
- MWL (Maximum water level): 1.50 m
- Design wide of pavement: 6.00 m
- Sidewalk wide to planting: 2.50 m
- Total Length of Roads: 316.0 m
- Profile slope: 0.00 %

(c) Geological Condition

Geological condition at IWPS site based on the soil test of borehole number of DSP-01 (Aug. 2000) is mentioned in the table below:

Properties	Unit	Layer 2	Layer 4	Layer 4a	Layer 5
Thickness of layer	m	2.0-4.2	2.8-5.0	33.7- 42.2	>7.8
Wet density, γ_w	g/cm^3	1.404	2.065	2.063	1.987
Unconfined compressive strength q_u	kg/cm^2	0.119	0.448	0.405	1.395
Compression index, Cc	cm^2/kg	1.3397	0.100	0.131	0.196
Coefficient of consolidation, Cv	cm^2/s	$2.78*10^{-4}$	$1.39*10^{-4}$	$7.89*10^{-4}$	$7.25*10^{-4}$
Coefficient of volume compressibility, m_v	cm^2/g	$8.01*10^{-5}$	$4.50*10^{-5}$	$6.22*10^{-5}$	$2.64*10^{-5}$
Standard penetration resistance, SPT, N	Blow	0-1	9-10	10-20	36-46

Note: - Layer 1: right on surface, thickness is from 0.50 to 1.50m.
Properties of layers 2, 4, 4a, 5 are following:
- Layer 2: Blackish gray, Organic Clay (OH), - Layer 4: Greenish gray, Clayey Sand (SC)
- Layer 4a: Yellowish gray, Silty Sand (SM), - Layer5: Clay (CH)

(3) Design Layout, Profile and Cross Section of Roads (refer to Fig.5.5)

(a) Layout

Inner road in IWPS composes of the ring road of 6.0m wide and maintenance working space with width of 10 m and length of 60m. A parking space of 12.5m wide and 7.0m long is also provided

(b) Profile Slope:

Profile slope of 0% is applied in relation with flat ground elevation of EL.+2.00m in the IWSP site.

(c) Cross Section

The proposed cross section of inner road is as follows:

- Roadway width of ring road is proposed at 6.0m and no sidewalk is provided. So, total width of inner ring road is 6.0m
- Cross slope of ring road and maintenance working space is designed at 2% and 5% respectively.
- Open space between some buildings and ring road including working space and car parking space is practically use for drainage ditches and planting.

(4) Pavement structure and Concrete Curb

(a) Pavement structure

It is proposed apply the flexible type of road pavement, asphalt concrete pavement, taking into consideration of assumed a traffic volume of 20 – 40 vehicle H10/day and a demand elastic modulus (Eyc) of 1,300 kg.cm^2. Pavement structure of Type P2 is as follows:

- 9 cm Binder course, Asphalt concrete middle size
- Emulsified asphalt Prime coat 1.0~2.0 l/m2
- 10 cm Base course, crush aggregate (size 2~4 cm)
- 20 cm Sub-base course, aggregate size 4~6 cm

Total thickness of pavement is designed to be 39cm. The proposed pavement structure is shown in DWG. No. PC-IWSP-220.

(b) Concrete Curb

Both sides of asphalt concrete pavement are connected with concrete curb with 180W x 210H, which is constructed by cast-in-situ concrete (Concrete Type E). Top elevation of curb is 5cm higher than that of pavement surface.

5.4 Architectural Works of Pump House/O.M Office and Guard House

5.4.1 General

This report presents the outline of the Detail Design of Architectural Works for package C – Intermediate Wastewater Pumping Station. The Detail Design was prepared based on the Concept design which had approved in last stage. The Detail Design aims to develop details sufficient for the tendering of the project under the financial assistance from the Japanese Government and Vietnamese Government. This report explains studies carried out since the Concept Design, and should be read in conjunction with the relevant Tender Drawings, Finish Schedules, Bills of Quantities and Engineer's Cost Estimates, which are prepared and submitted in separate volumes.

5.4.2 Scope of Work

Scope of architectural works includes the following construction:

(a) Construction of Pump House and O/M Office Building
(b) Construction of Generator House
(c) Construction of Guard House

5.4.3 Applicable Codes and Standards

The following codes and standards are applied for the detailed design of pump house and O/M office of the intermediate wastewater pumping station.

(a) National Building Codes of Vietnam, 1999 (TCVN) for construction codes and material requirements.
(b) Fire prevention & fire protection for buildings – Design requirements TCVN 2622 – 1995.
(c) National Building Codes of Japan: JISS & JASS.

5.4.4 Design Condition and Criteria

(1) Overall Concept:
The Design Concept applied for all building is:
- Fit for purpose and function
- Friendly to environment, society of Vietnam
- Harmonize with material market in Vietnam

(2) Pump House and O/M Office Building
The design concept specific to Pump House and O/M Office Building and generator building are:
- Functional and economical
- Equipment operation
- Accordant and united architecture external language in whole project.

5.4.5 Design of Pump House and O/M Office

(1) Building Site

The site of Pump House and O/M Office Building is in district 8, Ho Chi Minh City.

(2) Functional Requirements

Designed to be the operating office building of Intermediate Wastewater Pumping Station; Pump House and O/M Office Building is the combination of office operation and workshop operation, require sound insulation, practical door way and stairway for equipment installation and maintenance.

The total area of ground floor level and its breakdown were estimated from equipment

layout and office operation.

(3) Floor plan

The plan of Pump House and O/M Office is designed under the following considerations (Ref. to Detail Design Drawing No. PC-IWPS-301)

Floor plan includes conveyor room, operator's room, control room, pump room and facilities. All rooms have air conditioning except toilet, which have ventilating fan; pump room, which have roof fan. In order to install equipments, free openings on wall and floor at specified locations fit for purpose. Windows are install for each room to satisfy natural lighting condition and energy saving. In control room, window is opened toward pump room for a wide view watching. Total floor area of the building is as follows:

-	Control Room:	53 m^2
-	Meeting Room:	25.5 m^2
-	Operator's Room:	56.5 m^2
-	Conveyor Room:	35 m^2
-	Toilet:	15 m^2
-	Kitchen:	15 m^2
-	Night Duty:	28 m^2
-	Lobby:	30.5 m^2
-	Pump Room:	392 m^2
	Total:	650.5 m^2

(4) Elevations and Sections

The footprint of Pump House and O/M Office is 28 m x 26.4 m, and the height is about 11.3m (From the ground to the highest of roof ridge) and 7.3m (From the ground to the lower of roof ridge). Minimum height for activity and maintenance of the crane is 7m. The height of entrance with steel shutter in pump room is 4m so as to allow use of equipments.

The super structure is of one story with concrete frames for lower block and steel trust for higher block. The curved roof with zincalume roofsheet is used to suit weather condition, the corrosion resistance, long life, and have the same architectural language in the whole project.

(5) Finishing

The key words of the appropriate finishing materials for O/M office building are:

- Durability

- Low cost
- Ease of maintenance

Proposed exterior and interior finishing schedules are shown in Finish Schedule for Architectural Works, which are prepared and submitted, in separate volumes.

5.4.6 Design of Generator Building

(1) Building site

The site of Generator House is in North West side of Pump House and O/M Office.

(2) Functional requirement

Designed to satisfy operation of 2 generators, require sound insulation, practical door way and stairway for generator installation and maintenance.
The total area was estimated from equipment layout.

(3) Floor plan

The plan of Generator House is designed under the following consideration (Ref. to Detail Design Drawing No. PC-IWPS-324)

In order to install equipments, openings at specified location were opened to fit for purpose. Cable trench is provided. Concrete slab and foundation is designed for heavy duty operation and installation. Total floor area of the building is 154.0m^2.

(4) Elevations and Sections

The footprint of this building is 9.4m x 16.4m, and the height is about 7.8m (From the ground to the top of roof ridge). Required height of equipment installation is 5m. The height of entrance with steel shutter in pump room is 3.5m so as to satisfy equipments moving. The super structure is of one story with concrete frames. The curved roof with zincalume roofsheet is used to suit weather condition, the corrosion resistance, long life, and have the same architectural language in the whole project.

(5) Finishing

The key words of the appropriate finishing materials for Generator building are:

- Durability
- Low cost
- Ease of maintenance

Proposed exterior and interior finishing schedules are shown in Finish Schedule for Architectural Works, which are prepared and submitted, in separate volumes.

5.4.7 Landscape Work

The landscaping of the Intermediate Sewage Pumping Station site shall meet with the tendency of urbanization by residential in this area. Aesthetic landscape design solution shall be essential.

All facility sites shall be enclosed by steel grid fence with 2.3 m in height, main gate post with sliding gate door shall be 5.65m enough for loading trucks goes in and swing door of 1.3m shall be installed next to the main gate.

(1) Landscape facility

Main gate post (pair of posts): 1 (pair) Nos. Steel reinforced concrete post of 565 x 450 x H2500,
Sliding gate door: 4 Nos. for both gates, Size of H=2,000 x W500 x L5,650.
Steel 50 x 50 framed door with wheels on bottom (both side of door) and railway included.

Swing door (swing door with column): 1 No. H2,000 x W1,300 steel 50x 50 framed and the column shall be H2,500 x W 335 x 335 fixing with swing door.

Grid fence: H2,200 x @3,000 span unit of steel bar with base trim. Concrete column of H2,500 x W335 x 220 shall be installed at 3.000 intervals and end concrete column of H2,500 x W335 x 335 shall be installed at corner where fence change it's direction.

(2) Planting

Plantings shall be introduced for establishing aesthetic environment. Medium trees as major objectives shall be introduced for provision of rich greenery with seasonal flowering for the vicinity residential area.

Some flowering shrubs shall be also provided for an accent of the planting layout scheme. Along the enclosure fence hedge plant shall be introduced. Facility spaces except paving shall be furnished with grass for green full environment. All planting work shall required proper size of planting hole and existing soil to be replaced agriculture soil.

(a) Medium size canopy tree:

- *Lagerstroemia tomentosa* 23 Nos. and *Mimusops elengi* 14 Nos. shall be planted.

Both species are H=4.0m, stem diameter is 4cm in 1.2m height from the ground.

- *Mangifera indica* 2 No. *Tamarindus indica* 18Nos. and *Delonix regia* 2 Nos. shall be planted. H=3.0m, stem diameter is 4cm in 1.2m height from the ground. All trees shall be supported by tripod type support with pole individually to sustain trees in stable.

As a palm, *Areca catechu* 6 Nos. shall be planted at office front area. H=3.0m and stem diameter of 15cm in 1.2m height from the ground.

(b) Flowering shrub:

*Ixora chinensis rosa (=Ixora coccina),*11.5m2, *Lantana camara,*9.5m2. and *Hibiscus rosa-sinensis* 27.5m2, shall be planted in total. All flowering shrubs are 40cm in height and crown width is 25cm, Ixora, Lantana and Hibiscus are planted in group with 10 Nos/m2, and they are planted independently in proper location.
Bauhinia purpurea 34 Nos. and *Nerium oleander* 35Nos. shall be planted independently along the fence.

(c) Grass sods and sprigs:

Axonopus compressus 108m2 for grass sods at office entrance area and grass sprigs of 1,585.4m2 for rest of the area.

Fig. 5.7 shows the proposed landscape work.

5.5 Mechanical Works

5.5.1 General

This section covers the applicable codes and standards, design conditions and criteria, system description and key specification of mechanical equipment for workmanship, design, supply, delivery, installation, testing and commissioning of mechanical works at the Intermediate Wastewater Pumping Station (IWPS) comprising emergency gate, fine screen, pumps, pipes, gates, siphon breaker valves, overhead crane and other accessories.

5.5.2 Applicable Codes and Standards

All mechanical plant is to be manufactured and tested in accordance with the Specification and applicable Vietnamese standards. All materials and tests to be furnished under the Contract shall conform to the following standards as applicable.

(a) Japanese Industrial Standard (JIS)

(b) International Standard Organization (ISO)
(c) American National Standards Institute (ANSI)
(d) British Standards Institution (BS)

Other international standards may be accepted, provided that the requirements therein are equivalent to the latest issue of the relevant Japanese Industrial Standard (JIS).
If no standard is indicated, then the relevant Japanese Industrial Standard shall apply.
All electrical equipment shall comply with the requirements and latest revisions of the following codes and standard where applicable:

(e) Japanese Electro - Technical Committee's Standard (JEC)
(f) Japanese Electric Machine Industry Association's Standard (JEM)
(g) Japanese Cable - makers Association Standard (JCS)
(h) International Electrical Committee (IEC)

5.5.3 Design Condition and Criteria

Design condition and criteria has been established, aiming to propose more practical, economical and sustainable project. These are as follows:

(1) Stepwise Construction

IWPS is proposed to construct step by step to meet the design wastewater flow in two phases, of which target year is 2005 and 2010. However, for preparation of the detail design, main features and dimension of each facility and equipment shall be determined basically based on the design criteria of Master Plan and checked its availability on Phase 1 and 2.

(2) Design Wastewater Flow

Design wastewater flow (DWF) for IWPS is to be basically set to meet the wet weather hourly maximum wastewater flow including ground infiltration assumed to be at 10% of daily discharge. DWF in Phase 1 and 2 are estimated as shown in table below.

Phase	Wastewater Flow (m^3/day)			
	Dry Weather			Wet Weather
	Daily Discharge	Infiltration	Max. Daily Flow	Max. Hourly Flow
Phase 1	127,700	12,800	141,000	192,000 (133.3 m^3/min)
Phase 2	426,500	42,700	469,000	640,000 (444.4 m^3/min)
Master Plan	465,500	46,500	512,000	699,000 (485.4 m^3/min)

Note: 1. Wet weather max. hourly wastewater flow is assumed to be at 1.4 times of dry weather daily discharge plus ground infiltration assumed to be at 10% of daily discharge.
2. Target year of Phase 1, 2 and Master Plan is 2005, 2010 and 2020 respectively

(3) Design Water Level (DWL)

Design water levels at the inlet and outlet chambers of IWPS connecting up and down conveyance sewers is planned as the table below:

Place	Design High Water Level (DHWL) (m)			Design Mean Water Level (DMWL) (m)		
	Phase 1	Phase 2	M/P	Phase 1	Phase 2	M/P
Inlet Chamber	-11.59	-10.91	-10.72	-11.74	-11.25	-11.18
Outlet Chamber	+0.10	+0.10	+0.10	-0.11	-0.11	-0.11

Note: 1. DHWL represents water level at wet weather hourly maximum flow of 133.3 m^3/min in Phase 1, 444.4 m^3/min in Phase 2 and 485.4 m^3/min in Master Plan (M/P).
2. DMWL represents water level at wet weather average daily flow of 97.9 m^3/min. in Phase 1, 325.7 m^3/min. in Phase 2.and 355.6 m^3/min. in M/P.

5.5.4 System Description

In general, IWPS consists of two facilities, pumping station and grid chamber. In pumping station, intake chamber, screen and pump equipment, electrical equipment and operation room are to be installed. The grid chamber consists of gate equipment, grit removal equipment and outlet chamber.

(1) Design Water Level and Pump Head

Based on the design water level at inlet and outlet of the conveyance sewer mentioned before, the water levels for design of pump equipment by Phase were estimated as follows:

Phase	Inlet Chamber	Pump Pit		Discharge Sump	Grit Chamber	Outlet Chamber
		Before Screen	After Screen			
Phase 1	-11.59	-11.80	-11.90	+0.20	+0.15	+0.10
Phase 2	-10.91	-11.10	-11.20	+0.20	+0.15	+0.10
M/P	-10.72	-10.90	-11.00	+0.20	+0.15	+0.10

Static pump head (Hs) and total pump head (Ht) are estimated as follows:

Hs = DWL in discharge sump – DWL in pump pit (before screen)
Ht = Hs + Hl
Where, Hl = Hydraulic losses of screen, valves and pipe

Hl is estimated to be about 1.9 m for fine screen, pump and other facilities. Design static head and total pump head are estimated as follows:

Phase	Hs (m)	Hl (m)	Ht (m)
Phase 1	12.0	1.9	13.9
Phase 2	11.3	1.9	13.2
M/P	11.1	1.9	13.0

(2) Siphon System

Siphon system is proposed for design of the pump discharge system taking into consideration of the following technical and economical points.

(a) Area of the pumping station is reduced.
(b) Loss of non-return and butterfly valve is eliminated. As a result, total head of pump is reduced and energy consumption of the motor is also reduced.
(c) Mechanical equipment cost can be minimized.

Instead of non-return valve and butterfly valve, siphon breaker valve is proposed to install at top of pipe to prevent reverse flow from grit chamber when the pump stops. DC motor is proposed as driving unit of the siphon breaker valve in order to open the valve even in case of power failure.

(3) Emergency Gate

The emergency gate is proposed at the inlet of the IWPS in order to prevent excessive storm water flowing into the pump well and the pumping station flooding. The emergency gate will be closed if the suction water level reaches to HHWL and be closed within two (2) minutes by its own weight. The emergency gate can be opened/closed by an electric motor during normal operation.

The storm water, which will be stored in the interceptor will be discharged by the main sewage pumps after the rain stops.

The sizes of emergency gate are proposed to be 2000mm square and 1600mm square for Phase 1 and 2 respectively to maintain the flow velocity through the gate not more than 1.0m/s at maximum daily wastewater flow.

(4) Garbage Disposal Method

Garbage, rubbish and other materials in the sewer water are collected by the fine screen, which is installed in the IWPS. These garbage and other materials are transported by horizontal conveyor and inclined conveyor to the concrete made garbage-collecting box located outside of the station. In Phase 1, the stored garbage in the garbage-collecting box

are cleared by man(s) and transported by the dump truck to the dumping area. Frequency of these works depends on the volume flowing into the station. In Phase 2, garbage, rubbish and other materials will be ground, washed and dehydrated by the grinding equipment, etc. and stored in the hopper.

(5) Gate

Sluice gate of 1,500mm W x 1,500mm H is designed to install at each inlet of grit chamber. These gates are used to dry up and to maintain the grit chamber.

5.5.5 Key Specification of Mechanical Equipment

The mechanical equipment to be required for the installation, operation and maintenance works of the pumping stations are listed in 4.7 "Bill of Quantities".

Key specifications of major mechanical equipment are shown as follows;

(1) Main Pump

Type	: Submersible motor, vertical shaft, mixed flow pump with volute casing
Pump discharge	: 700mm dia.
Number of units	: 3 units
Total capacity	: 133.3 m3/min
Unit capacity	: 66.7 m3/min
Suction water level (before screen)	: DWL – 12.400 LLWL – 13.300
Discharge water level (before grit chamber)	: + 0.550
Expected range of static head	: 12.95 m to 13.85 m (at normal operation)
Designed static head	: 12.95 m
Total dynamic head	: 14.0 m
Pump speed	: Not more than 740 min-1
Motor output	: Not less than 220 kw
Pump rated efficiency	: Not less than 80.0 %
Drive method	: Driven by dry type motor

(2) Emergency Gate

Gate name	: Emergency gate
Type	: Cast iron made, rectangular shape, sluice gate
Quantity	: 1
Effective width	: 2000mm
Effective height	: 2000mm
Design water level	: +1.500 (P)

	-13.500 (A)
Operation water level	: -10.500 (P)
(At emergency case)	-13.500 (A)
Operation water level	: +1.500 (P)
(At normal condition)	-13.500 (A)
Gate sill level	: -13.500
Operating floor level	: +2.500
Operation method	: Close by own weight (at emergency case) Electrical (at normal condition)
Operation speed	: Not less than 1m/min (at emergency case) Not less than 0.3m/min (at normal condition)
Motor output	: Approx. 3.7kw
Electrical supply	: AC380V x 50Hz
Corrosion allowance	: Not less than 5.0mm

Note: (P) – Pressure side, (A) – Anti-pressure side

(3) Fine Screen

Type	: Rotary, continuous raking type
Width of channel	: 3500mm
Height of channel	: 4000mm
Net opening of screen	: 25mm
Installation angle of screen	: 75degree
Designed water level difference	: Not less than 1.0m
Allowable deflection of screen and supporting beam	: Not more than 1/800
Length of rakes	: 300mm
Number of rakes	: 4
Rake speed	: Not more than 5m/min
Motor output	: Approx. 3.7kw
Electrical supply	: AC380V x 50Hz
Quantity	: 1set

(4) Pipe work

Nominal bore	: 700 mm dia.
Material	: Ductile iron conforming to JIS G 5526 and G5527
Number of pipe	: 3 sets
Type of flange	: JIS G 5527 PN7.5
Thickness of pipe	: Not less than 17.0 mm
Hydrostatic test pressure	: Not less than 3.5 kgf/cm2

(5) Siphon Breaker Valve

Nominal bore	: Not less than 150 mm dia.
Type of valve	: Ball type valve
Driving method	: By DC100V motor
Maximum differential pressure	: Minus 4 m
Opening/closing time	: Not more than 22 sec
Frequency of opening	: Not more than ten (10) times per hour
Type of flange	: JIS 10 kgf/cm2 or equivalent
Quantity	: 3 sets

(6) Grit Removal Equipment

Type	: Grab bucket type with traveling crane
Width of chamber	: 5000mm
Height of chamber	: 4000mm
Hoisting capacity	: 2.0ton
Span	: 10.8m
Lifting height	: Approx. 6.9m
Traveling distance	: Approx. 20m
Speed	: Hoisting – approx. 10m/min Traversing – approx. 25m/min Traveling – approx. 30m/min
Motor output	: Hoisting – approx. 3.5kw Opening/closing – 3.5kw Traversing – approx. 0.6kw x 2 Traveling – approx. 1.5kw x 2
Electrical supply	: AC380V x 50Hz
Quantity	: 1 set

Key specifications for other mechanical equipment are referred in Section 10 "Mechanical Works" of the Tender Specification.

5.6 Electric Works

5.6.1 General

This Chapter describes the detailed design base of the electrical facilities for the Intermediate Wastewater Pumping Stations.

(1) Equipment Selection

All electrical equipment shall be selected in accordance with the general principles;

(a) Equipment shall be sufficient rated values.
(b) Future expansion shall be considered.

(c) Operation must be easy with an extended maintenance period.

(2) Scope of Works

The work covers the construction of the complete electrical systems for above mentioned both of Pumping Stations and supply of spare parts for electrical equipment comprising the following items;

(a) 22kV power receiving system (not included to transmission line)
(b) Power distribution system
(c) Emergency Generating system
(d) Instrumentation and control system
(e) Equipment for Intermediate Wastewater Pumping Station
(f) Materials

5.6.2 Applicable Codes and Standards

The equipment, materials, design and test and installation of the electrical facilities shall conform to the local law and regulation and the applicable portions of the latest edition of the standard and codes.

(a) International Electrotechnical Commission (IEC)
(b) Japanese Industrial Standards (JIS)
(c) Standards of Japanese Electrotechnical Committee (JEC)
(d) Standards of the Japanese Electrical Manufactures Associations(JEM)
(e) Vietnam Standards (TCVN)

5.6.3 Site Conditions

IWSP site conditions are summarized below:

(a) Altitude: less than 1,000m above sea level.
(b) Ambient temperature:
  - Maximum: 45^{o}C
  - Minimum: 5^{o}C
  - Design temperature: 40^{o}C
(c) Relative humidity: Maximum: 95%
(d) Climatic atmosphere: Tropical
(e) Wind pressure: 45m/s
(f) Salt contamination:

Unless otherwise specified, under the contract, design for salt contamination of the insulators and bushings shall be applied the following conditions:0.03mg/sq.cm

5.6.4 Design Criteria

The design of the electrical system shall be carried out with the following clarifications.

(1) Electrical system

(a) Power receiving system

Power supply from the electric power company will be one-circuit of 15(22)kV overhead lines and connected to the 15(22)kV/380V receiving transformer in the substation within Pumping Station. The technical parameters of electrical power from the electric power company will be as follows:

- Voltage system: AC15(22)kV, 50Hz, 3 phase 3wire,Solidly grounded
- Voltage variation: ±5%
- Frequency variation: ±2%

(b) Power distribution system

Power distribution trough out the Intermediate Wastewater Pumping Station shall be 50Hz, at the following voltage levels with an earthing system:

Power Distribution System

Service	Rated voltage	Phase/Wire	Earthing	Remarks
Power receiving (Transmission line)	15(22) kV	3/3	Solid	with earthing wire
Low voltage distribution				
Power	380 V	3/4	Solid	
Lighting & Miscellaneous	380/220 V	3/4	Solid	

(c) Equipment and load voltage rating shall be as follows:

Equipment and Load Voltage

Service	Rated voltage	Phase/Wire	Remarks
Motor	380 V	3/3	
Lighting fixtures & Convenient sockets	220 V	1/2 + E	E: Earthing

(2) Allowable Voltage Drop

The maximum allowable voltage drops in cables, as a percentage of system nominal line to line voltage, a full load shall be as follows:

(a) Main power distribution:
- 380 volt motor: 5%

(b) Total voltage drop at the terminal of low voltage motor shall not exceed 20% during staring period.

(c) Voltage drop between lighting panel-board and the furthest fixture shall not exceed 3% Voltage drop between main distribution board in substation and local lighting panel-board shall not exceed 2%.

(3) Transformer sizing

The transformer shall be sized for the maximum demand of load connected to the associated switchgear plus 10 to 15% spare capacity for design allowance and/or future expansion.

The maximum demand of load shall be calculated by summing up the following loads.

(a) The normally running loads.

(b) 30% of the intermittent loads (i.e. pumps, etc.)

(4) Cable sizing

The cable shall be sized based on the thermal limits in normal service conditions, and the maximum allowable voltage drops in the circuit. The current carrying capacity (thermal limit) of cables in normal service condition shall take account of the de-rating due to the laying conditions or grouping. The cables for main power distribution system shall be sized also to withstand without damage the maximum short circuit thermal stress for the full clearance time of the protective devices (i.e. fuses, or circuit breakers with protection relays). The current rating of the circuit for cable sizing shall be as follows:

(a) The transformer primary and secondary cables shall be coved on the rated current of the transformer.

(b) For switchgear/panel feeder circuit without a transformer, cables shall have a current carrying capacity equal to the maximum demand of loads connected to the switchgear/panel with 10% surplus.

(c) The motor feeder cables shall be sized based on the 110% of motor name-plated rated current.

(d) Other cables not mentioned above shall be covered to the maximum current demand.

(5) Lighting Arrangement

The lighting fixture shall be designed and arranged for required areas so as to meet the following illumination level:

Illumination Level

Installation Location	*Illumination Level (Lux)	Elevation	Remarks
Office	300	Floor	Architecture Works
Meeting Room	250	Floor	Architecture Works
Worker Room	100	Floor	Architecture Works
Tea Room	100	Floor	Architecture Works
Night Duty	50	Floor	Architecture Works
Lobby	50	Floor	Architecture Works
Toilet	50	Floor	Architecture Works
Storage Room	50	Floor	Architecture Works
Stairway	50	Floor	Architecture Works
Corridor	50	Floor	Architecture Works
Control Room	250	Floor	Architecture Works
Electric Room	100	Floor	Architecture Works
Substation (Outdoor)	20	Floor	Electrical Works
Generator Room	100	Floor	Architecture Works
Pump Room	50	Floor	Architecture Works
Outdoor Area	10	Floor	Architecture Works

*Averaged Illumination levels

5.6.5 System Description

(1) General

Electrical system for Intermediate Wastewater Pumping Station consists three systems such as power supply system, control system and instrumentation system. Each system is to be related with closely for operation of plant equipment.

(2) Power supply system

Power receiving system for main substation for Intermediate Wastewater Pumping Station is 3 [three]-phase, 50Hz. 2 [two]-circuit of 15(22) kV line. Power will be supplied from two souses of distribution substation owned by HCMC Power Company. Power sources are Chanh Hung Substation and Phu Dinh Substation through Wastewater Treatment Plant. Main substation distributes and supplies power to electric room by power cable with voltage 22kV. Electric room transfer voltage from 22kV to 380/220V by transformer and supply power to each equipment in the pumping station through motor control centers or AC distribution panels.

(3) Control and instrumentation system

The control and instrumentation equipment installed in control room shall have the following functions:

(a) Supervisory panel

Supervisory panel shall be indicated pump operating condition, fault indication and instrument indication for substation, emergency generator, lift pump equipment and miscellaneous equipment.

(b) Equipment operation

Operation of the mechanical equipment, such as pumps and gates, shall be controlled by the local control panel near the equipment.

- Manual operation: Local control
- Automatic operation: Automatic sequential operation by the water level

(c) Other

Outdoor lighting switchboard shall be installed in control room.

5.6.6 Key Specification of Electrical Equipment and Instrumentation

Key specifications of the major items are described as follows:

(1) Power receiving system

15(22) kV transmission line

(a) Power supply from the electric power company will be two [2] nos. of 15(22) kV underground cable lines and connected to the 22kV C-GIS in the 22kV substation within the Intermediate Wastewater Pumping Substation [IWPS].
(b) The technical data of electric power from the electric power company will be as follows;

- Power capacity of receiving system :
  Phase-1: 1 x 1500kVA – 15(22)/0.4kV transformer
  Phase-2: 1 x 1500kVA + 1 x 2500kVA-15(22)/0.4kV transformers
- Power supply substation:
  Source-1: From 110kV Chanh Hung Substation
  Source-2: From 110kV Phu Dinh Substation through Wastewater Treatment Plant [WWTP]
- Voltage system: AC15(22)kV–50Hz-3phase/3wires-Neutral solidly earthed
- Transmission line cable: This underground cable line will be laid by the electric power company

From Chanh Hung Substation to IWPS: XLPE 24kV-2circuit (250mm^2, 3core), 1850m
From WWTP Substation to IWPS: XLPE 24kV-2circuit (250mm^2, 3core), 3283m

22kV Main Substation (C-GIS)

(a) Power supply from the electrical company shall be connected to the 22kV C-GIS (Cubicle type SF6 Gas insulated Switchgear) in the main substation.
(b) The 24kV Metal-enclosed SF6 Gas Insulated Switchgear installed in the main substation shall be of outdoor use cable connected cubicle type, corrosion resistant vermin-proof and be mounted on steel base channels.
- Rated voltage: 24kV
- Rated current: 1200A, 600A
- Rated short-circuit breaking current: 31.5ka, 25kA

(2) Power distribution system

Distribution system equipment

(a) Power transformer

The main transformer installed in the electric room shall be of 50Hz, outdoor use, three-phase, oil-immersed, self-cooled with diaphragm conservator and on-load tap changer.

- Rated primary voltage: 15(22)kV
- Rated secondary voltage: 380 – 220V
- Rated capacity: 1500kVA
- Primary auxiliary tap: 15kV(22kV)
- OLTC Tap voltage: 15kV ± 5%, (22kV ± 5%)
- Impedance voltage (Design value): 15% at 15kV, 7% at 22kv
- No load loss (Design value): Less than 1.0kW at 15kV
  Less than 3.0kW at 22kV

(b) Low Voltage Metal-enclosed Switchgear

The low voltage metal-enclosed switchgears installed in the electric room shall be indoor use, metal enclosed and self-standing type, and shall include necessary protection devices, circuit breakers and accessories.

- Rated voltage: 600V
- Rated current: 2500A
- Rated short-circuit breaking current: 65kA
- Bus bar rating: 3 phase 4 wire, 2500A

(c) Low Voltage Static Capacitor and Series Reactor Panel

The static capacitor and series reactor panel(s) installed in the lift pump electric room shall be of indoor use, metal enclosed and self-standing type, and shall include necessary automatic power factor control equipment with protection devices.

- Type: Indoor, hermetically sealed (Capacitor only)
- Capacity: Improved power factor 0.9
- Rated voltage: 380V

(d) Sewage Pump Starter Panel

The sewage pump starter panels installed in the electric room shall be of indoor use, metal enclosed and self-standing type, local remote operation and shall include necessary motor starting equipment with protection device and accessories.

- Type: Circuit transition auto-transformer starting type
- Motor capacity: 220kW
- Motor voltage: 380V
- Rated voltage: 600V
- Circuit breaker type: Air circuit breaker, 3 phase, with alarm contact, 600V - 1000A - 25kA

(e) Motor Control Center (CC)

The motor control center installed in the electric room shall be of indoor use metal enclosed and self-standing type, and shall include necessary motor starting equipment with protection device, accessories and motor control relay panel(s). Each molded case circuit breaker unit shall be housed inside a separate compartment and shall be closed on front side. The hinged lockable door shall be provided at the front. The hinged door shall be interlocked with the breaker positions, such that the door cannot be opened unless the breaker is in "isolated position".

- Type: AC380V-3 phase/4 wire-600A-35kA
- Type of start circuit: Motor capacity less than 30kW-Direct start
  Motor capacity over 30kW-Star-Deita start

(f) DC Power Supply System

The DC power supply system shall supply essential DC power to critical loads such as electrical switchgear control circuits, emergency shutdown system, etc. The DC power supply system installed in the electric room and generator room shall be indoor use, metal enclosed and self-standing type, and shall include necessary protection device and accessories. The DC power supply system shall be rated 110V DC (nominal voltage), un-earthed (floating earth), with a back-up battery bank for a 30 minute period.

(g) Local Motor Control Panel and Switch Box

The local motor control panel and switch box shall be metal enclosed, corrosion resistant, vermin-proof and shall include necessary motor control equipment, meter and accessories. All motor control devices such as control switches, meters and indication lamps shall be mounted on panel. Outdoor type local motor control panel shall be weatherproof and shall have self-ventilating device.

(3) Emergency Generator Equipment

The emergency generator installed in generator room shall be normally on stand-by, manually started and connected to the low voltage switchgear when the normal power supply is lost. The emergency generator shall be rated suitable for continuous operation for at least 3 hours and shall supply power to the one (1) 220kW sewage pump and emergency gate loads through a low voltage distribution panel. One (1) set of emergency generator shall be indoor use, medium speed heavy duty water cooled, soundproof enclosed type, three phases AC synchronous generator with the following specification.

(a) Diesel engine:

- Type: 4 cycle, water cooled
- Output: More than 570kW
- Engine starter: Electric motor starter
- Rated speed: 1500 rpm
- Fuel: Diesel fuel oil
- Governor: Electro static type

(b) Generator:

- Type: Horizontal shaft, self-ventilated type
- Rated capacity: 750kVA
- Rated voltage: 380v
- Rated frequency: 50Hz
- Rated speed: 1500 rpm
- Number of pole: 4 poles
- Phase/wire: 3 phase/4 wires
- Power factor: 80% (lagging)
- Excitation: Brussels

(c) Generator auxiliary equipment

The following equipment shall be installed with generator:

- Generator control panel
- Fuel tank: Capacity for 3 hours operation
- DC power supply system

(4) Communication System

The communication system installed in the plant area shall be of indoor use, rack mounted exchanger with paging speakers, and master and local station intercom system. The communication system shall be provided following function;

- Individual zone broadcast and paging
- Paging announcement with microphone
- Paging announcer for intercom station
- Master-Local and Local-Local communication
- Public telephone interface

(5) Instrumentation and Control System

(a) Level Meter

The level meter installed in the pump station area shall be as following type:

- Submerged Diaphragm Type Level Meter
  The submerged diaphragm type level meter shall be measured the water level by detecting water pressure with detection element installed in the water.

(b) Level Control Switch

The level control switch installed in the plant area shall be as following type:

- Electrode Type Level Control Switch
  The electrode type level control switch shall be measure the water level by the difference between energizing of the electrode and interruption of electrode.

(c) Supervisory Panel

The supervisory panel installed in the control room shall be of indoor use, metal enclosed and self-standing type.

(6) Earthing System

(a) General

The exposed metal frames of all electrical apparatus and machinery not forming parts of the electric circuits, neutral of transformers, etc., shall be grounded.

(b) Earthing conductor, plate and rods

The following materials shall be used for earthing systems;

- Earthing conductor
- Annealed copper stranded conductor.
  The Contractor shall be calculated and selected the adequate size of conductors for main mesh, arrester, transformer neutral connection and each equipment earthing conductors.
- Earthing plate
  90 cm square, 1.5 mm thickness copper plate or equivalent
- Earthing rods
  16 mm diameter, 3 m length copper clad steel rod with coupling
- Connectors
  Compression type connectors which shall be able to connect the annealed copper stranded conductors each other, earthing plate and rod.

(c) Earthing works

- Earthing rods, plate and conductors shall be buried deeper than 0.6 m or more from

the ground surface.

- The connection between earthing conductor and ground rod, plate and equipment connection conductor shall be electrically and mechanically rigid.
- Earthing systems of the instruments equipment shall be done by separately from common ground
- The earthing for transformer neutrals and lightning arresters, earthing rod shall be installed in additionally for interconnections with earthing mesh.
- Boundary fences shall be earthed by means of earthing rods, separately from the main earthing mesh.

(7) Materials

This section covers cables, conduits, pull boxes, cable ducts and trays which will be used for the main circuit and secondary circuit of power, control, instrumentation and other requirement.

Power Cables, Control Cables and Instrument Cables

Conductor size for cables shall be adequate for the load requirements, voltage drop, short circuit current, and diversity factor for individual circuit application.

(a) Power cables

- 600V power cables for motor circuit, heater circuit and other power circuits shall be of jacket type, 600 V cross-linked polyethylene insulated PVC sheathed type (CV).
- 600 V cross-linked polyethylene insulated PVC sheathed, welded and corrugated steel armoured PVC sheathed power cable (CVMAZV) shall be used for burred portion in the ground of outdoor lighting power cables.
- Section area of cores for 600 V power cables shall not be less than 3.5sq.mm.

(b) Control and instrumentation cables

- Except for small wiring of equipment, control cables shall be of jacket type, 600 V polyvinyl chloride insulated and sheathed control cable with copper tape shielding (CVV-S).
- Section area of cores for control and instrumentation cables shall not be less than 2.5sq.mm. In case of important circuits, such as section areas of CT and VT circuits shall be 3.5sq.mm or more. In consideration of cables, the Contractor shall, if possible, design in such a manner that the size of cores or cables shall be unified.

Steel conduits and flexible conduits

Steel conduits shall be steel, hot-dipped galvanized and equipped with couplings and thread protector caps. All surfaces and threads shall be coated with zinc. The sectional areas of a steel conduit shall be, at least, 2.5 times the total cross sectional area of cables to be pulled in.

- Rigid steel conduits shall be installed for all exposed cable route.

- PVC coated conduits shall be installed for corrosive area cable route.
- Couplings and elbows shall be of the same materials as conduit pipes.

(a) Flexible metal conduits shall be used for flexible cable connection route. Flexible metal conduits shall have a interlocked flexible galvanized steel core with a permanently bonded outer polyvinyl chloride jacket.

Boxes and Fittings

The pull boxes, outlet boxes, fittings and covers shall be of mild steel and/or cast iron alloy with adequate strength and have sufficient size to provide free space for all conductors enclosed.

- Pull boxes shall be sufficient size to accommodate the connected conduits and enclosed conductors.
- Boxes and fittings shall be plated by melting zinc or coated with rust-preventive paint and tow or more finish coatings.
- Outlet boxes shall be of galvanized steel, square and of sufficient size to accommodate all the required conductors enclosed in the box.

Supporting Steel Materials

The supporting steel materials shall be of hot-dipped galvanized steel with adequate strength for support conduits, cable tray and/or wiring duct.

Outdoor Lighting

The pumping station shall be equipped with outdoor lightings apparatuses at appropriate areas. The Contractor shall provide all necessary materials and furnish complete lighting systems.

In the selection of lamps and fittings consideration should be given to ensure the maximum lamp life, the minimum likelihood of internal moisture accumulation, and also effects of vibration, operating temperature, and breathing.

Types of outdoor lighting fixture shall be of straight pole with pole head type lighting fixture and equipped with screwed base lamp holders, and shall be of high power factor suitable for stable operation in tropical climate and weatherproof type. The lamp shall be of high pressure sodium type and approximately 360 W rating.

Lighting supports for outdoor lighting shall be of base plate type steel poles painted with suitable colour. Ballast, cut out switch and terminals shall be equipped in the pole and other attachments necessary for wiring and fixing of the lighting fixtures shall also be provided with the pole.

The Contractor shall provide suitable outdoor lighting switch box for lighting systems. The lighting switch box shall be indoor use, metal enclosed wall mounted type and switching operated by manual at control room. The Contractor shall be provided enough capacity of branch circuit breakers for high pressure sodium lights to avoid tripped by increase of starting current. 600 Volt PVC insulated wires of 3.5sq.mm in size shall be laid in the lighting pole for connection from the lighting switch box to the lighting fixtures.

5.7 Work Quantities

Work Quantities of Package C: Intermediate Wastewater Pumping Station Construction Project are summarized in Table 5.2 (1/3) to (3/3). Details of Work Quantities are compiled in Design Report, Volume III

5.8 Construction Plan and Schedule

This section deals with the construction plan and schedule of Package C : Intermediate Wastewater Pumping Station.

5.8.1 Basic Conditions

For preparation of construction plan and schedule, the following considerations have been taken as a basic concept of construction works.

(1) Scope of Package C Project

Package C: Intermediate Wastewater Pumping Station Construction Project consists of the following main construction component:

(a) Construction of Pumping Station
- Diaphragm Wall work
- Excavation work
- H section steel strut work
- Construction of Pumping Station work
  * Civil work
  * Architectural work (Pump house and O/M office)
- Mechanical and Electrical work

(b) Construction of Grit Chamber
- Excavation work
- Construction of Grit Chamber work
- Mechanical and Electrical work
- Backfill work

(2) Other Conditions

(a) Mode of construction:
The construction shall be carried out by sufficient contractor(s) selected through the International Competitive Bidding (ICB).

(b) Availability of Construction Plant and Equipment:
The major construction works shall be conducted by applying heavy equipments which mostly procured locally due to the limited construction period and quality control of construction.

(c) Construction Materials
Most of basic construction materials are available in this country. Some particular processed materials (steel sheet pile, H type steel beam, mechanical and electrical equipments etc) are to be procured from outside.

(d) Pattern of Construction Method
Main work comprises of diaphragm wall work, earth work, steel strut work, concrete work, architectural work, and mechanical and electrical works.
Diaphragm wall work, steel strut work and earth work are planned to be conducted by heavy machinery (special excavator for diaphragm wall, backhoe, clamshell, truck crane, concrete pump, etc.) in combination with manpower. While, excavation for bottom slab level shall be conducted by manpower.

5.8.2 Major Works of the Project

Major works of Intermediate Wastewater Pumping station Project consists of the followings:

(1) Construction of Pumping Station

(a) Diaphragm wall work
Diaphragm wall work is to make a concrete wall in the under ground soil for temporary wall to prepare the deep excavation. At first, a guide wall is to be constructed along the designed wall to ensure a vertical accuracy of diaphragm wall. Excavation shall be conducted by special excavator, and pouring a bentonite liquid to stabilize a surface of excavated wall. After finishing excavation of wall, a reinforcement cargo is inserted and the bentonite liquid is replaced by concrete to make a designed wall. This wall is utilized as the permanent wall.
Construction method of diaphragm wall is shown in Fig.5.8.

(b) Excavation and steel strut work
Excavation shall be conducted by backhoe up to excavation depth of GL - 5.00m,

and for depth of more than GL - 5.00 m, it is conducted by clamshell. H section steel shall be installed as a strut against earth pressure and water pressure that affect to the wall. Steel strut shall be installed by truck crane.

(c) Construction of pumping station

1) Civil work

Civil work of pumping station is to construct reinforced concrete structures of pumping station. Structures are mainly under ground part.

Civil works consist of following works.

- Bar arrangement work
- Forming work
- Concrete work
- Removal of forming work

Concrete placing shall be conducted by concrete pump. Concrete structures shall be constructed in combination with mechanical and electrical equipments installation.

2) Architectural work

Architectural work is to construct pump house and O/M office. Generator room and Guard house are included to the architectural works. Architectural structures also shall be constructed in combination with mechanical and electrical equipments installation.

3) Mechanical and electrical works

Mechanical and electrical works are to install mechanical and electrical equipments into the pumping station. Installation of equipments shall be conducted according to drawings and specifications. Ventilation system of pumping station is included in mechanical works. Testing of the works shall be done after all equipments are installed.

(2) Construction of Grit Chamber

(a) Excavation work

Because of shallow structure of grit chamber, open cut method is used for excavation of grit chamber. Due to shallow depth of excavation, back hoe shall be applied for excavation.

(b) Construction of Grit Chamber

After excavation is finished, timber pile shall be drived for foundation of grit chamber.

Construction of grit chamber consist of following works.

- Bar arrangement work
- Forming work
- Concrete work

- Removal of forming work

  Concrete placing shall be conducted by concrete pump. Concrete structures of grit chamber shall be constructed in combination with mechanical and electrical equipments installation. No architectural works for construction of Grit chamber.

(c) Mechanical and electrical works

Mechanical and electrical works are to install mechanical and electrical equipments into the grit chamber. Installation of equipments shall be conducted according to drawings and specifications. Testing works shall be done after all equipments are installed.

(d) Backfill work

After construction is finished, backfill shall be conducted. Black sand will be used for material of backfill.

5.8.3 Construction Schedule

To consider the construction conditions, such as possible working area, working items, applicable construction machines and numbers, construction period for each works are expected as follows:

(1)	Preparatory Work	2 Months
(2)	Diaphragm wall Work	4 Months
(3)	Excavation Work for Pumping Station and Grit Chamber	6 Months
(4)	Pilling Work for grit Chamber	1 Month
(5)	Structure Work for Pumping Station and Grit Chamber	12 Months
(6)	Backfill Work for Pumping station and Grit Chamber	2 Months
(7)	Architectural Work for Pumping Station	11 Months
(8)	Mechanical and Electrical Work	8 Months
(9)	Landscape Work	5 months
(10)	Cleaning and Handing Over	2 Months

Construction schedule of Intermediate Pumping Station is shown in Table 5.3.

TABLE 5.1 COMPARATIVE TABLE OF EARTH RETAINING WALL

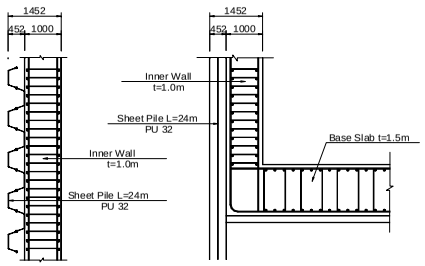
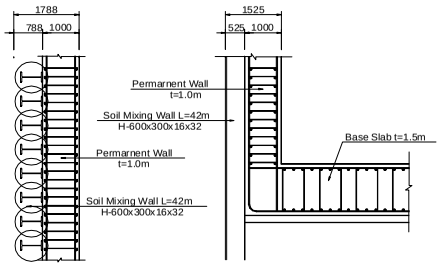
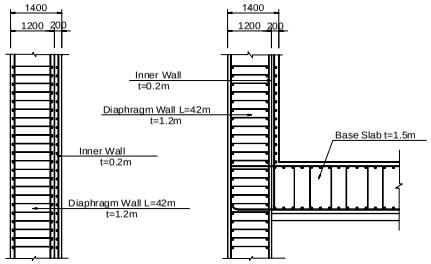
	Sheet Pile Method	Soil Mixing Wall Method	Diaphragm Wall Method
General Figure			
Outline of Method	Driving a sheet pile into the soil continously by slice each sheetpile to make a watertight wall. Sheetpile is temporary wall. After excavation inside, construct a structure and take off the sheetpile. Maximum excavation depth is arround 25 m. Allowable capacity for earth pressure is small compared with another method. Most suitable driving methode is jacked pile method by using a earth auger. This method is suitable for silt soil, sand soil and clay soil	Excavation a soil by earth auger (D = 900mm) with pouring a cement mortar. Construct a watertight wall by mixing a cement mortar and existing soil. To make a core, H section steel (600x300x16x32) is put into a wall. After finishing of excavation, it is necessary to construct a structure inside. Because this wall is temporary wall. Maxximum excavation depth is arround 50 m. Allowable capacity for earth pressure is bigger than sheetpile.	Excavate a soil (width 1.20 m) by using a bentonite liquid to stabilize a surface of soil. After excavation, insert a reinforcement and replacement a bentonite liquid with concrete to make a watertight wall. This wall use for permanent structure. It is necessary to attach a thin wall (t = 200mm) after excavation of inside. Maximum excavation depth is arround 60 m. But it is possible to excavate a 100 m depth. Allowable capacity foy earth pressure is biger than other method.
Adaptability to Ground Condition	Excavation depth is to deep and the soil around a bottom of excavation is not hard, strong stress should occur to sheetpile. It is necessary to take measures to stop the occurrrence of strong stress.	Some measurement is necessary to stabilize a soil arround bottom of excavation soil. Suitable method for existing soil condition, because allowable capaciy for earth pressure is big.	Some mesurement is necessary to stabilize a soil arround bottom of excavation soil. Suitable method for existing soil condition, because allowable capacity for earth pressure is big. Bentonite liquid is not leak to soil, because coefficient of permeability of sand is very low.
Supplemental Methods	To stabilize a soil arround bottom of excavation and to stop the occurrence of strong stress for sheetpile, some measurement are necessary. Such as lowering of groundwater level method or soil improvement method. It is difficult to take a method of lowering of groundwater level. Because coefficient of permeability of sand is very low. Soil improvement method is suitable method.	To stabilize a bottom soil, the tip point elevation of wall should reach to good soil (CH layer, GL -40m) Other measure is not necessary.	To stabilize a bottom soil, the tip point elevation of wall should reach to good soil (CH layer, GL -40m). Other measure is not necessary.
Cost	Sheetpiles construction cost Soil improvement cost Inner wall construction cost (t = 1000mm) 1.00	Soil Mixing Wall construction cost Inner Wall construction cost (t = 1000mm) 0.94	Diaphragm Wall constructin cost Inner Wall construction cost 0.81
Assesment	× Soil improvement is necessary	△ Cost is expensive than Diaphragm Wall Method	○ Cost is cheap and structure is strong

TABLE 5.2 (1/3) WORK QUANTITIES OF INTERMEDIATE WASTEWATER PUMPING STATION

No.	Item	Unit	Total
A. Civil Works			
A.1 Clearing and Grubbing		m2	6,400
A.2 Demolition of Existing Revetment		m3	0
A.3 Earth Work			
3.1 Excavation			
3.1.1 Common Excavation for P.S.		m3	12,490
3.1.2 Common Excavation for G.C			3,180
3.1.3 Excavation for Diaphragm Wall			6,390
3.2 Backfilling by Excavated Materials			1,650
3.3 Sandy Soil Backfill			55
3.4 Sand Backfill			30
3.4 Sandy Soil Fill			6,930
3.5 Sand Bedding			243
A.4 Concrete			
4.1 Concrete Type C for Diaphragm Wall		m3	6,000
4.2 Concrete Type E			
4.2.1 Pumping Station			2,320
4.2.2 Grit Chamber			480
Total			2,800
4.3 Concrete Type F			
4.2.1 Pumping Station			100
4.2.2 Grit Chamber			0
Total			100
4.4 Concrete Type G			
4.2.1 Pumping Station			90
4.2.2 Grit Chamber			50
Total			140
A.5 Forming			
5.1 Pumping Station		m2	7,250
5.2 Gr	5.2 Grit Chamber		1,130
Total			8,380
A.6 Reinforcing Bar			
5.1 Diaphragm Wall		kg	600,000
5.2 Pu	5.2 Grit Chamber		232,000
5.3 Grit Chamber			38,400
Total			870,400
A.7 Shear Connector for Diaphragm Wall		kg	18,170
A.8 Water Stop for Diaphragm Wall		m	670
A.9 Cement Screed Surfacing for Pumping Station		m2	55
A.10 Steel Balustrade		kg	1,530
A.11 Fabricated Manhole Cover			
5.1 Pumping Station		kg	120
5.2 Gr	5.2 Grit Chamber		40
Total			160
A.12 Ladder Rungs			
5.1 Pumping Station		No.	220
5.2 Gr	5.2 Grit Chamber		23
Total			243
A.13 Timber Piling for Foundation of Grit Chamber		m	11,070
A.14 Landscape Works			
14.1 Gate and Fence			
14.1.1 Main Gate Post		set	1
14.1.2 Sliding Gate Door		set	1
14.1.3 Swing Door		set	1
14.1.4 Fence (Type A)		m	325
14.2 Planting Work			
14.2.1 Tree		ton	65
14.2.2 Shrub		m2	119
14.2.3 grass Sod and Spring		m2	1,700

TABLE 5.2 (2/3) WORK QUANTITIES OF INTERMEDIATE WASTEWATER PUMPING STATION

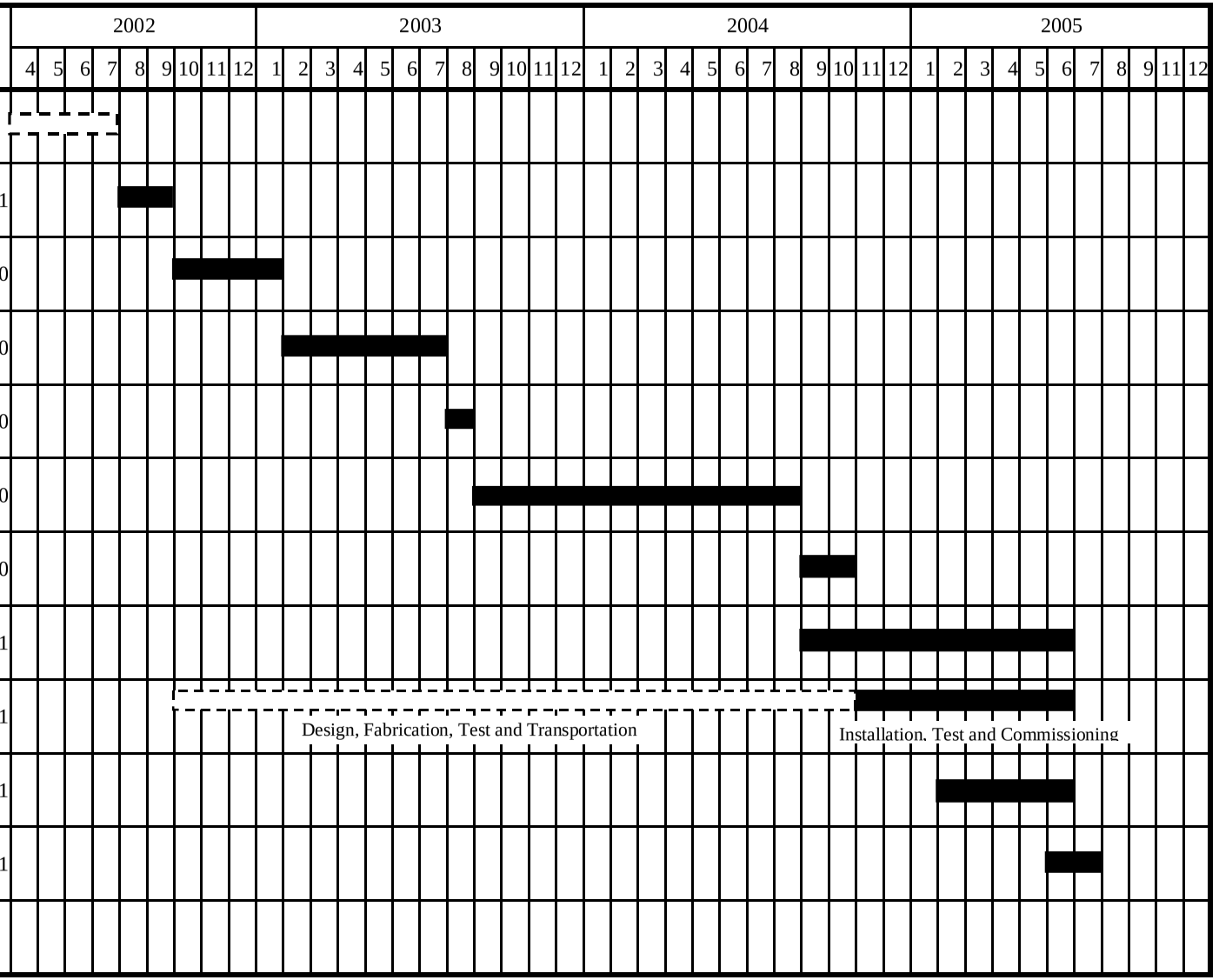
No.	Item	Unit	Total
A.15 Road Works			
	15.1 Concrete Curb w/ leveling concrete and gravel bedding	m	590
	15.2 Subgrade Preparation	m2	2,365
	15.3 Sub Course	m3	475
	15.4 Base Course	m3	240
	15.5 Asphalt Binder Course	ton	470
	15.6 Asphalt Prime coat	litre	3,450
			3,550
A.16 Storm Water Drainage System			
	16.1 Pipe Foundation (Timber Piling)	m	1,150
	16.2 Pipe Installation (600 dia.)	m	23
	16.3 Concreting		
	16.3.1 Concrete Type E	m3	125
	16.3.2 Concrete Type G	m3	50
	16.4 Reinforcing Bar	kg	9,100
	16.5 Precast Reinfoeced Concrete Cover	No.	10
	16.6 C 16.3.6 Ladder Rungs	No.	7
B. Archutectural Work Quantities			Refer to Work Quantities in Design Report, Volume III
	B.1 Construction Pump House and O/M Office		
	B.2 Construction of Generator Building		
	B.3 Construction of Guard House		
C. Mechanical Works			
	C.1 Mechanicak Equipment		
	C.1.1 Main Pump (700mm dia.)	set	3
	C.1.2 Pipe Work (700mm dia.)	set	3
	C.1.3 Siphon Break Valve (150mm dia.)	set	3
	C.1.4 Portable Type Drain Pump (50mm dia.)	set	1
	C.1.5 Portable Type Drain Pump (100mm dia.)	set	1
	C.1.6 Overhead Crane (10ton)	set	1
	C.1.7 Emergency Gate (2.0mWx2.0mH)	set	1
	C.1.8 Stop Log (3.5mWx4.0mH)	set	2
	C.1.9 Rotary Fine Screen (3.5mWx4.0mH)	set	1
	C.1.10 Bar Screen (3.5mWx4.0mH)	set	1
	C.1.11 Holizontal Conveyor (750mmWx6.5mL)	set	1
	C.1.12 Air Inlet fan (Centrifugal Type)	set	1
	C.1.13 Air Inlet Fan (Axial Flow Type)	set	1
	C.1.14 Exhaust Fan (Axial Flow Type)	set	1
	C.1.15 Exhaust Fan (Wall Mounted Type)	set	2
	C.1.16 Sluice Gate (2.0mWx1.2H)	set	2
	C.1.17 Grit Removal Equipment	set	1
	C.1.18 Spare parts	lot	1
	C.1.19 Weather Cover	pieces	2
	C.1.20 Frame For Wall Mounted Fan	pieces	4
	C.2 Duct Work		
	C.2.1 Rectangular Duct Galvernized steel plate)	m2	227
	C.2.2 Spiral Duct (150mm dia - 600mm dia.)	m	149
	C.2.3 Flexible Joint	set	3
	C.2.4 Outlet (1200mmWx900mmH)	pieces	3
	C.2.5 Outlet (800mmWx800mmH)	pieces	2
	C.2.6 Outlet (350mmWx350mmH)	pieces	5
	C.2.7 Outlet (300mmWx300mmH)	pieces	6
	C.2.8 Outlet (250mmWx250mmH)	piece	1
	C.2.9 Inlet (900mmWx1500mmH)	pieces	4
	C.2.10 Inlet (1000mmWx800mmH)	pieces	4
	C1.2.11 Adjustable Damper	L.S.	1
	C.2.12 Chamber Box	L.S.	1
	C.2.13 Box for Outlet	L.S.	1

TABLE 5.2 (3/3) WORK QUANTITIES OF INTERMEDIATE WASTEWATER PUMPING STATION

No.	Item	Unit	Total
D. Electrical Works			
	D.1 22KV Substation (MSUB)		
	D.1.1 22kv Incomming C-GIS unit	sets	2
	D.1.2 22kv Bus C-GIS unit	set	1
	D.1.3 23kv Metering C-GIS unit	set	1
	D.1.4 24kv Transformer Primary C-GIS unit	set	1
	D.1.5 Others (refer to Design Report, Volume III)	L.S.	1
	D.2 Electrical Room		
	D.2.1 Main Transformer with OLTC	set	1
	D.2.2 1500kVA TR Secondary Panel	set	1
	D.2.3 1500kVA TR Secondary Duct	set	1
	D.2.4 750kVA Generator Incoming panels	set	1
	D.2.5 220kw Lify PumpStarter Panel	set	3
	D.2.6 380V Capacitor / Reactor	set	3
	D.2.7 AC Distribution Panel	set	1
	D.2.8 Motor Control Center	set	3
	D.2.9 Ry Panel for MCC	set	1
	D.2.10 DC Power Supply System	set	1
	Others (refer to Design Report, Volume III)	L.S.	1
	D.3 Control Room (CTCR)		
	D.3.1 22kv Control and Protection Panel	set	1
	D.3.2 1500kVA TR OLTC Panel	set	1
	D.3.3 Supervisary Panel	set	1
	D.3.4 Billmetering Panel	set	1
	D.3.5 Communication System	set	1
	D.3.6 Others (refer to Design Report, Volume III)	L.S.	1
	D.4 Generator Room		
	D.4.1 750kVA, 380V Diesel Engine Generator	set	1
	D.4.2 main Fuel Tank	set	1
	D.4.3 Generator Control Panel	set	1
	D.4.4 Generator Primary Circuit Break Panel	set	1
	D.4.5 DC Power Supply System	set	1
	D.4.6 Others (refer to Design Report, Volume III)	L.S.	1
	D.5 Instrumenttation Equipment		
	D.5.1 Submerged Diaphragm Type Water Level Mete	set	2
	D.5.2 Electroe Type Water Level Control Switch	set	3
	D.5.3 Others (refer to Design Report, Volume III)	L.S.	1
	D.6 Local Control Panel		
	D.6.1 Local Contro Pamelfor Motors	set	10
	D.6.2 Local Control Panel for Instreument	set	2
	D.6.3 Others (refer to Design Report, Volume III)	L.S.	1
	D.7 Outlet Lighting Equipment		
	D.7.1 Outerdoor Lighting Switch Box	set	1
	D.7.2 Others (refer to Design Report, Volume III)	L.S.	1

TABLE 5.3 CONSTRUCTION SCHEDULE OF PACKAGE C (INITERMEDIATE WASTEWATER PUMPING

No.	Major Work Item	Unit	Quantity
1	Relocation and Tendering		
2	Preparatory Work	L.S.	1
3	Diaphragm Wall Work	m^3	6,000
4	Excavation Work for Pumping Station and Grit Chamber	m^3	15,670
5	Piling Work for Grit Chamber	m	11,070
6	Structural Work for Pumping Station and Grit Chamber	m^3	2,800
7	Backfill Work for Pumping Station and Grit Chamber	m^3	8,660
8	Architectural Work for Pumping Station	L.S.	1
9	Mechanical and Electrical Work	L.S.	1
10	Landscape Work	L.S.	1
11	Clearning and Handing Over	L.S.	1



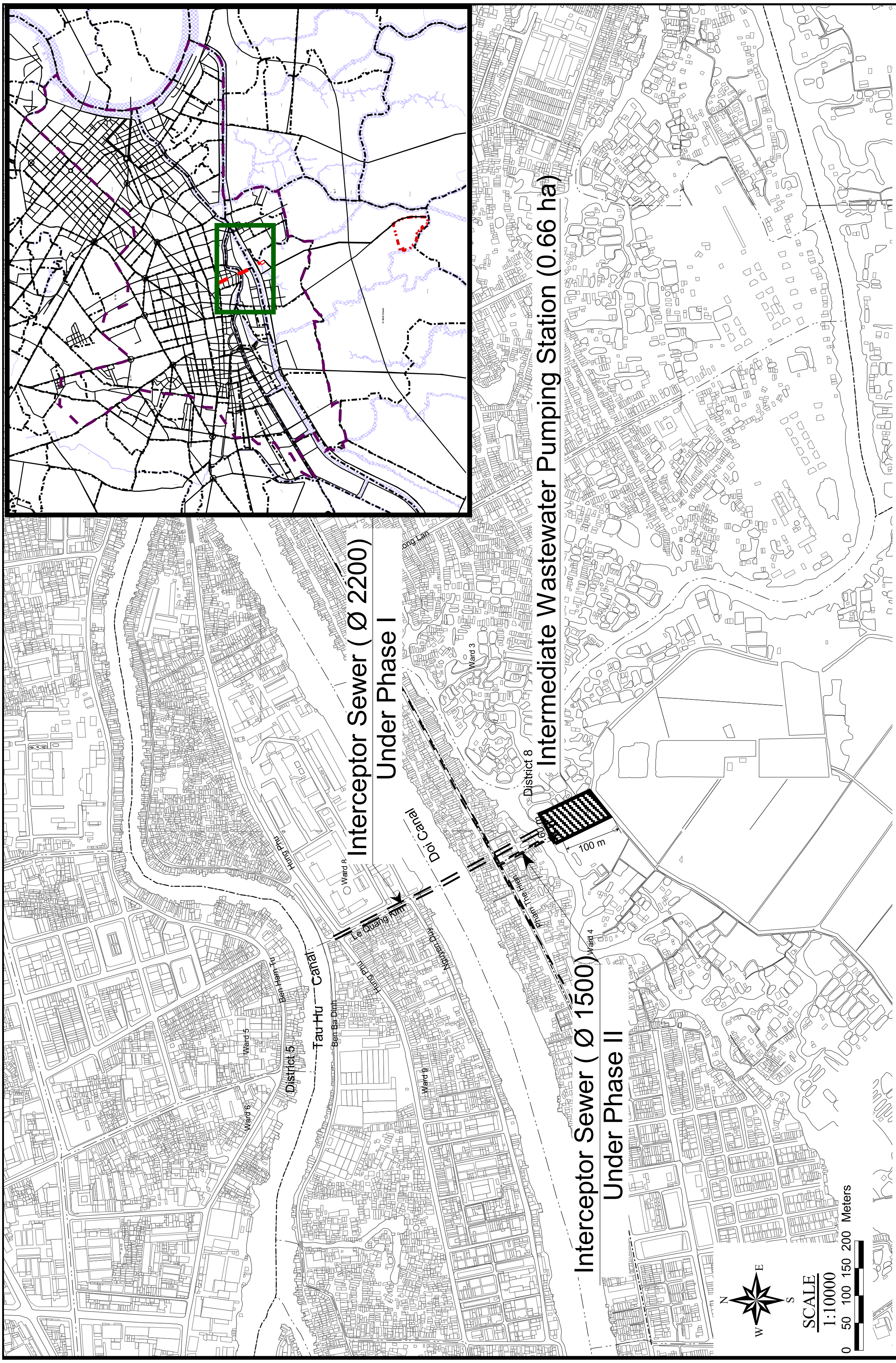
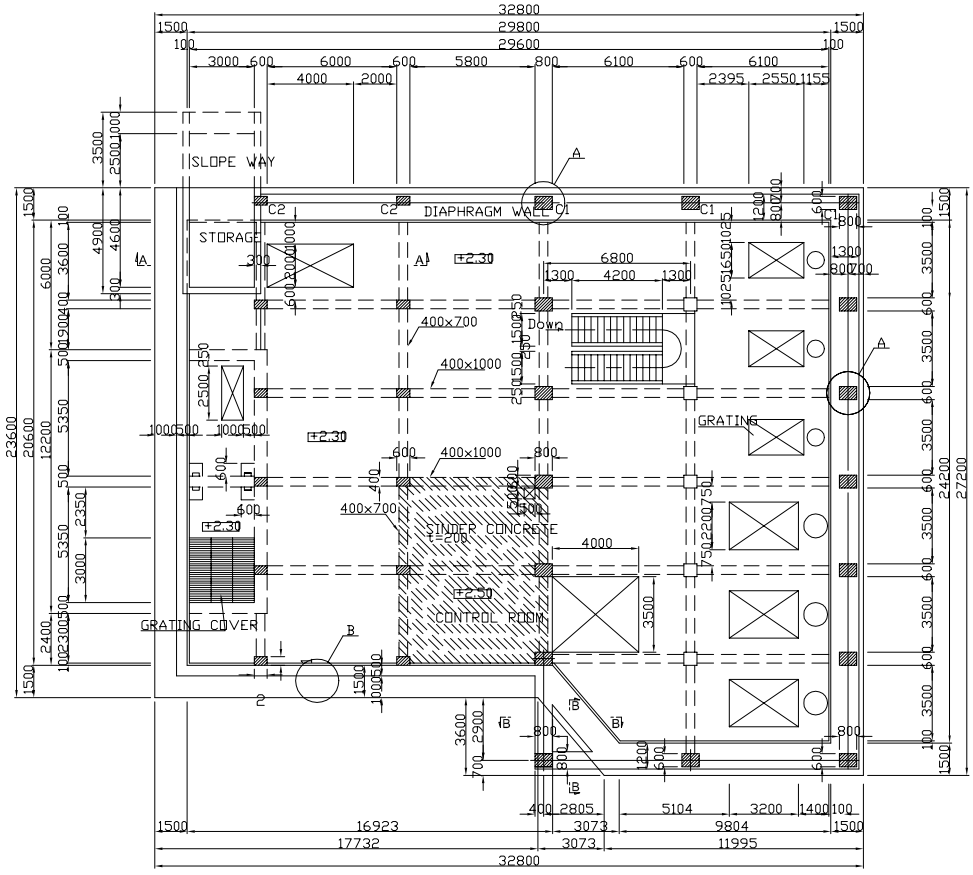


FIG. 5.1 PROPOSED LOCATION OF INTERMEDIATE WASTEWATER PUMPING STATION

GROUND FLOOR



BASEMENT 1 FLOOR

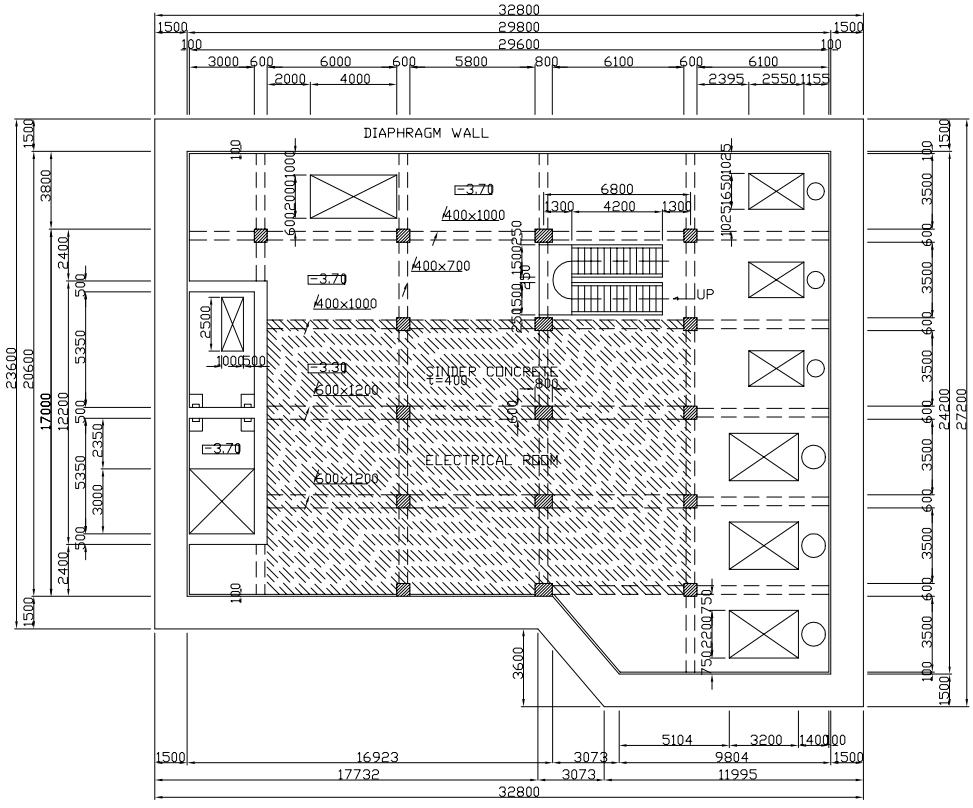
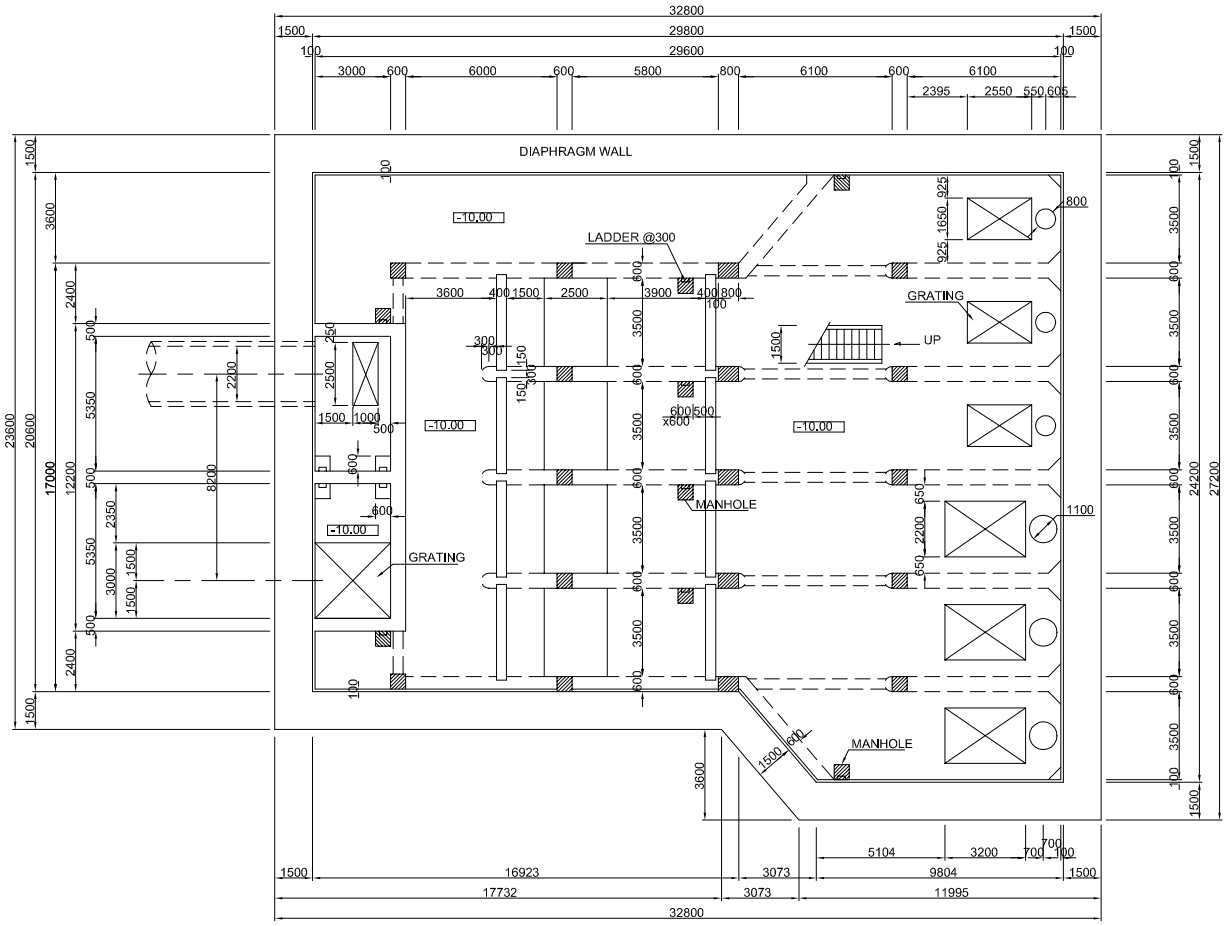


FIG. 5.2 PLAN OF IWPS

BASEMENT - 2 FLOOR



SECTION

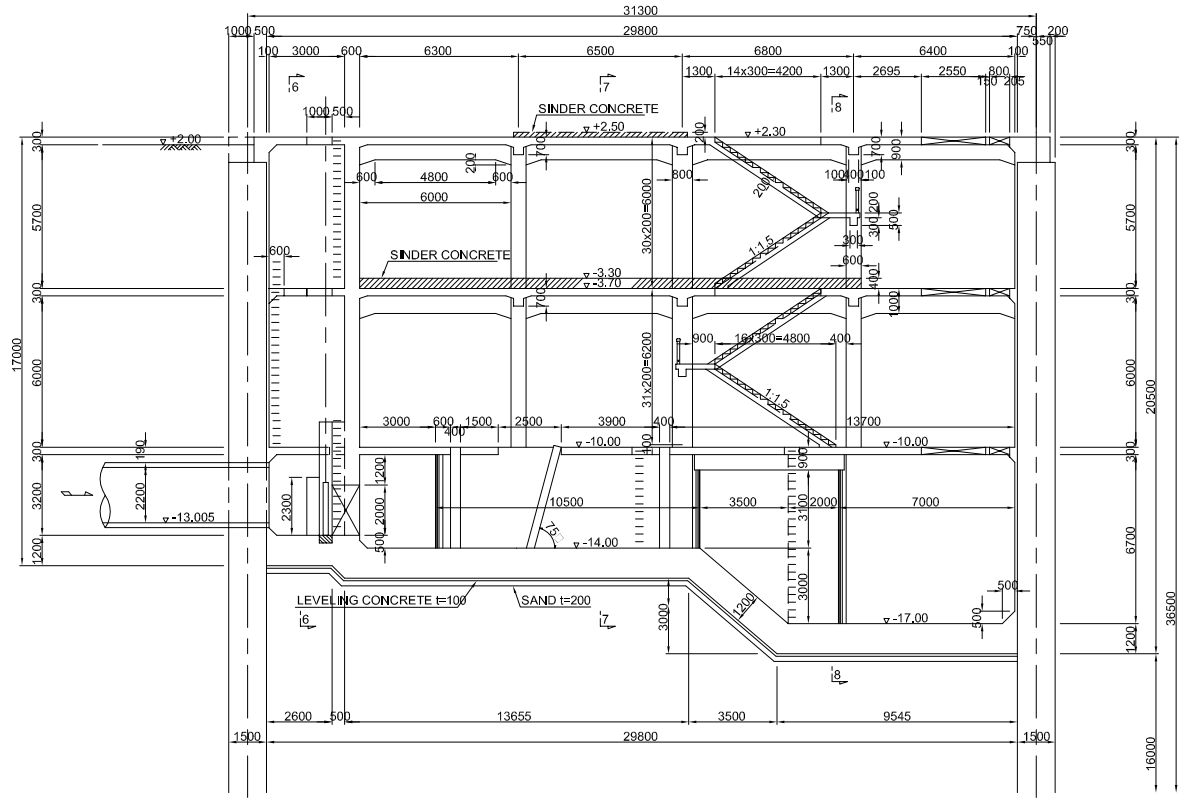


FIG. 5.3 PLAN AND SECTION OF IWPS

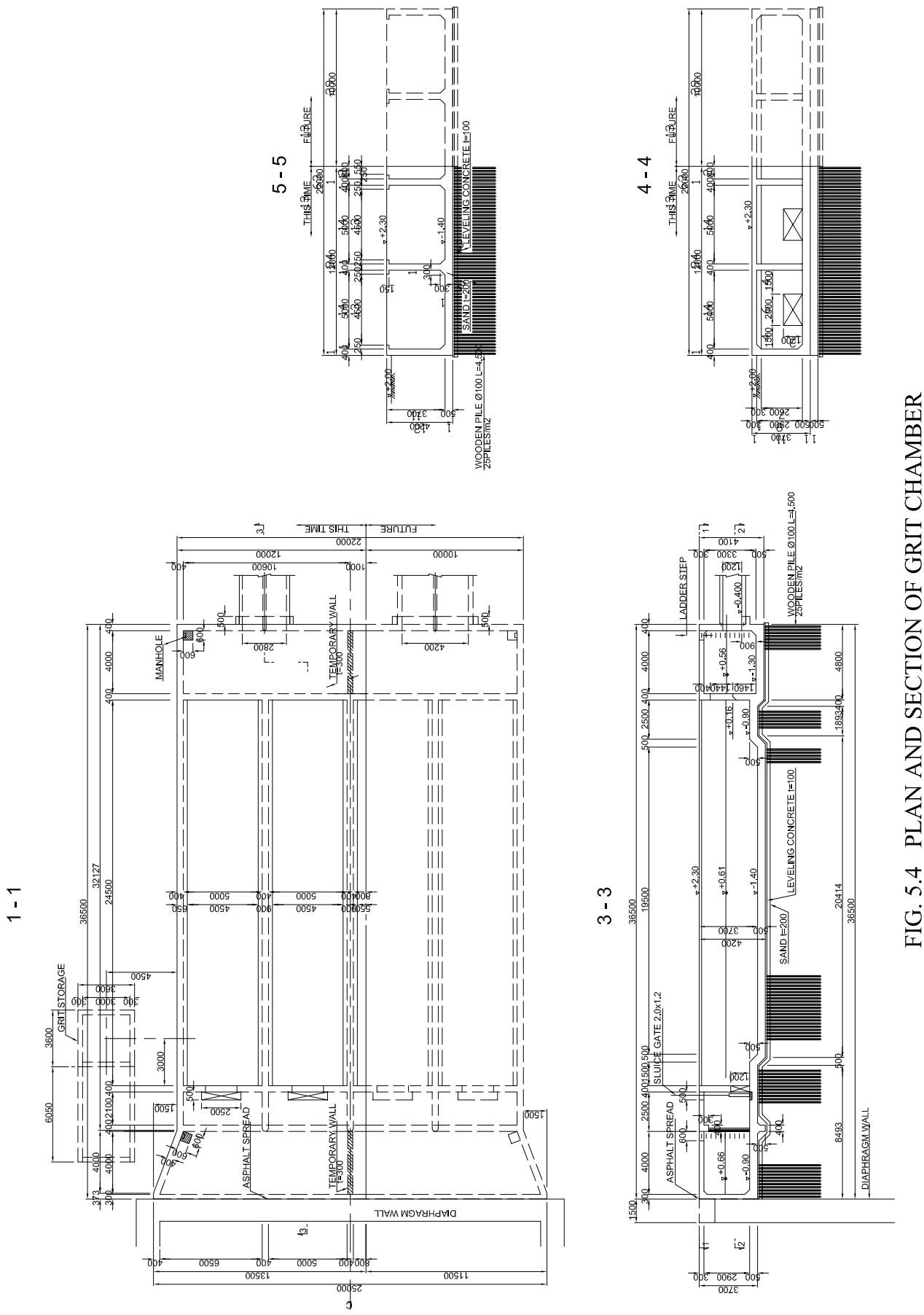
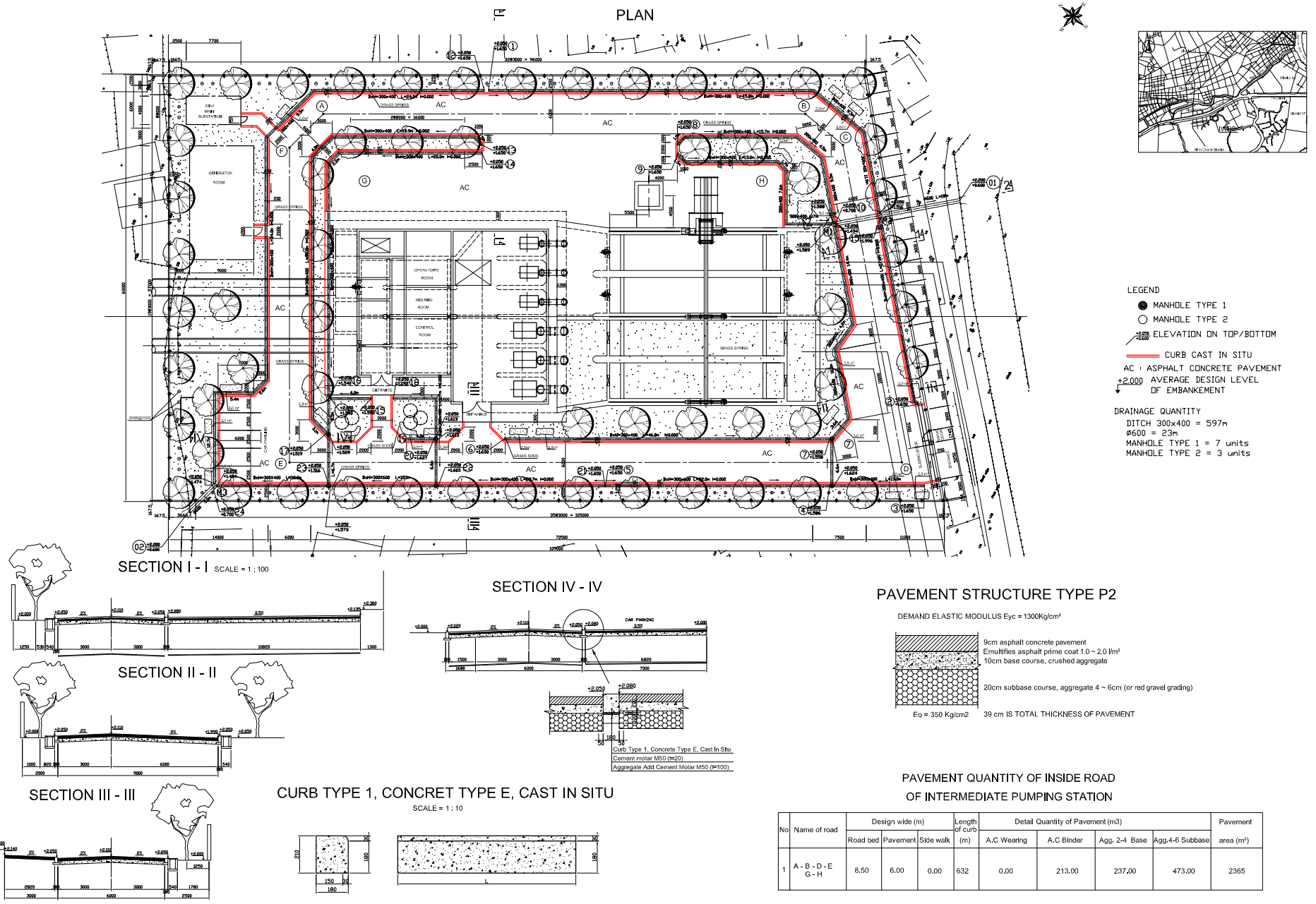


FIG. 5.4 PLAN AND SECTION OF GRIT CHAMBER



PAVEMENT QUANTITY OF INSIDE ROAD
OF INTERMEDIATE PUMPING STATION

No	Name of road	Design wide (m)			Length of curb (m)	Detail Quantity of Pavement (m3)				Pavement area (m²)
		Road bed	Pavement	Side walk		A.C Wearing	A.C Binder	Agg. 2-4 Base	Agg.4-6 Subbase	
1	A - B - D - E G - H	8.50	6.00	0.00	632	0.00	213.00	237.00	473.00	2365

FIG. 5.5 INNER ROAD STORMWATER DRAINAGE PLAN

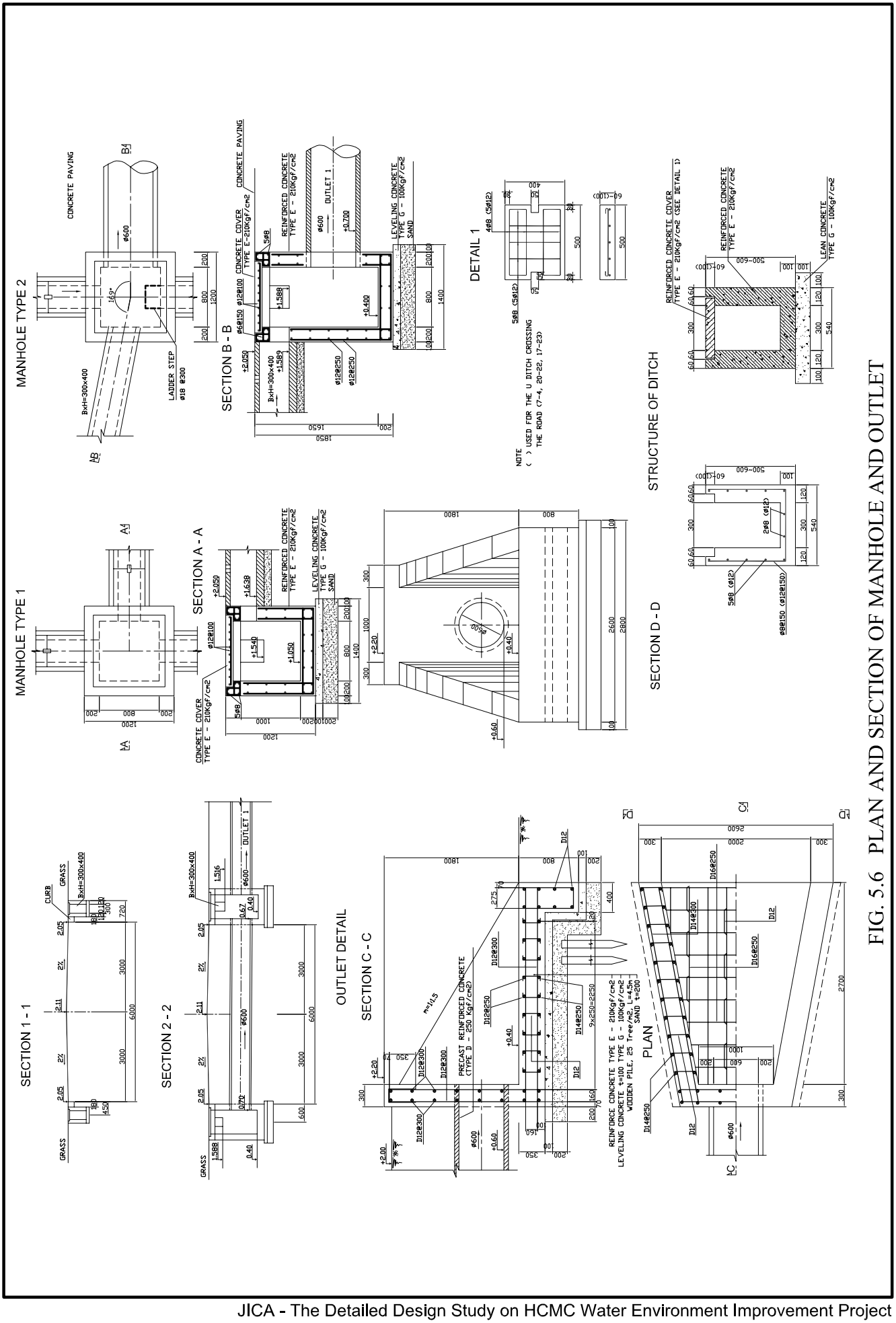
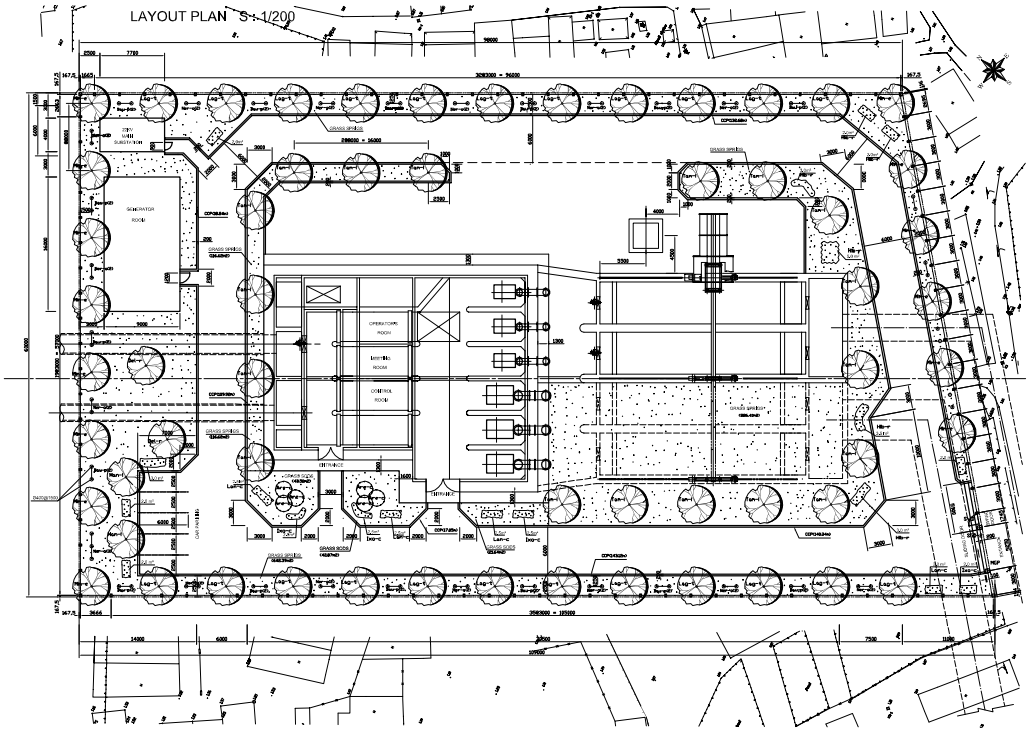


FIG. 5.6 PLAN AND SECTION OF MANHOLE AND OUTLET



LANDSCAPE WORK LIST (PACKAGE 2) INTERMEDIATE PUMPING STATION)

LEGEND	WORK ITEM	UNIT	QUANTITY	SIZE / DIMENSION	REMARKS
MGP	MAIN GATE POSTS (2 POSTS IN 1 SET)	No.	1,00	500 x 400 x H 2500 STEEL REINFORCED CONCRETE	
SGD-2	SLIDING GATE DOOR (TYPE-2)	No.	1,00	H 2000 x W 500 x L 5000 STEEL 60 x 50 FRAMED DOOR W/H WHEELS ON BOTTOM	RAILWAY INCLUDED
SWD	SWING DOOR (SWING DOOR W/H COLUM)	No.	1,00	H 2000 x W 1300 STEEL 60 x 50 FRAMED H 2500 X W 335 x 335 CONC. IND COLUMN	REINFORCED CONC. COLUMN
GF-A	GRID FENCE (TYPE-A) (STEEL FENCE AND COLUMN)	m	319,69	H 2200 x 3000 SHAM STEEL BAR WITH BASE TRIM H 2500 X W 335 x 335 CONC. (IND COLUMN H 2500 X W 335 x 335 CONC. (IND COLUMN	REINFORCED CONC. COLUMN
CCP	CURB OF CONCRETE PAVING	m	544,99	200 x 250 x L CAST IN SITU CONCRETE	
CPV	CONCRETE PAVING	m2	2281,00	150 THK CAST in SITU CONCRETE	
	PLANTING WORK				REFER TO PLANTING LIST

PLANT LIST: PACKAGE 2) DEVELOPMENT INTERMEDIATE PUMPING STATION(PCA1)

LEGEND	PLANT CATEGORY	SPECIES (SCIENTIFIC NAME)	UNIT	QUANTITY	DIMENSIONS & SIZE AT DELIVERY TIME (m) HEIGHT	STEM DIA. at 1.2m HEIGHT	CROWN DIA.	ROOT BALL DIA.	TREE SUPORT	REMARKS
Del-	TREE	Delonix regia	No.	3,00	3,0	0,06		0,45	TRIPOD WITH POLE	
Lag-I	TREE	Lagerstroemia loremtosa	No.	23,00	4,0	0,04		0,45	TRIPOD WITH POLE	
Mang	TREE	Mangifera indica	No.	7,00	3,0	0,03		0,40	TRIPOD WITH POLE	
Mim-c	TREE	Mimusops elengi	No.	14,00	4,0	0,04		0,45	TRIPOD WITH POLE	
Ter-I	TREE	Terminalicus Indica	No.	15,00	3,0	0,04		0,45	TRIPOD WITH POLE	
Are-c	PALM	Areca catechu	No.	6,00	3,0	0,15		0,45	TRIPOD	
Hib-r	SHRUB	Hibiscus rosa-sinensis	m2	27,00	0,4		0,25			GROUP PLANTING (10/sq.m2)
Ixo-c	SHRUB	Ixora coccina (Ixora chinensis)	m2	11,00	0,4		0,25			GROUP PLANTING (10/sq.m2)
Lan-c	SHRUB	Lantana camara	m2	9,00	0,4		0,25			GROUP PLANTING (10/sq.m2)
Bau-c	SHRUB	Bauhinia purpurea	No.	34,00	1,0	0,01				
Ixo-c	SHRUB	Ixora coccina	No.	35,00	1,0	0,01				
	GRASS SODS	Axonopus compressus (Broad leafed grass)	m2	168,01						MAIN ENTRANCE FRONT AREA
	GRASS SPRIGS	Axonopus compressus (Broad leafed grass)	m2	1955,42						

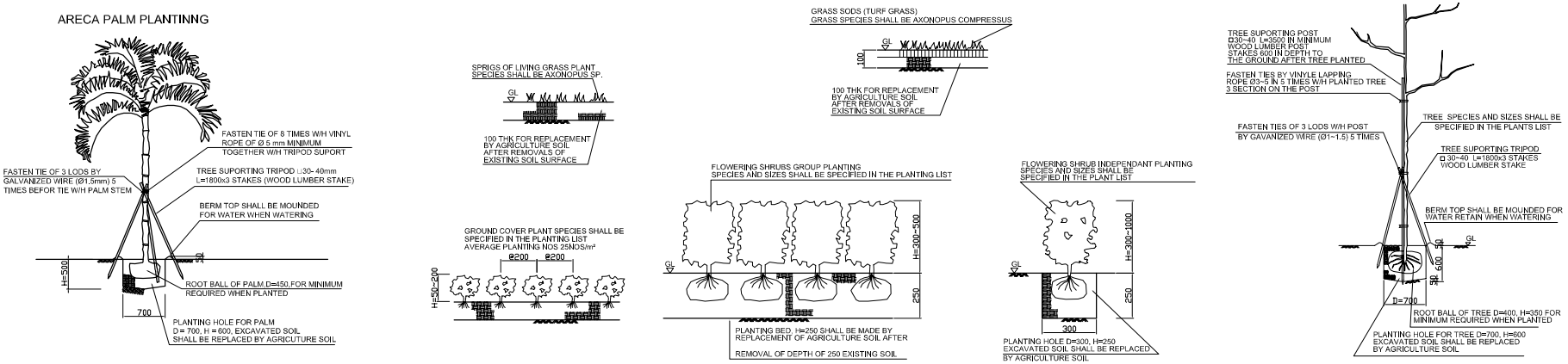


FIG. 5.7 PROPOSED LANDSCAPE WORK OF IWPS

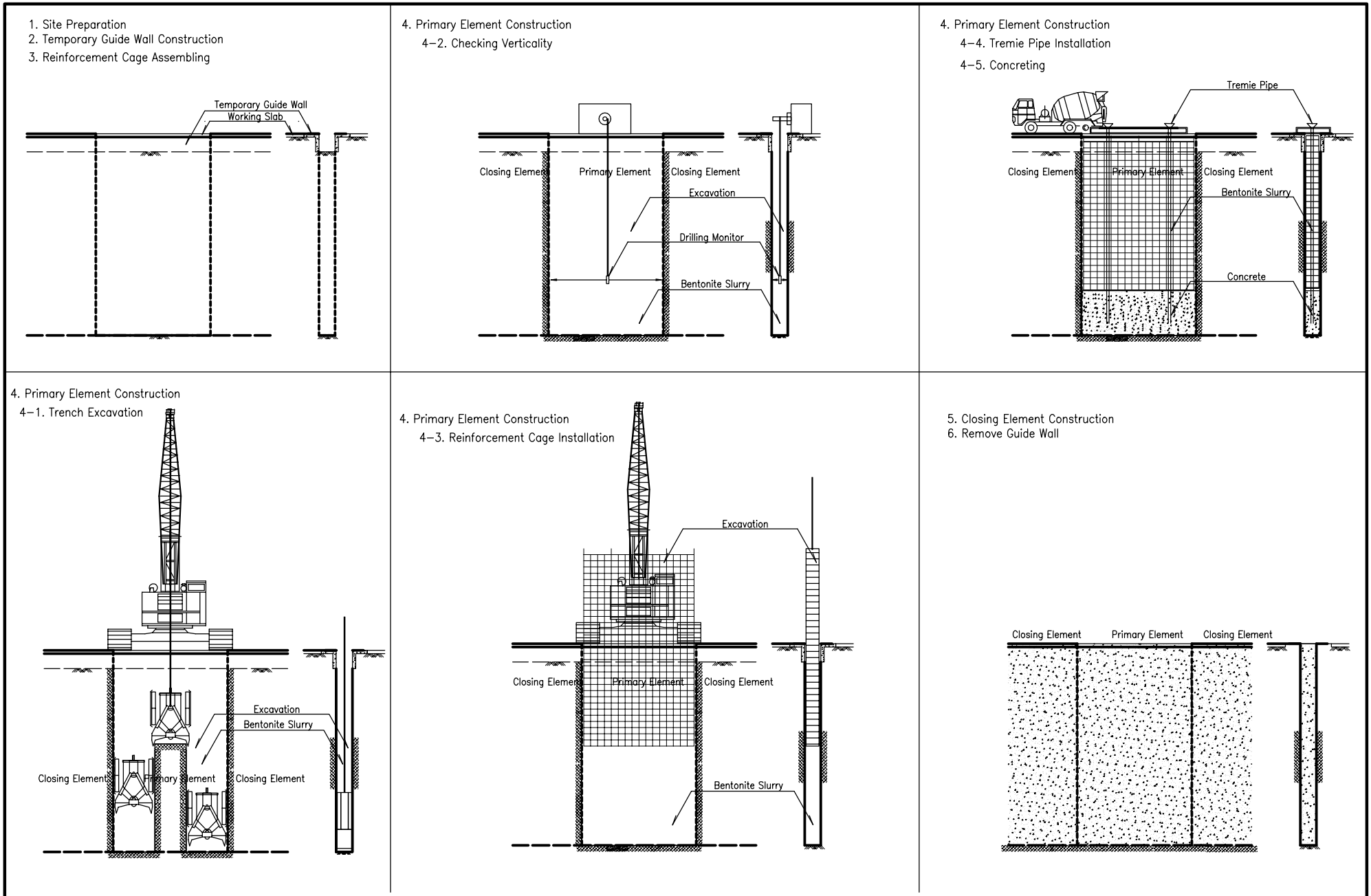


FIG.5.8 CONSTRUCTION METHOD OF DIAPHRAGM WALL