

**Independent Public Business Corporation  
The Independent State of Papua New Guinea**

**DETAILED DESIGN (PHASE 2)  
ON  
PORT MORESBY SEWERAGE SYSTEM  
UPGRADING PROJECT  
IN  
THE INDEPENDENT STATE OF  
PAPUA NEW GUINEA**

**FINAL REPORT**

<b>PART II: Bidding Documents</b>
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**Volume III – Technical Specifications  
A: Particular Specification**

**December 2011**

**JAPAN INTERNATIONAL COOPERATION AGENCY**

**NJS CONSULTANTS CO., LTD.**

**Independent Public Business Corporation  
The Independent State of Papua New Guinea**

**PORT MORESBY SEWERAGE SYSTEM  
UPGRADING PROJECT**

**(JAPANESE ODA LOAN NO. PN-P9)**

**BIDDING DOCUMENTS  
FOR  
PROCUREMENT  
OF  
PORT MORESBY SEWERAGE SYSTEM  
UPGRADING WORKS**

**Volume 3  
(Technical Specifications)**

**3A. Particular Specifications**

*[Insert Month and Year ]*

## PREFACE

Volume 3 of Bidding Documents contains Technical Specifications for the Works of Port Moresby Sewerage System Upgrading Project (hereinafter referred to as “POMSSUP” or “the Project”), which documents consist of 3A – Particular Specifications and 3B – Standard Specifications. These Specifications are collectively called “Technical Specifications”.

The Works of POMSSUP comprise the following six components:

1. Sewer Network: construction of Sewer Network
2. Pumping Stations: construction of Pumping Stations, including rehabilitation and/or re-construction of existing Pumping Stations
3. Sewage Treatment Plant (STP): construction of a STP, including construction of ocean outfall for discharging treated effluent
4. Pilot Project: a pilot project for providing water supply and sewerage facilities to a block of selected 20 houses built on sea (so-called water-houses)
5. Procurement: procurement of vehicles to be used for the operation and maintenance of the sewerage system
6. Social Development Programme: implementing an education/ dissemination programme for HIV/AIDS prevention to the Contractor’s employees/workers and the residents around the Project Site.

3A Particular Specifications set out the scope of work, specifications and requirements to be carried out, furnished and completed/accomplished by the Contractor with regards to the above six components. The Particular Specifications documents are divided into the following five parts:

- Part I: Sewer Network, Pumping Stations and Sewage Treatment Plant; covering the works of Component No.1 to No.3, except ocean outfall
- Part II: Ocean Outfall; covering the construction of ocean outfall involved in a part of Component No.3
- Part III: Pilot Project; covering Component No.4
- Part IV: Procurement; covering Component No.5
- Part V: Social Development Programme; covering Component No.6

3B Standard Specifications set out the standard specifications for the works of Sewer Network, Pumping Stations and STP provided for in Particular Specifications – Part I, but also apply to the Ocean Outfall provided for in Particular Specifications – Part II, the Pilot Project provided for in Particular Specifications – Part III, and the Procurement provided for in Particular Specifications – Part IV. For these works, Standard Specifications shall be read in conjunction with Particular Specifications; provided, however, that Particular Specifications supersede Standard Specifications in interpretation and application. For the Social Development Programme, only the Particular Specifications – Part V is applicable.

# **PART I**

## **SEWER NETWORK, PUMPING STATIONS AND SEWAGE TREATMENT PLANT**

## **DIVISION 1.**

# **GENERAL REQUIREMENT**

## Division 1. General Requirements

### Section 01010 Summary of Works

#### PS 1.01 General

- A. This Part I relate to the three components of the works, namely, (1) Sewer Network, (2) Pumping Stations (PS) and Sewage Treatment Plant (STP), among six components for the Port Moresby Sewerage System Upgrading Project (hereinafter referred to as “POMSSUP” or “the Project”) as defined in Preface of the Particular Specifications.
- B. The Particular Specifications – Part I shall be read in conjunction with the Standard Specifications forming another part of the Technical Specifications, and the Standard Specifications shall be applied to these works, except any specifications, requirements and provisions contradicting those in the Particular Specifications – Part I that shall take precedence.
- C. Port Moresby, the National Capital District (NCD), records a significant increase of the population (an average growth rate from 1990 to 2000 of 2.7% per annum) as well as a rapid economic growth in the recent years, leading to an increase in the water demand. In Port Moresby, there exists no sewage treatment plant (STP) in the coastal area, although there is an existing sewerage system with three STPs to service in the inland area.
- D. Under these situations, sewage in the coastal areas are directly discharged to the surrounding sea without treatment, causing serious pollution of closed coastal water body, including coral lagoon called the Papuan Lagoon, and the deterioration of living environment of communities in the coastal areas. The worsening marine environment in the lagoon has been adversely affecting fishing around the lagoon that is essential to villagers and inhabitants there.
- E. The objective of the Project is to construct sewerage facilities to improve the sanitary condition and living environment of Port Moresby, as well as improving seawater quality around Port Moresby harbour, thereby contributing to development of PNG’s capital town.
- F. Service Area for the Project: The sewerage service area of the Project is the coastal region of Port Moresby, including part of Town/Hanuabada, Kila Kila/Kaugere, Boroko/Korobosea and Hohola/Tokarara in terms of Census division, and Kanudi, Idubada, Hagara, Hanuabada, Konedobu, Stanley Esplanade, Sea Park, Davara, Lawes Road, Koki, Badili, Kila Police, Gabutu/Konebada, Kaugere and Kila Kila area in catchment-wise divisions as shown in Table 1.1

**Table 1.1 Service Area**

Catchment	Area (ha)	Catchment	Area (ha)
Kanudi	161	Lawes Road	31
Idubada	176	Koki	48
Hagara	141	Badili	192
Hanuabada	74	Gabutu/Konebada	58
Konedobu	285	Kila Police	21
Stanley Esplanade/ Old Yacht Club	110	Kaugere	50
Sea Park	21	Kila Kila	194
Davara	24	Total	1,586

- G. The Project will construct a trunk sewer pipeline in a total length of approximately 17.7km and branch pipelines in a total length of approximately 17.4km to connect existing and expanded sewer networks to the new STP to be constructed under the Project. As the trunk pipeline passes undulating terrains in the route, 17 pumping stations (PSs) will be built up with the construction of new PSs and rehabilitation of existing PSs. The new STP having a treatment capacity of 18,400 m<sup>3</sup>/day will be constructed at a grass-root site in Kila Kila district located in the southern part of the service areas near to the coast. A 1.4 km long ocean outfall will be constructed to discharge treated effluent from the STP to the offshore. Descriptions of the above works are stated in more details in subsequent parts of this section, except the ocean outfall for which specifications are provided for in Part II of the Particular Specifications

### PS 1.02 Design Condition

#### A. Service Population

Future population in 2020 was projected based on the previous national Census in 1980, 1990 and 2000.

Service Population in Target Year is 68,176=68,200 person

Breakdown of the population to the catchment of each pumping station at every 5 years interval from 2000 to 2020 is shown in Table 1.2

**Table 1.2 Population Projection**

Sub-catchment Name		Population				
		2000 (Census)	2005 (actual)	2010	2015 (treatment)	2020 (target year)
③	Kanudi	596	634	675	719	765
④	Idubada	637	678	722	768	818
⑤	Hagara	3,861	4,110	4,375	4,657	4,958
⑥	Hanuabada	5,619	5,982	6,367	6,778	7,215
⑦	Konedobu	5,564	5,924	6,306	6,711	7,142
⑧	Stanley Esplanade	1,936	2,061	2,194	2,335	2,487
⑨	Lawes Road	1,477	1,572	1,673	1,781	1,897
⑩	Dabara	473	503	536	571	607
⑪	Sea Park	826	879	936	996	1,061
⑫	Koki	5,954	6,338	6,748	7,182	7,647
⑬	Badili	9,847	10,482	11,157	11,878	12,644
⑭	Kila Police	575	612	652	694	738
⑮	Gabutu	578	615	655	697	742
⑯	Kila Kila	15,151	16,127	17,169	18,277	19,455
	(Horsecamp)	3,469	3,693	3,932	4,185	4,455
	(Kaugere)	11,682	12,434	13,237	14,092	15,000
	<b>Sum</b>	<b>53,094</b>	<b>56,518</b>	<b>60,165</b>	<b>64,044</b>	<b>68,176</b>

#### B. Unit Flow Rate

Overall unit rate is set as 270 lpcd (= 303 x 0.9, 0.9 as a return rate) as studied in Table 1.3.

**Table 1.3 Estimated Water Consumption by Area**

Category		Area	2000	2001	2002	2003	2004	Average	
Population Served (person)	Inland	0.75	103,037	105,765	108,493	111,221	113,949	108,493	
	Coastal	0.25	34,346	35,255	36,164	37,074	37,983	36,164	
	Total	1.00	137,382	141,020	144,657	148,295	151,932	144,657	
Water Consumption (m <sup>3</sup> /d)	Domestic	Inland	0.75	22,883	21,461	16,374	15,650	14,311	18,136
		Coastal	0.25	7,628	7,154	5,458	5,217	4,770	6,045
		Total	1.00	30,511	28,614	21,832	20,867	19,081	24,181
	Commercial	Inland	0.75	9,662	9,717	9,520	9,665	9,341	9,581
		Coastal	0.25	3,221	3,239	3,173	3,222	3,114	3,194
		Total	1.00	12,882	12,956	12,693	12,886	12,445	12,775
	Government	Inland	0.93	19,440	22,030	21,706	23,273	23,398	21,970
		Coastal	0.07	1,463	1,658	1,634	1,752	1,761	1,654
		Total	1.00	20,903	23,688	23,340	25,025	25,159	23,623
	Total	Inland		51,985	53,207	47,600	48,588	47,050	49,686
		Coastal		12,311	12,051	10,265	10,190	9,654	10,892
		Total		64,296	65,258	57,865	58,778	56,695	60,578
Per Capita Water Consumption (lpcd)	Inland		505	503	439	437	413	459	
	Coastal		358	342	284	275	254	303*	
	Total		468	463	400	396	373	420	

### C. Sewage Flow

- (1) Daily Average Sewage Flow = Daily Maximum Sewage Flow;  
 $68,200 \times 270 \times 10^{-3} = 18,400 \text{ m}^3/\text{d}$
- (2) Hourly Maximum Sewage Flow;  
 $18,400 \times 2.0 = 36,800 \text{ m}^3/\text{d}$

While STP capacity is calculated based on this figure, pumping station and sewer pipe is calculated using two types of unit flow rate corresponding to the catchment conditions.

For the trunk line, flow fluctuation rate is the same as above 1.0:1.0:2.0, and that of branch line is 1.0:1.0:2.5.

Target inflow for the first phase of the STP is determined as 75% of total flow considering the phased increase in inflow as follows:

- (1) Daily Average Inflow = Daily Maximum Inflow =  $18,400 \times 0.75 = 13,800 \text{ m}^3/\text{d}$
- (2) Hourly Maximum Inflow is =  $13,800 \times 1.5 = 27,600 \text{ m}^3/\text{d}$

### D. Design Sewage/Treated Effluent Quality

**Table 1.4 Design Sewage Quality**

ITEM	BOD <sup>5</sup> (mg/L)	SS (mg/L)	T-N (mg/L)	Coliform group (MPN/100cc)	Oil & Grease (mg/L)
Influent	190	180	45	-	-
Effluent	20	20	20	3,000	10



**PS 1.03 Description of the Sewers and Pumping Stations****A Sewer pipelines**

The Sewer Network covers 1,586 ha of coastal area of Port Moresby, which comprises the existing sewer network currently directly discharging sewage to the sea without any treatment and the new sewer network to be constructed under this Project. The catchment area is shown in **Table 1.1**. The new main trunk sewer will be laid in a length of approximately 17.7 km, of which about 90% is the force main and the rest 10% is the gravity flow. The main trunk sewer connects all the existing and new pumping stations located along the coastal area of Port Moresby. For the branch sewers, the Project will construct only collection pipes under public road. House connection pipes are out of the works under the Project. The new branch sewer is generally installed along the road by gravity flow system, and includes house connection reserve in some parts as indicated in the Drawings. The new branch sewer pipelines will be laid in a total length of approximately 17.4km.

Table 1.5 shows the Summary of the Sewers to be constructed under the Project. Profile of pipeline routes and details of these pipelines are given in the Tender Drawings.

**Table 1.5 Summary of Sewers**

Category	Collection	Material	Diameter (m)	Length
Trunk Sewer	Force Main	HDPE	DN110	4,010
			DN125	1,605
			DN160	80
			DN225	1,575
			DN355	2,579
			DN400	713
			DN450	0
			DN500	2,771
			DN710	2,473
	Force Main-total			15,806
	Gravity Main	HDPE	DN225	772
			DN355	764
			DN450	175
			DN560	27
			DN630	184
DN710			603	
Gravity Total			2,525	
Trunk Sewer total			17,618	
Branch Sewer	Gravity	uPVC/HDPE	100~DN355	17,376

**B. Pumping Stations**

17 intermediate PSs will be built up with the construction of 13 new PSs and rehabilitation of 4 PSs. Since steady and reliable operation of the pumping stations is required, each pumping station is equipped with on-site generator as a countermeasure for frequent electrical outages.

Table 1.6 shows the Summary of Pumping Stations to be constructed under the Project, details of which are given in the Tender Drawings

**Table 1.6 Summary of Pumping Stations**

Pumping Station	Pump Capacity	Motor Output	Description
	m <sup>3</sup> /min	kW	
PS-1 Kanudi	0.36 x 2(1)	5.5 x 2(1)	New Construction
PS-2 Idubada	0.65 x 2(1)	22 x 2(1)	New Construction
PS-3 Hagara	1.90 x 2(1)	22 x 2(1)	New Construction
PS-4 Hanuabada	4.80 x 2(1)	22 x 2(1)	New Construction
PS-5 Konedobu	4.40 x 3(1)	55 x 3(1)	New Construction
PS-6 Old Yacht Club	0.65 x 2(1)	5.5 x 2(1)	New Construction
PS-7 Stanley Esplanade	1.40 x 2(1)	15 x 2(1)	Rehabilitation
PS-8 Sea Park	0.60 x 2(1)	7.5 x 2(1)	Rehabilitation
PS-9 Davara	5.60 x 3(1)	15 x 3(1)	Rehabilitation
PS-10 Lawes Road	6.20 x 3(1)	75 x 3(1)	New Construction
PS-11 Koki	2.60 x 2(1)	37 x 2(1)	New Construction
PS-12 Badili	3.50 x 3(1)	45 x 3(1)	Rehabilitation
PS-13 Kila Police	0.36 x 2(1)	5.5 x 2(1)	New Construction
PS-14 Konebada	0.45 x 2(1)	7.5 x 2(1)	New Construction
PS-15 Gabutu	0.75 x 2(1)	22 x 2(1)	New Construction
PS-16 Horsecamp	1.50 x 2(1)	11 x 2(1)	New Construction
PS-17 Kaugere	12.50 x 3(1)	55 x 3(1)	New Construction

#### **PS 1.04 Description of the Sewage Treatment Plant**

- A. The Sewage Treatment Plan (STP) has a treatment capacity of 18,400m<sup>3</sup>/day. Wastewater treatment process employs oxidation ditch method with comparatively deep reactor of 6m in which fine diffusers and mixers will be installed to secure efficient balanced oxygen supply even at the bottom of the tank. Sludge dewatering machine will be installed for sludge treatment.
- B. The STP comprises the following process units and facilities:
  - a. Grit Chamber
  - b. Distribution Tank
  - c. Oxidation Ditch
  - d. Final Sedimentation Tank
  - e. Treated Water Tank
  - f. Disinfection
  - g. Sludge Dewatering Facility
  - h. In-plant Yard Pipe
  - i. Electrical Substation
  - j. Administration Building
  - k. Landscaping
  - l. Ocean Outfall

Descriptions of these units and facilities are briefed below, and drawings are given in the Tender Drawings. Table 1.7 shows a Summary of the Process Units.

**Table 1.7 Summary of Process Units**

<b>Process Unit</b>	<b>Design Criteria</b>	<b>Size &amp; Specification (Units for duty and stand-by)</b>
Grit Chamber Inlet gate	Manually operated	W 0.5 m x H 0.75 m x 2 units
Grit Collecting Unit		Vortex Type Dia 1,600mm x 0.75 kW x 2 units
Screen	Screen Gap: 20 mm	Automatic Drum Screen Dia 1,200mm x OP. 12 mm x 1.5 kW x 2 units
Distribution Chamber	Adjustable Weir	W 0.8 m x ST 0.4 m x 4 units
Oxidation Ditch	BOD-SS Loading: 0.05 kg/kg/day MLSS Concentration: 3,000 mg/l Sludge Retention Time: 21 days Hydraulic Retention Time: 24 hr	Width 6.0m x Length 128.0 m x Depth 6.0m x 3 basins
Air Diffuser	Dissolution Efficiency $\geq 30\%$	36 pieces/unit x 10 units x 3 basins
Blower	Operation Hours: 12 hr/day	Rotary Blower Dia 200 mm x 42 m <sup>3</sup> /min x 70 kPa x 75 kW Duty 5 units, Stand-by 1 unit
Mixer	Unit Required Electric Power: 1.5 W/m <sup>3</sup>	Submersible Propeller Type 2.3 kW Duty 12 units
Clarifier	Hydraulic Load: 10m <sup>3</sup> /m <sup>2</sup> /day Settling Time: 2.7 hr	Dia 25.0 m x Depth 3.5m x 3 basins
Return Sludge Pump	Return Sludge Ratio: 200% (Max) Operation Hours: 24 hr/day	Non-clog Type Sludge Pump Dia 150 mm x 3.2 m <sup>3</sup> /min x 9 m x 11 kW 6 units (Stand-by 3 units)
Waste Sludge Pump	Operation Hours: 8 hr/day	Non-clog Type Sludge Pump Dia 100 mm x 0.7 m <sup>3</sup> /min x 10 m x 5.5 kW Duty 3 units, Stand-by 2 units
Sludge Yield	2,397 kgDS/day	
Sludge Dewatering Unit	Operation Time: 94 hrs/week, DS: 15%	Multi Diskplate Screw Press 490 kg/hr x 6 kW Duty 1 unit, stand-by 1 unit
Sludge Disposal	2,397 kgDS/day, 16 m <sup>3</sup> /day (15%DS)	
Sludge Cake Hopper	Number of Dump Trip: 2 times/day	Motor Driven Cut-gate Type 15 m <sup>3</sup> x (2.2 x 2) kW x 1 unit
Buildings		Refer to Table 1.9 and 1.10

**(a) Grit Chamber**

The grit chamber includes drum screens, grit removal chamber, oil skimmers and measuring weir.

Fine screen (Drum type)

A mechanical fine screen (drum type) will be installed in the influent channel of the grit chamber to remove floating particles from incoming sewage. The cleaning operation will be carried out intermittently by means of a time clock. It will also be actuated by a pre-determined differential head loss across the screen. Screening conveyer operation is interlinked with the screen cleaning operation.

Grit chamber

Two Vortex-type grit chambers will be constructed. Grit pump will remove accumulated grit from the bottom of the chamber. The pump operation will be made intermittently by means of a timer.

Oil skimmer

Manually operated oil skimmers will be installed downstream of the grit chamber. A pipe skimmer is capable of handling all sewage flow to oxidation ditches. Oil discharging pump will be operated according to the liquid level of the oil sump.

Scum screen

Removed scum at the clarifiers will be pumped to the scum screen installed in the grit chambers. Operation of the scum screen is interlinked with that of the scum transfer pumps in the clarifiers.

Measuring weir

Fixed weir will be installed to set a stable water surface for flow measuring equipment.

## (b) Distribution Tank

The distribution tank will be constructed with four (4) movable gates. Inflow sewage from grit chamber is to be controlled by adjustment of gate opening and distributed to four oxidation ditch equally.

## (c) Oxidation Ditch

The advanced oxidation ditches consists of 6 meter deep closed-loop channel equipped with aeration and flow-generation systems. Aeration is carried out by combination of blowers and air diffusers. Submersible mixers will generate circulation flow in order to keep activated sludge and incoming solids in suspension. Air output of blowers will be made proportional to the incoming sewage flow by means of varying number of operating blowers and their motor speed. Blowlers may also be operated intermittently by a timer control in order to create anoxic condition and aerobic condition of the mixed liquor alternately. The proposed advanced oxidation ditches have provision for biological nitrogen removal as well as BOD and SS removal.

Blower room, located on top of the oxidation ditch, houses air blowers and associated equipment. It is a single story RC framed structure, which is acoustically treated to minimize noise level outside the room.

## (d) Final Sedimentation Tank

Solid-liquid separation will occur in clarifier by gravity. Settled solids (activated sludge) will be recycled to the oxidation ditches by return sludge pumps in order to maintain MLSS concentration in the oxidation ditches. Variable-speed return sludge pumps will operate proportionally to the incoming sewage flow to the oxidation ditches.

Waste (excess) sludge will be transferred to the sludge gravity thickener by waste sludge pumps, which operate intermittently by a timer control. Scum skimmer will remove floating scum into the scum sump from which it will be pumped to the scum screen installed at the grit chamber. The level sensor in the scum sump actuates scum pumps. The scum screen operation is interlinked with scum transfer pump operation. Operations of all the scum transfer pumps are interlinked so that not more than one pump will feed scum to the scum screen at the same time.

Sludge pump room houses return and waste sludge pumps. It is a single storey reinforced concrete framed structure with brick walls and metal roofing.

(e) Treated Water Tank

Clarified effluent through a strainer, which produces clear water for reuse, will be supplied to de-foaming sprays in the oxidation ditches and for equipment cleanings.

(f) Disinfection

UV disinfection with contact time of 5 to 10 seconds will be applied for the treated effluent. Chlorine disinfection facility shall also be installed for the malfunction of the UV disinfection.

(g) Sludge Dewatering Facility

The dewatering press machines will dewater excess sludge to at least 15% of water content. Chemical conditioning by polymer and coagulant will be used. A screw conveyor will transfer the dewatered sludge cake from the dewatering press to the sludge hoppers for direct loading into the dump truck from the hopper. Loaded sludge will be transported to the final disposal site in the Morata STP. Operations of the polymer feed pumps, coagulant feed pumps and sludge cake screw conveyors will be interlinked with the dewatering unit operation.

(h) In-plant Yard Pipe

In-plant piping consists of underground pipes between structures or process units conveying liquids or sludge material. the piping works are briefed in Table 1.8 below.

**Table 1.8 Underground Services**

Description	Size (mm)	Material
Force-main from Receiving MH to Grit Chamber	600	HDPE
Force-main from Horsecamp P.S. to Grit Chamber	150	HDPE
Grit Chamber to Oxidation Ditches (4 lines)	300	HDPE
Oxidation Ditches to Final Sedimentation Tank (4 lines)	450	HDPE
Final Sedimentation Tank to Treated water Tank	350~600	HDPE
Discharge (Ocean Outfall) Pipe	700	GRP, FRPM

In addition, other services (i.e., electrical cables, water pipes, sewer pipes, instrumentation wiring, street lighting wiring and grounding system) are laid underground in the plant access road reserves, between and around the structures. Manholes, inspection chambers, or connecting chambers for valves, bends, etc. are provided where necessary.

(i) Electrical Substation

The electrical substation building houses electrical transformers, switchgears and standby diesel generators. It is a single storey reinforced concrete framed structure with brick walls and reinforced concrete flat roof. Sound absorbing materials are used for the walls and doors of the generator room. The components of electrical substation are shown in Table 1.9 below.

**Table 1.9 Components of Electrical Substation**

Designation	Dimension (m × m)	Floor Area (m <sup>2</sup> )
Switchgear Room	4.7×8.0	37.6
Transformer Room	4.0×4.3	17.2
Generator Room	9.1×5.4	49.1
Others (Store etc)	3.7×4.0	14.8
Total		118.7

(j) Administration Building

The administration building provided is a two-storey building with a built-up area of 600 square metres. The building provided is a reinforced concrete framed building with a steel roof truss and metal roofing sheets. Walls are of brickwork with aluminium framed windows and timber doors. The components of administration building are shown in Table 1.10 below.

**Table 1.10 Components of Administration Building**

No.	Designation	Dimension (m × m)	Floor Area (m <sup>2</sup> )
	<b>Ground Floor</b>		
1.	Laboratory	10.0×5.0	50
2.	Operating Staff Room	10.0×5.0	50
3.	Work shop & Store	10.0×10.0	100
4.	Male Toilet & Locker Room	3.5×8.0	28
5.	Accessible Toilet	3.5×2.0	7
6.	Common space	-	65
	<b>First Floor</b>		
7.	Manager Room	5.0×5.0	25
8.	Conference Room	10.0×5.0	50
9.	Supervisory Room	5.0×5.0×3	75
10.	Monitoring Room	10.0×5.0	50
11.	Female(Male) Toilet & Locker Room	3.5×8.0	28
12.	Pantry	3.5×2.0	7
18.	Common space	-	65
	Total		600.0

(k) Landscaping

Landscapes in the Site are required for Operation and maintenance work of STP and Environmental protection for surrounding.

The landscape work includes the construction and installation of;

- 1) Pavement road,
- 2) Parking space,
- 3) Drainage facilities,
- 4) Lighting equipment,
- 5) Gate / fence,
- 6) Guard house, and
- 7) Planting, etc.

(l) Ocean Outfall

Treated effluent will be discharged to the Joyce Bay, 1040 m offshore point through ocean outfall. This discharging point is the shortest alternative which can be expected the diffusion and a dilution effect with the depth of 20 to 30m across the shallow depth (5 to 15m) of coast area. From the outlet point beside the disinfection chamber, treated effluent flows down through pipes installed under the maintenance road which will be constructed along the 5-6m contour line, through pipe installed along the shore line with concrete encasement, and finally to the ocean outfall pipe installed under the sea bed.

Pipes of GRP 700mm diameter on land have a slope of 3.5‰ to the sea for the peak flow of 27,600 m<sup>3</sup>/d (=18,400 m<sup>3</sup>/d × 1.5 = 0.319 m<sup>3</sup>/s) with a capacity of 0.548 m<sup>3</sup>/s providing 72% of marginal capacity.

The Contractor is required to make a preliminary geological survey of the seabed and detailed and to propose an appropriate work method and plan at the Tender, and then at the construction stage shall carry out detailed geological survey and detailed design for the Engineer's approval and execute the works with the approved design. The design conditions and requirements are specified in Part II of the Particular Specifications

**PS 1.05 Modification to the Existing Facilities**

- A. The proposed trunk sewer network for the POMSSUP is to be constructed on a part of the existing sewers, pumping stations and ocean outfall. After the construction, all flows are to be diverted to the new trunk sewers. On completion of the trunk sewer network and the new STP, all sewage flow shall be directed to the new STP.
- B. The Contractor is required to keep the drainage capability of existing outfalls to avoid flooding of wastewater even in the unexpected emergency events. Existing outfalls shall be de-sludged before commissioning of the new STP
- C. The Contractor shall ensure that all works shall be undertaken without disruption to the drainage of sewage by which flooding will be brought about. Where temporary shutdowns are needed to undertake such works, the Contractor shall provide submersible pumps and gen-sets of sufficient capacity to ensure continuous drainage. The Contractor shall allow

for the costs of hiring, transporting, operating including fuel of submergible pumps and gen-sets and all else necessary in his tender prices and costs.

During the course of the work, modifications would need to be made to the existing pumping stations and sewers, electrical wiring and control panels, etc. The Contractor shall allow for the cost of providing such works to decommission existing facilities to connect to the new facilities completed under this Contract and commission the overall facilities including existing and new facilities.

#### **PS 1.06 Contractor's Use of Site**

- A. All construction operations and facilities on the sewers, the pumping stations and the treatment plant site shall be confined to within the property boundary unless otherwise approved by the Engineer and the relevant authorities.
- B. The Contractor shall be required to install a separate sub-meter for tapping water supply and power from the in-plant mains supply throughout the duration of the construction period. The meters shall be read jointly by the Employer, EDA RANU, the operator of existing sewerage system, and the Contractor.
- C. The Contractor shall give full consideration for access to the Employer and EDA RANU vehicle or personnel to the construction camp site and new sewage treatment plant site for operation and maintenance. Designation areas shall be identified and allocated for the storage of all construction materials and equipment.
- D. The Engineer will make an arrangement with the Employer and EDA RANU for the Contractor's site visit and inspection of the existing plant and facilities at the Tender stage and prior to site possession.
- E. The Employer and/or EDA RANU will provide the Contractor with an inventory list of all existing equipment at the existing pumping stations. The Contractor shall make inspection and verification of the equipment jointly with the Employer and/or EDA RANU prior to site possession.
- F. As the construction sites and construction worker's camp site shall be handed-over to the Contractor for the whole duration of the Works, the Contractor shall be fully responsible for the safety and security aspects of all sites.
- G. Security, health and safety
  - a. .
  - b. Due consideration and emphasis shall be given to ensuring that adequate safety and health aspects of the works are adhered to with regard to the requirements of Health and Safety regulations including management and prevention of HIV/AIDS and Cholera inside the Site, construction worker's camp and neighbouring residential area. Proper warning and other safety signboards shall be installed at appropriate locations of the Site. Workshop for the workers must be conducted periodically according to the Contractor's educational programme in accordance with the Social Development Programme for which the specifications and requirements are set out in Part V of the Particular Specifications.
  - c. The Contractor shall be required to provide the Employer and EDA RANU with the name and contact telephone number of the personnel who can be contacted during any emergencies.

#### **PS 1.07 Method Statements**



Within fourteen (14) days after the Commencement Date for the Works, the Contractor shall submit to the Engineer for approval his detailed Method Statement giving particulars of how he proposes to construct the new facilities without interference with the planned or existing facilities. He shall include in the Method Statement as to how the existing treatment, drainage and other systems are to be maintained functional whilst construction works being undertaken on the new facilities.

The Contractor will require for this Method Statement to be approved by the Employer and EDA RANU in time prior to commencing field works; therefore the Contractor shall coordinate with the Engineer and EDA RANU in preparation of this Method Statement with due assistance of the Engineer.

#### **PS 1.08 Site Restrictions**

- A. The Contractor shall refer to and observe EIA permit and the conditions imposed by the Ministry of Environment and also the relevant Local Authorities and Agencies.
- B. Soil investigation had been carried out and these can be viewed by the Contractor for information and guidance. Appropriate methods of construction that will overcome failure of side walls of excavated pits, holes, areas and trenches; up-heave of bottom of pits, hole, or trenches; flotation of pipes; flooding of excavation; difficulty of pipe laying, etc. must be incorporated in the Work Methods to be proposed in his Tender and more details to be submitted in accordance with the provision of PS 1.07 hereof.

The Contractor shall also conduct soil investigation for the Pilot Project and the Ocean Outfall and appropriate work methods for these works in his Tender in compliance with the requirements stipulated in Part II and III of the Particular Specifications as well as the Standard Specifications.

It must be noted, however, that the above conditions are subject to the conditions set out in 1.05 A, Section 01010 of the Standard Specifications. The Employer does not guarantee the accuracy of the data given in the report, nor does he guarantee it is typical of the ground conditions likely to be encountered. The Contractor shall inspect and examine all work sites and its surroundings and shall satisfy himself before submitting his tender as to the nature of the ground and sub-soil, the quantities and nature of the works and materials, tools and equipment necessary for the completion of the Works. No claim will be considered for additional expenses that the Contractor may incur on account of any unforeseen obstacle of whatever nature, over and above such costs and expenses quoted and agreed by the Employer at the Tender stage.

- D. The information of existing services is given in the Tender Drawings to some extent for guidance only. However, the Employer does not guarantee that these information are accurate, or correct. The Contractor shall make his own investigations and inquiries to all service authorities to ascertain what services exist at all work sites, and execute all works with necessary steps and precautions to avoid damage to any service in complying with the requirements set out in 1.05 B, Section 01010 of the Standard Specifications. However, it must be noted that these requirements will not relieve the Contractor of any responsibility for taking every precaution to avoid, and further that the Contractor shall fully assume entire responsibility for the cost or repair of any and all damages.

#### **PS 1.09 Ground Status of the new STP site**

The following information is provided for information and guidance only and to draw the Contractor's attention to the fact that soil conditions at the site of the new STP to be constructed under POMSSUP are mostly rocky with shallow bed rock under the top soil.

- (1) The top soils at the site comprise thin soft silty marine CLAY which is compressible and of low shear strength. The top soils must be stored for the landscaping and re-vegetation at the final stage of the Works, in case if it is difficult to secure commercial top soil.
- (2) A ground improvement scheme shall be implemented with the Engineer's approval in the event that the Contractor encounters deep soil layers of compressible nature, which must STP.

The Employer, however, will not accept the Contractor's claim for any extra costs incurred in relation to or in connection with the works based on (1) and (2) above.

#### **PS 1.10 Drawings**

- A. The Drawings forming a part of the Contract Documents are listed in Volume 4 of the Bidding Documents, subject to change in the volume number in the Contract Documents.
- B. Further drawings may be issued to the Contractor by the Engineer as work progresses.
- C. The Employer accepts no responsibility for any omissions or the correctness of the representation of existing features on the Drawings.
- D. The Contractor shall comply with the following conditions:
  1. All work, during its progress and upon completion shall conform to the lines, elevations and grades as shown on the Drawings.
  2. The Contractor shall complete the proposed work in every detail as shown in the Drawings and/or specified in the Technical Specifications.
  3. Should any detail or details be omitted from the Drawings and the Technical Specifications which are essential to its intended completeness, then it shall be the responsibility of the Contractor to design such detail and then furnish and install the Works so that upon completion, the Works will be acceptable, operational and ready for use.
- E. Interpretative Drawings
  - 1 Any additional drawings which the Contractor requires to interpret the Drawings for the use of his employees shall be prepared by the Contractor.
  - 2 Four (4) copies of each shall be supplied to the Engineer, if required by him.
- F. Foundation Drawings

The Contractor shall, within the times named in the Specifications or in accordance with the programme, provide drawings showing the manner in which the equipment is to be fixed together with all information relating to the works, required for:

  - 1 Preparing suitable foundations and anchoring facilities;
  - 2 Providing suitable access for the equipment to the point on site where the equipment is to be erected; and
  - 3 Making all necessary connections to the equipment (whether such connections are to be made by the Contractor under the Contract or not).
- G. Record Drawings and Technical Specifications

- 1 The Contractor shall maintain one record copy of all Drawings, Technical Specifications, Addenda, Variations, Approved Submittals, Correspondence and Transmittals at the Site, in good order and readily available to the Employer, the Engineer and the Engineer's representative.
- 2 In addition to the requirements of the Technical Specifications, Record Drawings shall be clearly and correctly marked and the Record Specifications annotated by the Contractor to show all changes made during the construction process at the time the changed work is installed and the Works as executed complete with:
  - a existing & finished levels
  - b National Grid co-ordinates;
  - c profiles of all pipelines larger than 100 mm diameter;
  - d dimensions;
  - e reinforcing steel details;
  - f details of supports left in place;
  - g locations of all services and underground utilities encountered;
  - h locations of all structures including STP, Pump Station, buildings, chambers & appurtenances including those existing features not to be demolished;
  - I invert and cover levels of all chambers;
  - j connection details and locations;
  - k details of pipe materials and bedding;
  - l sizes and types of manhole and access covers
  - m any other information requested by the Engineer.
- 3 For Mechanical and Electrical equipment, the details shall include the whole plant as erected and described in the Technical Specifications.
- 4 Drawings shall be supplemented as necessary by schedules and data sheets:
- 5 Draft Record Drawings shall be submitted to the Engineer for his approval, and then finalized in accordance with any amendments required by him.
- 6 Record Drawing submission shall include:
  - a five bound sets of "As-Built" Record Drawings on paper to A1 size
  - b five bound sets of "As-Built" Record Drawings on paper to A3 size
  - c one set of first copy mylars (negatives) to A1 size.
  - d one set of CD-ROM containing the record drawings in AutoCAD format. The Engineer will make available to the Contractor an electronic copy of the tender drawings and specification
- 7 Each drawing shall have the Contract Number & Drawing Number detailed to the approval of the Engineer. Computer files containing AutoCAD Drawings shall be maintained as seamless Drawings.
- 8 No final payment shall be made except for work that has been completed in accordance with the Specification and has been duly presented on the "As-Built" Record Drawings.
- 9 The Contractor shall not be entitled to any extra payment or extension of time for the preparation or changes thereto of the As-Built Record Drawings.

### **PS 1.11 Local Conditions**

- A These data are provided as an indication of the type of conditions in which the Contractor's plant will have to operate and particular attention should be paid to concrete curing and corrosion conditions. In the event of the Tender being awarded to the Contractor, he shall satisfy himself as to the accuracy of the information provided.
- B The site conditions shall be taken as follows:

Max. ambient Temperature	36°C
Min. ambient Temperature	10°C
Annual Ambient Humidity Range	60-80 %
Diurnal Humidity Range	60-100 %

Average Yearly Rainfall 1000 mm

- C NCD of PNG has a total land area of 250 km<sup>2</sup> and a population of 254 thousand (growth rate 2.7%) and is divided into two distinct parts, Inland area and Coastal area. Proposed sewerage service area is the coastal area in which areas of Town/Hanuabada/Kila Kila/Kaugere are involved. The two areas are adjacent to each other but they are divided by a watershed.

The Project is based in the coastal area of NCD, which has the share of approximately 25 % of the NCD population.

- D The area is half-sewered with pumping stations and ocean outfall to the sea. Existing sewerage system will be fully utilized after rehabilitation for emergency or drainage, as long as they are available. Even outfalls will be used as emergency discharge outlet. Sites for the new construction of sewers, treatment plant and pump stations are located along the coast of low-lying ground level. The water table in some area close to the coast is high and sub-surface relatively soft.

The prevailing conditions can have the impact on the method of construction of the works. The Contractor shall take all necessary steps to ensure that all works are safe and secure. On request, bore-logs of the site can be made available for the Contractor's inspection. However, the Employer does not guarantee accuracy and correctness of these data. The Contractor should carry out further sub-soil investigation when he feels deemed necessary at his own expenses.

#### **PS1.12 Compliance with Laws and Regulations**

- A. Unless otherwise explicitly provided in the Specification, all permits and licenses necessary for the proper execution of the Works shall be secured by the Contractor. The Contractor must provide payment of all money deposits, fees and charges, contribution whatsoever required to be deposited, given or paid under any written law, by-laws, ordinances, regulations, rules, directives, guidelines, requirements whatsoever in relation to the execution of the Works or any temporary works which are in effect or which may become effective during the period of the Contract, notwithstanding that the applicant therefore or the guarantee thereof is a party other than the Contractor.
- B. The Contractor shall not transport plant and heavy equipment to and from the work site(s) until he has obtained any required permits and clearance from the relevant Governmental and Local Authorities and the Police in PNG.
- C. All works carried out on drains, rivers, streets, roads, lanes and highways shall be in accordance with the requirements of all relevant Local Authorities, Police and other agencies. It shall be the responsibility of the Contractor to determine all requirements and to submit and obtain approvals way-leaves, permits, etc. where required by the local authorities and agencies. In particular, the Contractor shall apply for work execution permits to the following authorities:
1. Construction of sewer pipelines, pumping stations, and access road to STP:  
National Capital District Commission (NCDC) and National Road Safety Council
  2. Construction of ocean outfall: Ministry of Environment and Port Authority.
- C The Contractor shall note that all deposit (refundable and non-refundable), fees and charges imposed by statutory boards and government authorities, agencies, utility companies, etc. pertaining to all necessary applications/processing/submissions done shall be paid by the Contractor, and these shall be claimed with proper receipts and documentation.

## SECTION 01041

### PS 1. 13 Project Co-ordination

- A. The Contractor shall co-operate with the Employer, the relevant Government and Local Authorities and Agencies, other contractors and private and public utility entities with regard to the execution of work, connections to the work and the delivery of materials, and co-ordinate with them subject to concurrence of the Engineer. The agencies and utility companies with which the Contractor should coordinate include, but are not limited to, the followings:
- EDA RANU
  - National Capital District Commission (NCDC)
  - National Road Safety Council
  - PNG Ports Corporaton Ltd.
  - PNG Power Ltd., Telikom PNG, Mobil Oil New Guinea Ltd., InterOil Products Ltd.
- B. **Notification to Residents, Business and Public**  
 Prior to the commencement of the Sewer Network construction works, the Contractor shall hand deliver to each residence and business in close proximity to the respective working site, a written notice three days in advance of commencing any construction work, including delivery of pipe, which will involve temporary inaccessibility or water shutdown to their properties. Said notice shall state when operations will start and approximately when they will end. The notices shall be printed on A4 paper with wording similar to that shown as follows in English. In addition, the Contractor shall post, no further than 10 metres apart along the pipeline route, signs on posts (feet shall be a minimum of 600 mm below ground and surrounded with 150 mm of concrete) placed 1.4 m above ground with the same wording in all English as directed by the Engineer. The notice shall be laminated to protect it from rain, securely fastened to a signboard and securely fastened to the post.

#### **NOTICE**

*To The People along this Road:*

*Within the next few days, work will be started on the installation of a water transmission main in this road as part of the Port Moresby Sewerage System Upgrading Project. The work is expected to be completed by*

.....

*This work may cause some inconvenience but will be of permanent benefit.*

*We will appreciate your co-operation in the following:*

- *please be alert when driving or walking in the construction area;*
- *tools, materials, pipe and equipment are attractive to children. For their safety, please keep them away from the construction site;*
- *please report all inconvenience to the job superintendent or call the office at the number given below.*

*This work is being performed for the EDA RANU on behalf of the Independent State of Papua New Guinea by \_\_\_\_\_  
 (Insert name, address and telephone number of the Contractor in this space)*

*We will endeavour to complete this work as rapidly as possible and with a minimum of inconvenience to you.*

*Signed :  
 Title :*

**PS 1.14 Contractor's Responsibility to ascertain, protect and divert structures, services, utilities, etc.**

- A It shall be the responsibility of the Contractor, before commencing any excavation, to contact all possible owners/occupiers of utilities/services and properties or businesses within the work area and to ascertain from records or otherwise, including on-site detection by suitable instruments the existence, position and ownership of all utilities/services, structures and connections. No error or omission regarding the said utilities/services shall be construed to relieve the Contractor from his responsibility in protecting all such facilities and properties.
- B The Contractor shall also undertake surveys to ascertain invert levels, utility detection surveys, etc. of all utilities and services within the work area, and shall furnish the Engineer with all such information as and whenever requested by the Engineer. The Contractor shall be deemed to have allowed all such cost in his tender prices.

**SECTION 01043****PS1.15 Details of Contractor's Supervisory Staff and Subcontractors**

- A. The Contractor's Project Manager: Unless otherwise provided elsewhere in this Contract, the Contractor shall keep the Project Manager constantly on the Site of the Works. The Project Manager must be capable of receiving instructions and communicating proficiently in written and have adequate English capability for communication with the Engineer, Employer and other parties concerned.
- B. Discharge of Workmen: The Contractor shall employ a project manager, technical staff, foremen, artificers and labourers for the Works who are thoroughly competent, efficient and of good character. If, in the sole opinion of the Engineer, any person employed by the Contractor misconducts himself or has delays or is incompetent, the Contractor, when so directed by the Engineer in writing, shall at once remove such person from the Works and he shall not again be employed on the Works without the written permission of the Engineer. Any person so removed from the Works shall be replaced without delay by a substitute approved by the Engineer. The Contractor shall not be entitled to any claim for any expense whatsoever incurred by him in respect of any direction given by the Engineer under this Section.
- C. Epidemics and Medical Attendance: The Contractor shall maintain the Site in a clean and sanitary condition and shall comply with all requirements of the Government Health and Sanitary Authorities. In the event of any outbreak of illness of an epidemic nature the Contractor shall comply with and carry out such regulations, orders and requirements as may be made by the Government or Local medical or health authorities for the purpose of dealing with and overcoming the same.
- D. The Contractor shall provide to the satisfaction of the Government or Local Authorities concerned adequate medical attendance for his employees. In particular the Contractor shall provide first aid kits at suitable locations on the Site and shall instruct an adequate number of person in their use. The names of the persons so instructed shall be made known to all employees of the Contractor.

**PS1.16 Access Road**

- A. The STP site is presently accessed from an entrance off the horse camp village. A new entrance to the STP will be constructed so as to detour the village in the route given the Drawings. Besides this access road to the STP to be constructed as part of the Works, the Contractor shall be responsible to construct any temporary access roads to the work sites at his own cost.
- B. Attention shall also be drawn to the likely presence of underground utilities and services, which may require temporary or permanent diversions or protection, streams requiring access crossings, and varying soil conditions at different areas within and without the site which may influence the selection and cost of alternative temporary access route.
- C. The Contractor shall be responsible for obtaining the consent of the landowner, tenant or occupier of any land he proposes to use as temporary access and to abide by all conditions, regulations and requirements as may be imposed on him. He shall abide by and comply with access instructions which may be imposed on him. He shall also abide by and comply with access instructions which may be issued by the Engineer or relevant authority from time to time.
- D. The Contractor shall provide suitable entry and exit roads from the nearest public or access road to and within the construction site and facilities, and hard standing for parking areas. All access roads within the site and associated drainage shall be designed, constructed and maintained by the Contractor as may be approved and instructed by the Engineer. The Contractor shall take note that the site access will require maintenance to motorable condition for the movement of construction plant machinery and staff vehicular movements.
- E. The Contractor shall bear all such costs arising from the provision of access roads to the Site, except the access road to be constructed as permanent works as a part of the Contract, including the cost of design, construction and maintenance, and shall allow for the cost in his tender price.

**PS1.17 Days and hours of working and overtime**

- A. No work shall be done on:
  - 1 the weekly day of rest; and
  - 2 any public holiday which is recognized in PNG or the district where this Contract is being carried out; or between the hours of six in the evening and the hours of six in the following morning; without the written consent of the Engineer (such consent not to be unreasonably withheld or delayed).
- B. Provided that when the written application of the Contractor is approved by the Engineer, the Contractor shall comply fully with all requirements of the relevant regulations in force in PNG in regard thereto or any subsequent modification or re-enactment thereof and shall bear all cost for compliance therewith.

**SECTION 01050****PS 1.18 Field Datum**

- A. The Contractor shall source all necessary information on the Planimetric Reference Grid and the Project Elevation Datum necessary to establish the lines and levels of the Works, and to establish the Contractor's setting out within the Site.
- B. The Contractor shall protect all Primary Survey Markers and Benchmarks whether inside or outside the Site in a manner approved by the Engineer. The Contractor shall ensure that the Primary Survey Markers and Benchmarks that have been established are protected from all disturbance until the Contractor has determined locations for all necessary Secondary Survey Markers and Temporary Benchmarks that are required to be provided with sufficiency of numbers, stability and accuracy for the construction of the Works to the required tolerances.
- C. The Contractor shall establish all Secondary Survey Markers and Temporary Benchmarks of approved design in a unique referencing system, and undertake a full survey of all such Secondary Controls. These surveys shall be adjusted to provide final values for co-ordinates and elevations. These values shall be formally issued to the Engineer on a record document cross-referenced to a layout drawing of the Secondary Survey Markers and Benchmarks. All such records shall be kept up to date by formal notice to the Engineer. All such markers shall be painted with distinguishing colours for identification and with the agreed value legibly thereon as may be agreed with the Engineer.
- D. The Contractor shall maintain and check all Primary Survey Markers, Secondary Survey Markers and Benchmarks at regular intervals, and formally issue notification to the Engineer of any changes to the values previously presented. The Contractor shall check all such markers as required for the accurate construction of the Works and immediately notify the Engineer in writing of any discrepancy in values.
- E. All primary and Secondary Survey Markers and Benchmarks shall be carefully preserved except where construction requires their removal, and before such removal the approval of the Engineer shall be obtained. The Contractor shall replace any Primary or Secondary Survey markers and Benchmarks that have been damaged or displaced, unless sufficient control is available to control the Works and the Engineer's approval is obtained.
- F. Prior to commencement of any section of work, the Contractor shall check existing ground levels and shall notify the Engineer where these differ from those shown on the Drawings. Should any difference occur, it shall be checked both by the Engineer and Contractor, and revised ground levels shall be mutually agreed.
- G. For the Sewer construction sites, the Drawings are based on the Permanent Survey Marks (PSM) in PNG. The data used for producing the Drawings will be provided from the Employer or the Engineer. The Contractor is required to use PMS for his surveys and measurements with checking the accuracy of PMS's positions at his responsibility. The Employer will not guarantee accuracy and correctness of the PMS's positions as well as the field datum provided by the Employer or Engineer.

**PS 1.19 Contractor to Verify Levels**

- A. The Contractor shall check and verify all levels as shown in the Drawing before commencing work on the particular section. In particular the hydraulic profile and levels of the train of process units, invert levels of existing and proposed drains, manholes, services, culverts and other appurtenances that may affect the execution of the work should be checked and verified. Discrepancies should be immediately communicated to the Engineer who shall then issue appropriate instructions on the matter.



- B. Survey Accuracy: Accuracy for horizontal positioning shall be better than 1:4000 and for vertical positions shall be to  $\pm 5$  mm.

**PS 1.20 Surveying Equipment and Operatives**

- A. The Contractor shall provide for the exclusive use of the Engineer all equipment necessary for checking the setting out of the Works including levels, theodolites and electronic distance measurement instruments. The instruments shall be of the latest model, and the Contractor shall maintain them in good condition at all times. All items of equipment shall be suitable for working in metric units. In addition he shall protective items such as survey umbrellas, safety and waterproof clothing.
- B. The Employer or his agents will not be responsible for loss, damage or normal wear and tear to surveying equipment and protective items provided under this clause resulting from normal use of the equipment or items on the Site. At the end of the Works, the surveying equipment shall revert to the Contractor. The Contractor shall make all survey equipment available for use within fourteen (14) days of the Commencement Date of the Works. The survey equipment shall be deemed to be part of the equipment to be provided in the office for the Engineer.
- C. The Contractor shall supply chainmen and labourers as described in the Contract, and as required by the Engineer, in carrying out his surveying duties. The Contractor shall provide men suitable for the tasks required, and shall maintain continuity of staff. Chainmen shall be experienced in assisting the Engineer in survey work.

**PS 1.21 Survey by Licensed Surveyors**

All surveys undertaken shall be performed by Licensed Surveyors. All survey plans submitted by the Contractor shall be certified by a Licensed Surveyor.

**Section 01090**

**PS 1.22 Reference Standards**

- A. Whenever the Contract Documents require that a product complies with any specific standard, the Contractor shall present an affidavit from the manufacturer certifying that the product complies therewith. Where requested, or specified, the Contractor shall submit supporting test data to substantiate compliance.
- B. Materials which meet standards equivalent to the designated specific standard shall be acceptable, provided that the Contractor substantiates their equivalence and ensures their compatibility with other components of the system. Copies of the current version of the proposed standards, and a comparison with any specified standard, shall be submitted to the Engineer. The proposed details which qualify such items as being of the acceptable quality shall be submitted to the Engineer for approval in accordance with Section 01300 hereof as well as the same section of the Standard Specifications.

**PS 1.23 Abbreviations**

PNG	Independent State of Papua New Guinea
IPBC	Independent Public Business Corporation
EDA RANU	EDA RANU

DOW                      Department of Works  
 NCDC                    National Capital District Commission

## SECTION 01300

### PS 1.24      Drawings

All drawings and calculations submitted by the Contractor shall be endorsed by a professional engineer registered with the authorized institution in PNG in relevant discipline. The format of the drawings and calculations shall follow the requirements of Section 01300 of the Standard Specifications and any further requirements by the Engineer.

## SECTION 01310

### PS 1.25      Progress Schedules

To enable the Engineer to interface with the scheduling system, the Contractor shall provide to the Engineer an original, licenced copy of the software used by the Contractor for scheduling purposes registered in the name of the Employer and EDA RANU. This software shall be handed over to the Employer and EDA RANU at the end of the project and will become the property of the Employer and EDA RANU thereafter.

## SECTION 01380

### PS 1.26      Photography Requirements

- A Prior to beginning of construction, initial photographs shall be taken at every bend, junction, culvert, bridge and every building adjacent to the site of the STP and PSs and at no more than 0.5 km apart along the road from the treatment plant to the nearest highway prior to construction. Sufficient numbers of photographs shall be taken of the treatment plant, access roads and sewer routes to record the existing conditions prior to construction.
- B For the monthly progress photographs the Contractor shall use a high quality digital camera, with a minimum resolution of 3.3MegaPixel and shall furnish four colour presentation prints (200 mm x 250 mm) and JPEG format files of each of the maximum of ten of the photographs selected by the Engineer.

## SECTION 01500

### PS 1.27      The Engineer's Site Offices

- A. The Engineer's Site Office shall be made up in the STP site as follows:

Room	Approximate Area (m <sup>2</sup> )
Chief Resident Engineer's Room	25
Resident Engineer's Room	20
Assistant Resident Engineer's Rooms	15

<b>Room</b>	<b>Approximate Area (m<sup>2</sup>)</b>
File Room	30
Secretary and Reception area	15
Other Staff Rooms	40
General Work Space	20
Conference Room	60
Storage Room	15
Equipment Room (Photo Copy Machine, etc.)	15
Kitchen	10
Wash Room	10
2 rest rooms with toilet (2 Water Closets for each)	6

- B. The kitchen shall contain a sink, a 300-litter refrigerator, two ring gas burners with 13.5 kg gas cylinder, lockable cupboard (approx. 1.9 x 0.7 x 0.9 m high) with Formica top. The washroom shall contain low level suite complete with fittings, washbasin, shower, 500 x 400 mm mirror, towel racks, paper holders, soap holders etc. All plumbing fittings shall be porcelain and all plumbing including pipes shall comply with local laws and regulations.
- C. New furniture and equipment as shown below shall be provided to meet the approval of the Engineer.

<b>Item</b>	<b>Quantity</b>
Steel desk 1.6 m x 0.9 m with six lockable drawers	2
Steel desk 1.5 m x 0.75 m with six lockable drawers	12
Conference table with chairs	for 30 seats
Typist table, 1.2 m x 0.6 m with drawer and typist chair	1
Swivel medium back executive chair	2
Arm chair	12
Inclined plan table for drawings	2
Steel Cupboard 1.8 m 0.9 m x 0.45 m	2
4-drawer steel filing cabinet	10
4-drawer steel drawing cabinet	3
Steel book shelf 1.8 m x 1.2 m	10
Magnetic white board 1.0 m x 1.5 m	2
2 telephone lines (with 10 extensions)	1 set
Pentium 4 Computer/monitor/mouse/UPS	6 sets
CD-Writer (to be installed in one of the computers)	1
A3 B/W Laser Jet Printer	2
A3 Colour Ink Jet Printer	1
(all computer and printers to be linked each other by LAN using a router)	

<b>Item</b>	<b>Quantity</b>
Software to be installed in each computer	Windows 7 Pro MS Office 2010 Pro
Software to be installed in one of the computers	Auto CAD 2010
Colour Inkjet Plotter A1 size, with continuous paper feed and cutter	1
Scientific calculators	8
Heavy duty photocopy machine A3 size with 10 bin sorter	1
Dry-type photocopy machine, A1 size	1
Scanner IBM compatible A4 size high resolution colour	1
High quality digital camera	1
Plain paper fax machine	1
Steel cash box	1
Binding machine A4 size	1
File trays	20
Waste paper baskets	10
Water dispenser (hot and cold water) with bottled water replenished regularly	2

- D. The Contractor shall install in the Engineer's Site Office two telephone lines with 10 extensions and provide an e-mail system for the Engineer's use and maintain it in good working order and pay for all monthly charges, excluding overseas call charges.
- E. The Contractor shall provide, as required by the Engineer, safety helmets, safety boots, rubber boots, gloves, torches and the like for the use of the Engineer and his staff and for visitors to the Site.
- F. A covered parking area shall be constructed and maintained for at least five motor vehicles in the STP site for the Engineer's use.

**PS 1.28 Vehicles for the Engineer and Representatives**

- A. The Contractor shall provide 5 vehicles complete with taxes, insurances, and services, and maintain them for the use of the Engineer and their staff until six months after the Completion of the Works or such time as they are no longer required by the Engineer in connection with the Works.
- B. All vehicles shall be supplied new and shall be maintained in conformity with the vehicle manufacturer's recommendations.
- C. The Contractor shall provide all fuel and oil, and shall replace any damaged or faulty parts as required and as directed by the Engineer.
- D. Should any of the Engineer's vehicles be unserviceable for a period greater than 24 hours, the Contractor shall provide a replacement vehicle to the approval of the Engineer. Where the Contractor fails to supply a replacement vehicle to the Engineer's satisfaction, the Engineer may hire a suitable vehicle outside the Contract, and debit any incurred costs from subsequent payments due to the Contractor.

- E. Insurance shall be fully comprehensive and shall include all risks to any passenger or other party, and shall allow for carriage of persons or goods as required in the Contract. The vehicles will be driven by the drivers provided by the Contractor either on or off the Site.
- F. Vehicles shall conform to the following requirements:
  - One (1) Four-wheel drive cross-country/road vehicle, with a full length hard top; five door, five-seater with additional back seats or similar approved with an engine capacity of not less than 2.5 litres.
  - One (1) Four-wheel drive cross-country/road vehicle, with a full length hard top; five door, five-seater with additional back seats or similar approved with an engine capacity of not less than 2.0 litres.
  - Three (3) Four-door sedan with engine capacity of not less than 2.0 litres
- G. The Contractor shall provide one (1) driver each at the Engineer's Site Offices. Drivers shall be available throughout the whole periods until the vehicles are reverted to the Contractor, for exclusive service for the Engineer and his representatives for delivery and/or dispatch of documents, transportation of Engineer's staff, etc.
- H. All vehicles shall be equipped with supplier's standard equipment and other provision including automatic transmission, air conditioning, reverse sensor, power windows, safety triangle, tool kit bag, door visor, radio and CD player.
- I. All vehicles shall be available for use within fourteen (14) days of the letter of instruction by the Engineer to supply the vehicles. When no longer required, the vehicles shall be reverted to the Contractor. In the event that the Contractor fails to make available any of the vehicles within the specified time, the Engineer may hire a suitable vehicle outside the Contract, and debit any incurred costs from subsequent payments due to the Contractor.

#### **PS 1.29 Mobile Phones**

The Contractor shall supply the Engineer with Eight (8) mobile telephones and maintain them and pay for all monthly charges, excluding overseas call charges until they revert to the Contractor on completion of the project.

#### **PS 1.30 The Plant Manager's House and Operator's Site Dormitory**

- A. The Contractor shall construct the Plant Manager's House and Operators' Site Dormitory in the STP site as specified hereunder. The Contractor shall carry out architectural design and all construction drawings for the Plant Manager's House and Operators' Site Dormitory. Decision of the site/location shall be made by the Employer/EDA RANU prior to the design.
- B. Architectural and construction drawings for the Plant Manager's House and Operators' Site Dormitory shall be submitted to the Engineer for review and shall be finalized to meet the interest and requirement of the Employer and EDA RANU. These drawings shall include garages and paved drive ways.
- C. The Plant Manager's House and Operator's Site Dormitory shall be built inside the STP site and include the following provisions:

:

- (1) A common, water-proof package type Emergency Generator and fuel tank for 6 hours operation shall be provided in the premises of the area. The Generator shall be installed under a metal roof, and generated electricity shall be distributed to the Manager's House and Operators' Dormitory.
- (2) A paved driveway and footway with streetlights shall be constructed from STP entrance and administration building to the Manager's House and Operators' Dormitory, which shall landscape with greening and tree planting along the road.
- (3) A brief specification of the Manger's House and Operators' Dormitory is given below.
  - (A) Plant Manager's House

Room	Approximate Area (m <sup>2</sup> )
2 story wooden house with metal roof, with garage Height of a story shall be more than 3.5 m	
Living Room with a rest room	25
Main Bed Room with Bathroom	15
Bed Room (1)	10
Bed Room (2)	10
Bed Room (3)	10
Common Bath Room	10
Wash Room	15
Kitchen	10
Balcony with Roof in the first story	10
Storeroom	5
Solar Water Heater	1 set
Telephone line (with 3 extensions)	1 set
Portable extinguisher in the kitchen	1 set

- 1) The kitchen shall contain two sinks, two ring gas burners and oven with electric range hood and 13.5 kg gas cylinder, built-in kitchen counter and lockable cupboard (approx. 1.9 x 0.7 x 0.9 m high) with Formica top.
- 2) The bathroom in the main bedroom shall contain a toilet, shower, 500 x 400 mm mirror, towel racks, paper holders, soap holders, with drainage on the tiled floor, etc.
- 3) The common bathroom shall contain a toilet, a bath tub, shower, 500 x 400 mm mirror, towel racks, paper holders, soap holders, with drainage on the tiled floor, etc.
- 4) Wash room shall be enough for washing machine and a tumbler with tiled floor, etc.
- 5) All plumbing fittings shall be connected with water tank receiving public water supply and be porcelain and all plumbing including pipes shall comply with local laws and regulations. All drainage shall be connected to sewerage.
- 6) All the doors and windows shall be equipped with a double locking system. All the windows shall be furnished with curtain rods (rails) and blind. All the rooms shall be furnished with lighting fixtures and ceiling fans. Balcony shall be furnished with lighting fixture.

- 7) All the rooms, kitchen and bath rooms shall be furnished with plural numbers of wall plug sockets.

(B) Operators' Dormitory

Room	Approximate Area (m <sup>2</sup> )
2 units of 2 story wooden house partitioned into 5 units with metal roof, for 10 operators Height of a story shall be more than 3.5 m	
Specification for one unit is shown below:	
Living Room with a rest room	15
Bed Room (1)	10
Bed Room (2)	10
Balcony with Roof in the first story	5
Common Bath Room w/ Wash room	15
Kitchen	10
Solar Water Heater	1 set
Telephone line (with 2 extensions)	1 set
Portable extinguisher in the kitchen	1 set

- 1) The kitchen shall contain two sinks, two ring gas burners and oven with electric range hood, with 13.5 kg gas cylinder. The bathroom shall contain a toilet, a shower, 500 x 400 mm mirror, towel racks, paper holders, soap holders, with drainage on the tiled floor, with space for a washing machine, etc.
- 2) All plumbing fittings shall be connected with water supply and be porcelain and all plumbing including pipes shall comply with local laws and regulations. All drainage shall be connected to sewerage.
- 3) All the doors and windows shall be equipped with a double locking system. All the windows shall be furnished with curtain rods (rails) and blind. All the rooms shall be furnished with lighting fixtures and ceiling fans. Balcony shall be furnished with lighting fixture.
- 4) All the rooms, kitchen and bath rooms shall be furnished with plural numbers of wall plug sockets.

D. The costs for the construction of the Manager's House and Operators' Dormitory as specified above are accounted as a Provisional Sum in the Bill of Quantities. The Contractor shall submit a price proposal to the Engineer in response to the Engineer's instruction and request for proposal issued after the commencement of the Works in accordance with the procedures set forth in the Conditions of Contract, and shall execute the construction works in accordance with the design and prices agreed by the Engineer and Employer.

## SECTION 01580

### PS 1.31 Project Signboard

The Contractor shall provide and maintain project signboards on the Site as shown in the Drawings or indicated by the Engineer. Within one week of the completion of the Contract,

the signboards shall be disposed of unless otherwise approved by the Engineer or Employer.

## **SECTION 01670**

### **PS 1.32 Training of Operating and Maintenance Personnel**

- A. For a minimum period of 12 months commencing from the commissioning of the STP, the Contractor shall provide complete and comprehensive training for the integrated operation of the plant facilities to the various levels of operating personnel appointed by the Employer on the procedures, controls and functions, operation (in the normal, emergency and shutdown modes), maintenance (for the normal, preventive and specific scenarios) and equipment installation, setting and adjustment of each and every item of plant as specified. The Contractor shall render the training services at the places indicated by the Engineer and/or the Employer.
- B. The Contractor shall provide a well-structured training programme for prior approval of the Engineer in accordance with the Training Programme indicated in Technical Schedule A: Training Programme that is attached as Annex to Particular Specifications. The Programme shall be subdivided and shall include separate training modules for managers, mechanical and electrical fitters, and plant operatives. The programme shall also include general modules for all staff relating to specific issues such as site safety in relation to the plant and equipment installed. The Contractor shall submit comprehensive syllabus, technical literature, reference materials and documents, and the duration of each distinctive aspect of the training exercise - classroom, site demonstration, hands-on operation and maintenance and supervision - for approval.
- C. For the training, the Contractor will be allowed to use or consume free of charge laboratory equipment and testing chemicals that have been furnished to the Employer under the Contract.

## **Section 01730**

### **PS 1.33 Operation and Maintenance Manuals**

- A The O & M manuals shall be provided in English.
- B The Contractor shall prepare Operation and maintenance manuals in a systematic format throughout. The format shall be approved by the Engineer.
- C Operation and Maintenance manuals shall include but is not limited to:
  - 1 A detail description of the Pumping Stations and Sewage Treatment Plant as installed and commissioned.
  - 2 A full description of the individual systems installed, written to ensure that the Employer's staff understand the scope and facilities provided.
  - 3 Interface details between the equipment systems within the Works and related systems installed by others.
  - 4 Diagrammatic drawings of each system indicating principal items of plant, machinery, equipment, pipes, valves etc.
  - 5 A photo-reduction of all record drawings to A2 to A3 size together with an index.
  - 6 Legend for all colour-coded services.



- 7 Schedules (system by system) of plant, machinery, equipment, pipes, valves, etc., stating their locations, duties and performance figures. Each item shall have a unique number cross-referenced to the record and diagrammatic drawings and schedules.
  - 8 The name, address and telephone number of the manufacturer of every item of plant, equipment and material together with catalogue list numbers.
  - 9 Manufacturer's technical literature for all items of plant, equipment and material assembled specifically for the Works, including detailed drawings, electrical circuit details and operating and maintenance instructions.
  - 10 A set of all certified test certificates and reports (including but not limited to electrical circuit tests, corrosion tests, type tests, works tests, start and commissioning tests) for the installation and plant, equipment, pipes, valves, etc., used in the installation.
  - 11 A set of all manufacturers' guarantees or warranties.
  - 12 Starting up, operating and shutting down instructions for all equipment and systems installed.
  - 13 Control sequences for all systems installed.
  - 14 Schedules of all fixed and variable equipment settings during commissioning.
  - 15 Procedures for seasonable changeover.
  - 16 Recommendations as to the preventive maintenance frequency and procedures to be adopted to ensure the most efficient operation of the systems.
  - 17 Lubrication schedules for all lubricated items.
  - 18 A list of normal consumable items.
  - 19 A list of recommended spares to be kept in stock by the employer, being those items subject to wear or deterioration and which may involve the employer in extended deliveries when replacement are required at some future date.
  - 20 Procedure for fault finding.
  - 21 Emergency procedures, including telephone numbers for emergency services.
  - 22 Other useful data and information regarding the operation and maintenance of the Equipment and system as required by the Employer's operating personnel.
- D The Contractor shall prepare the manuals in A4 size plastic covered, loose leaf, four (4) ring binders with hard covers, each indexed, divided and appropriately titled. The Contractor shall properly fold drawings larger than A4 to accommodate them in the binders. The Contractor shall prepare five (5) preliminary sets of manuals with preliminary record drawings and preliminary performance data available and submit them at commencement of pre-commissioning to enable the Employer's operating personnel to familiarise themselves with the documentation and to acquaint themselves with the installed equipment.
- E The submitted documents will be used during the pre-commissioning and post commissioning periods and relevant comments forwarded to the Contractor for incorporation into the final manuals for the approval of the Engineer. These will become the format for the final manuals.
- F Before the employer's Taking Over of the Works, the Contractor shall provide the Engineer with five (5) copies of the final manual plus three (3) copies on diskette including text, diagrams and graphics using AutoCAD and MS Word or equal software approved by the Engineer. The Engineer shall not issue the Taking-Over Certificate until he has received the final manuals. In addition, the Contractor shall provide one (1) copy of all the documents on transparency for reproduction.

## END OF DIVISION 1

**DIVISION 2.**

**SITE WORK**

## Division 2 Site Works

### Part – A Sewer Network

#### PS 2.01 General

- A. This Part A relates to the site works for the sewer network to be constructed under the Port Moresby Sewerage System Upgrading Project (hereinafter referred to as the “POMSSUP” or “Project”).
- B. The sewer network to be constructed under the POMSSUP comprises the followings:
1. Main Trunk Sewer Pipelines;  
Pressure mains and gravity flow pipeline to be installed
  2. Branch Sewer Pipelines;  
Gravity flow pipeline to be installed
  3. House Connection Reserve;  
Sewage and wastewater collection (gravity flow) pipes to be installed for house connection reserve (stop at ROW by end-cap) basically in each manholes. However, connection work to each household out of the scope of works.

Details of these pipelines are described below.

#### 1. Main Trunk Sewer Pipeline

Total Pipe Length: 17.7 km

Materials: HDPE Straight Pipe, HDPE Bend, HDPE Fittings and DIP fittings

Pipe Diameter: 100mm (DN 110) to 700mm (DN710)

Details by section are shown in the following table:

Trunk No.	Collection System	Diameter (mm)	Length (m)	Manhole etc. No.	Remarks
1. Kanudi to Idubada	Pressure	DN110	1,100.10	AV 1	
2. Idubada to Hagara	Pressure	DN110	897.04	AV 1	
3. Hagara to Hanuabada	Pressure	DN225	793.48	AV 1, DV 1	No. 3-1
	Gravity	DN355	522.7	MH 12	No. 3-2
4. Hanuabada to Konedobu	Pressure	DN355	1,351.20	AV 1, DV 2	
5. Konedobu to Davara	Pressure	DN450	1,362.05	AV 1, DV 1	No.5-1
	Gravity	DN450 DN560	175.24 27.44	Special MH 1	No.5-2 Receiving Manhole (2) Water Pressure Reducing Chamber
6. Stanley Esplanade to Ela Beach Road	Pressure	DN160	445.73	AV 1	
7. Sea Park to Ela Beach Road	Pressure	DN110	630.82		
8. Ela Beach Road	Gravity	DN355	241.07	MH 5	
9. Ela Beach Road to Davara	Gravity	DN630	184.23	MH 6	
10. Davara to Lawes Road	Pressure	DN450	747.73	AV 1	
11. Lawes Road to	Pressure	DN500	2,687.66	AV 3, DV 3	

Receiving Well(1)					
12. Koki to Badili	Pressure	DN225	71.47		No.12-1
	Gravity	DIP, dia.300	-		Existing Pipe
13. Badili to Receiving Well(1)	Pressure	DN400	1,158.68	AV 1	Flow Meter Chamber
14. Kila Police to Konebada	Pressure	DN110	221.06		14-1 Peak Point
	Gravity	DN225	432.32	MH 9	14-2
15. Konebada to Gabutu	Pressure	DN110	214.69		15-1 Peak Point
	Gravity	DN225	340.03	MH 10	15-2
16. Gabutu to Receiving Well(1)	Pressure	DN125	735.65		
17. Receiving Well(1) to Kaugere	Gravity	DN710	602.85	MH 11	
18. Kaugere to STP	Pressure	DN710	1,831.47	AV 1, DV 1	
19. Horsecamp to STP	Pressure	DN225	843.40		
Old Yacht Club to Stanley Esplanade	Pressure	DIP, dia.150	-		(Branch), Existing
<b>Total</b>	<b>Pressure &amp; Gravity</b>	<b>HDPE</b>	<b>17,618</b>		-

Note: AV=Air valve, DV=Drain Valve, MH=Manhole

## 2. Branch Sewer Pipelines

Total Pipe Length: 17.4 km

Materials: uPVC Straight Pipe, uPVC Fittings and HDPE Straight Pipe (Only Badili area under highway and Kila Kila area under Storm water open channel)

Pipe Diameter: 100mm (DN100), 150mm (DN150) and 225mm(DN225)

Collection System: All Gravity Flow (including House Connection Reserve)

Details by catchment are shown in the following table:

Branch Sewer Catchment	Diameter (mm)	Length (m)	Manhole No.	Existing Connection No.	Remarks
1. Idubada	100	70	14	2	*1
	150	441			
2. Hanuabada	100	125	25	3	*1
	150	1,153			
3. Ela Makana	100	55	12	2	*1
	150	380			
4. Touaguba	100	185	37	2	*1
	150	1,216			
5. Koki	100	145	29	4	*1
	150	890			
	225	214			
6. Badili	100	565	105	10	*1
	150	144			
	DN160	648			HDPE under Highway
	DN225	27			HDPE under Highway
	150	3,212			
	225	237			
7. Gabutu	100	195	33	1	*1
	150	1,124			

Branch Sewer Catchment	Diameter (mm)	Length (m)	Manhole No.	Existing Connection No.	Remarks
8. Kaugere	100	390	48	3	*1
	100	71			Stair Steep Piping
	150	1,630			
9. Kila Kila	100	790	79	4	*1
	150	3,029			
	225	428			
	DN355	12			HDPE under Channel
<b>Total</b>		<b>17,376</b>	<b>382</b>	<b>31</b>	

### 3. House Connection Reserve

House connection reserve pipes will be installed from manholes up to the end cap located at about 5.0m from each manhole in order to accelerate house connections, However, connections to every household are out of the scope of works.

- C. The Contractor shall note that all sewer pipelines shall be constructed by the methods of open trench excavation as indicated in the Drawings. Nevertheless, if the Contractor identifies, in the course of executing the works, any area in the pipeline routes on which the application of pipe-jacking method is technically sound and more economical to meet the site conditions, the Contractor may propose to execute the pipe-laying on such area by applying the pipe-jacking method, instead of open-cut method, subject to the Engineer's approval. In such event, the Contractor shall submit the work proposal and cost estimates for the Engineer's approval, and shall be responsible to revise all designs in the route as necessary for the Engineer's approval, and execute and complete the works based on the pipe-jacking method approved by the Engineer. In no circumstance, the Engineer's approval shall waive the Contractor's responsibility and also the Contractor can entertain any additional time and cost over those proposed in his tender.
- D. All the sewer pipelines will be laid along the roads which are under the control of National Capital District Commission (NCDC). The Contractor shall submit to NCDC an application for the execution of the sewer pipeline construction works, accompanied with necessary documents as required for NCDC's approval prior to the commencement of the works, and shall carry out the works to meet the NCDC's requirements.

## Section 02060

### PS 2.02 Demolition

The Contractor shall demolish all structures as and when directed by the Engineer and as detailed on the Drawings.

## Section 02200

### PS 2.03 Earthworks and Site Preparation for Sewer Network Pipelines

- A. In addition to the requirements of Clause 1.14 of Section 02200 of the Standard Specifications, the Contractor shall undertake a survey of all the underground existing utilities/obstructions/culvert foundations along all pipeline routes and shall determine the exact locations and depths of all such underground utilities and obstructions. The results of the survey shall be incorporated in the “As-Built” drawings.
- B. For each trial hole (test pit), the Contractor shall furnish a written report and a neat sketch of the data uncovered including:
1. soil characteristics;
  2. utilities uncovered, materials, sizes and dimensions and depths;
  3. any other interesting observations.

Trial hole shall be a size as shown on the Drawings and depth as low as proposed pipe invert level plus 300mm deeper. While the excavation, the Contractor shall excavate basically by manual very carefully to prevent any damage of existing facilities. If the Contractor requires to conduct trial hole where is not shown on the Drawings, the Contractor shall conduct the test pit excavation with his own expenses.

- C. On the pipeline working sites, the Contractor can remove trees, if necessary, and shrubs within the area delineated on the Drawings. The remaining areas shall be left in their natural state.
- D. After the site clearance, the ground shall be excavated to form the finished compound level as shown on the Drawings. All cut and fill slopes not likely to be disturbed by the construction of structures/buildings shall be trimmed to final profiles as indicated in the Drawings or as directed by the Engineer and close turfed immediately after trimming to prevent surface erosion. All turfing that has become defective within the construction period and the defects notification period defined in the Contract shall be replaced at the Contractor’s expense.

## **Section 02221**

### **PS 2.04 Trench Excavation**

- A. The Contractor shall carry out trench excavation of the roads for the pipe installation works as shown in the Drawings and in accordance with Section 02221 of the Standard Specifications and NCDC’s requirements.
- B. Soil survey data indicates that subsoil in some areas of the pipeline routes contains bed rock layer in shallow undergrounds. The Contractor shall investigate these conditions and carry out the excavation in appropriate methods with the Engineer’s approval. The Contractor shall allow for such excavation costs in his tender. The Employer will not consider any extra costs in account of unforeseen causes over the rates/prices quoted in his tender.
- C. The Contractor shall take all precautions necessary to avoid damage to existing trees. Tree roots encountered larger than 75 mm in diameter shall not be cut and hand excavation may be required to avoid root damage.
- D. The Contractor is advised that the trench excavation will be adjacent to existing properties in numerous areas. Therefore all trenches shall be shored and braced, or otherwise stabilized, to prevent damage to such properties, to prevent sloughing and to protect workman in the trench and to safely accommodate surface surcharge loads from excavated materials, pipe, equipment and vehicles. Design calculations and details by a certified

soils engineer shall be submitted for approval by the Engineer prior to any trench excavation.

- E. The trench width may be increased at joints to allow proper installation of the joint. This increased working width should be kept to a minimum and shall be approved by the Engineer.
- F. The Contractor shall remove and dispose all debris, buried obstacles and unusable soils after excavation to meet the NCDC's requirement. The Contractor shall secure the dumping site for disposal as allowed by the NCDC and other relevant authorities prior to the commencement of the excavation works. The Contractor shall allow for the disposal costs in his tender price.

#### **PS 2.04 Pipe Bedding**

All pipes shall be laid in granular material or selected hill sand (F.M.08), except where otherwise stated or where concrete surround is to be provided. The granular bedding shall be provided with a geotextile surround when directed by the Engineer. The Contractor shall ensure the supply of suitable soil, aggregate and other materials required for the pipe bedding as specified in Section 02221 of the Standard Specifications. The Contractor shall be responsible to ensure the supply sources of suitable pipe bedding materials at his costs.

#### **PS 2.05 Reinstatement of Roads after Completion of Pipe Installations**

- A. The Contractor shall carry out temporary reinstatement and permanent reinstatement of the roads excavated for the pipe installation works, after completion of the pipe installation works. These reinstatement works shall be executed in complying with the NCDC's requirements and completed to meet the NCDC's satisfaction. The reinstatement works shall also include reinstatement of landscaping for any areas where landscapes were demolished for the construction.
- A. Temporary reinstatement of the roads shall be provided immediately after backfilling and compacting the trench and compacted as specified to enable the road to be used for vehicular traffic, as shown in the Drawings and also specified in Section 02221 of the Standard Specifications. Backfill ground level such as right of way, roundabout, grass area and so on except walk way (foot path) and asphalted road shall be backfilled and well compacted as it was (same as existing ground level).
- B. The Contractor shall also provide all temporary and permanent reinstatement of surface water drains, culverts and other facilities, the costs for which, except those for the permanent reinstatement of the road pavements, are deemed to be entirely covered by the Contractor's rates for pipeline installation.
- C. The Contractor shall employ a local contractor registered with NCDC for the permanent reinstatement of the road pavements, and force him to carry out and complete the works in full compliance with the NCDC's requirements. These permanent reinstatement works of the road pavements are indicated as Provisional Sums in the Bill of Quantities. The Contractor shall submit a work and price proposal for these works in response to the Engineer's instruction and request after the commencement of the Works, and shall carry out these works at the rates/prices agreed by the Engineer/Employer in accordance with the procedures set forth in the Conditions of Contract. The Contractor shall be responsible for the works performed by the employed local contractor.

#### **PS 2.06 Watercourse Crossings**

- A. The Contractor shall furnish all labour, equipment and materials and perform all incidental work required to install watercourse crossings as shown in the Drawings, specified in the Technical Specifications and/or directed by the Engineer.
- B. The Contractor shall submit to the Engineer his proposed method and details of the construction of watercourse crossings for the Engineer's approval. Approval of such methods and details shall not relieve the Contractor of his obligations.
- C. The Contractor shall take extreme care to protect the existing structures from damage. Vehicular and pedestrian traffic shall be maintained at all times. Costs or charges resulting from damage thereto shall be borne by the Contractor.
- D. Where crossings are outside of culverts but under the invert level, the necessary trench cut off walls and riprap shall be provided as shown in the Drawings.
- E. Steel used for pipe supports and incidental works of crossings shall be of structural steel as specified in Section 05120 of the Standard Specifications.
- F. When the Contractor constructs the pipe bridge of open channel crossing, the Contractor shall submit the construction drawing with location map to the Engineer and NCDC for NCDC's approval prior to the commencement of the works. The Contractor shall carry out detailed design of the pipe bridge by following the standard drawing given in the Drawings, and submit shop/construction drawings to the Engineer for his approval.

#### **PS 2.07 Existing Utility Services**

- A. The Contractor shall be responsible to investigate and ensure the locations and details of the existing services prior to the commencement of the works. Any data and information regarding the existing utilities indicated in the Drawings or provided by the Employer are for information and guidance only, and will not guarantee on accuracy and correctness of the provided data and information. It shall be the Contractor's responsibility to check the accuracy of the same.
- B. The Contractor shall contact all utilities companies to ensure the locations and details of the existing utilities, and prepare and submit to the Engineer construction drawings for the pipe installation works for his approval prior to the commencement of the works. However, the Contractor shall be responsible to protect the existing utility services from damage, and shall indemnify the Employer and Engineer from any claims by the utility companies.

### **Section 02222**

#### **PS 2.08 Structure Excavation and Backfill**

A minimum 100 mm thick layer of bottom shall be carefully excavated and trimmed immediately before placing the permanent work on it except where layer is hard soil/rock to support the foundations or floor of a structure.

### **Section 02700**

#### **PS 2.09 Pipework – General**



- A. The minimum cover to the top of the pipelines shall be more than 0.9m under vehicle and 0.6m under non-vehicle. In the pump station sites and pipe laying places, a depth of the pipe work shall be as shown on the Drawings.
- B. All pipes and fittings to be buried shall be HDPE, uPVC or epoxy lined ductile iron, as shown in the Drawings and/or specified herein. The fittings must be manufactured by the same manufacturer as the pipes, and the manufacturer must have an accredited local agent with technical support services. Self-anchoring (restrained) joints shall be provided as indicated in the Drawings and/or specified herein. If the joint anchor system cannot be incorporated into fittings, then the Contractor shall provide flanged fittings with the necessary restrained flanged adapters. The actual configuration of the fittings and joints shall be as recommended by the pipe manufacturer to resist the thrusts. Any welding of ductile iron pipe and fittings or fusion of HDPE pipes and fittings outside of the pipe manufacturer's manufacturing and fittings facility will be approved only in exceptional circumstances, under strict quality control requirements and with the agreement of the pipe manufacturer. Where detailed in the Drawings, thrust blocks will be constructed on the pipelines to resist horizontal or vertical forces. The Contractor shall submit to the Engineer details of his proposed location and types of required thrust blocks for his approval prior to the construction.
- C. Acceptable materials for pipes and appurtenances are as follows:
1. Main Trunk Sewer Pipelines (Force Main and Gravity Flow):
    - High Density Polyethylene (HDPE) pipe with HDPE fittings or Ductile Iron Fittings with epoxy coating or Black HDPE pipe with carbon black as shown in the Drawings
      - a) High Density Polyethylene (HDPE) pipe with HDPE fittings in class as stated in the BOQ.
      - b) Class 10 (Nominal working head : 100 m at 20 °C), PN10
  2. Branch Sewer Pipelines (Gravity Flow):
    - Polyvinyl Chloride (uPVC) pipe except under highway  
uPVC pipe with uPVC fittings in accordance with PNGS 1039 Class SH minimum shall be used for 150 mm nominal diameter.
    - High Density Polyethylene (HDPE) pipe or Black HDPE pipe with carbon black under highway
      - Class 10 (Nominal working head : 100 m at 20 °C), PN10
  3. House Connection Reserve (Gravity Flow):
    - Polyvinyl Chloride (uPVC) pipe except under highway  
uPVC pipe with uPVC fittings in accordance with PNGS 1039 Class SH minimum shall be used for 150 mm nominal diameter.
- D. The Contractor shall note that many of the routes of the pipelines are in narrow and winding roads. Therefore, the Contractor is advised to use a majority of the pipes in a length not exceeding 6.0 m for uPVC and Ductile Iron pipes in order to help convenience in transportation and laying.
- E. At the bend with equal or more than 22.5 degree, thrust block with required retaining area shall be installed as specified in the Drawings.
- F. Flanges for all pipes, valves and fittings shall be PN 10 as shown in the Drawings.

- G. The test pressure will be one and half times the working pressure.
- H. After testing the pipelines shall be flushed out with clean water.
- I. Test Certificates: Each consignment of pipes, pipe specials, fittings and valves delivered to site shall be accompanied with a witness testing and inspection certificate from a third party inspection and testing agency approved by the Engineer. The Engineer or his representative reserves the right to inspect the pipes, specials, fittings and valves to be supplied for the works at the place of manufacture and to witness the manufacture and works tests.
- J. Transportation of Pipes & Fittings: Any vehicle on which pipes are transported shall have a bed of such length that the pipes do not overhang. Large pipes shall be placed on cradles and the loads adequately secured during transit. The pipes shall be handled in accordance with the manufacturer's recommendations.
- K. Inspection of Pipeline Materials: Transportation of pipes, specials, fittings and valves to site over rough terrain may give rise to a high proportion arriving damaged. Before incorporation into the pipeline each item of pipeline material shall be brushed out and carefully examined for soundness. Damaged items which in the opinion of the Engineer cannot be satisfactorily repaired at site shall be rejected and removed from site. If under line test, the Engineer considers that an unacceptable proportion of the pipes within a test length has failed, the Contractor shall be required to test hydraulically to the works test pressure each pipe and joint before pipe laying. In this event, test results shall be submitted to and approved by the Engineer before any further pipes are laid.
- L. Resistivity Survey: The Contractor shall undertake a resistivity survey along the route of the transmission main in accordance with the requirements of BS. 1377 Part 9, Section 5.1 to determine highly aggressive soil conditions and the type of special external coating system required. The results of the resistivity survey shall be presented in a tabular report format to be approved by the Engineer and the resistivity survey report for each section of pipeline shall be presented to the Engineer prior to placing the orders for pipes & fittings. As a minimum, the report shall list the following information for each measurement:
- 1) Date & time
  - 2) National grid coordinates
  - 3) Brief description of location
  - 4) Resistivity values at depths of 1.5, 2, 3, 4 & 5 m.
- M. Pipeline Marker Tape: All pipelines shall be marked with an acid and alkali resistant polyethylene detectable warning tape with a minimum width of 300 mm and shall consist of all accessories necessary for installation at the chambers, splicing, junctions etc. The tape shall be blue in colour and clearly marked in black lettering with "CAUTION – SEWER MAINS BELOW" in English with a maximum repeat distance of not more than 1 m. The tape shall be placed during backfilling of the pipeline trench at a depth below finished ground level indicated on the drawings. The tape shall have a minimum strength of 125 kg/sq. cm in the longitudinal direction and 105 kg/sq.cm transversely. The minimum thickness of the tape shall be not less than 0.575 mm comprising of polyethylene sealing layer of 0.1 mm, aluminium foil of 0.075 mm and base layer of polyethylene 0.4 mm. The metallic conductor(s) shall be either aluminium foil having a width of not less than 50 mm and a thickness of not less than 0.075 mm or stainless steel wires. The aluminium foil shall be not less than 99.5% pure. The foil/wires shall be totally enclosed within the polyethylene laminate such that the edges of the foil are totally protected against corrosive attack. The aluminium foil/wires shall be detectable from the ground surface using a buried cable locator. The manufacturer of the tape shall provide methods for joining and terminating the tape to enable a low resistance connection to be made to the foil/wires. Electrical

connection points shall be made at each chamber along the pipeline route. Tape is not required in the sewage treatment plant site.

N. Casting Pipes or HDPE Pipes into Concrete Sections

- 1 The Contractor shall provide and fix all ductile iron pipe or HDPE pipe works both inside and immediately outside the structures as shown in the Drawings. The pipe work includes items required for building-in or under the structures. It is therefore imperative that the Contractor should place orders for these pipe work items immediately after the Contract is awarded and makes every effort possible to ensure early delivery to the site.
  - 2 The supply and delivery of the built-in pipe work should be clearly shown on the construction schedule to be submitted by the Contractor in accordance with Section 01310 Para 1.02 of the Standard Specification.
  - 3 Where specified all pipes passing through concrete in structures where a thrust load has to be transmitted to the structure shall be provided with a puddle/thrust flange and shall be fixed in position before and rigidly held in position during concreting. The supports shall not be removed until the concrete has set sufficiently to support the item. Boxing out of the opening in the above circumstances shall not be permitted.
- O. Flotation of Pipe work: The Contractor shall be solely responsible for ensuring that flotation of pipe work does not occur during construction.
- P. Pipeline Swabbing: Upon completion of water pipeline installation but before hydraulic testing, the Contractor shall demonstrate and prove that the line is clear of debris and obstructions. This will require a video camera survey of the pipeline

**PS 2.10 Installation of HDPE pipe and fittings**

- A. HDPE (High Density Polyethylene) pipe and fittings to be used for the Main Trunk Sewer Pipelines, Branch Sewer Pipelines and House Connection Reserve shall conform to ISO 4427, Pipe Grade PE 100 with SDR 9 which is rated for PN 20 at 20 °C, and HDPE pipe and fittings for the House Connections shall conform to ISO 4427, Pipe Grade PE 100 with SDR 11 which is rated for PN 16 at 20 °C.
- B. The nominal outside diameters of the HDPE pipe and fittings shall be as follows

Internal Diameter (mm)	Nominal Outside Diameter (mm)	Class
50	63	SDR9, PN20
100	125	SDR11, PN16
150	200	SDR9, PN20

- C. All jointing for HDPE pipe and fittings shall be by fully automatic butt fusion welding, electrofusion welding, or by mechanical restrained joints.
- D. Jointing of PE pipes to metal pipes shall use special restrained transition fittings manufactured specifically for that purpose. Fabricated fittings will not be permitted. The system shall be restrained completely, except the parts where HDPE pipes are connected to unrestrained pipe systems. The restrained transition fittings shall be in accordance with PS 3.03 C. hereof
- E. Fittings and bends shall be manufactured from PE 100 polymer that is compatible to the pipe material. Pipe coils may be required for pipes at an internal diameter of 100 mm or less.

## F. Specific Requirements for PE Pipes

### 1 Requirements for Pipe Sizes

PE pipes are manufactured with extruding to control outer diameter, and the pipe sizes are determined on the basis of metric system. Allowable tolerances shall accord to ISO 11922-1, and outer roundness of the pipes shall be within the values for Grade N given in Table 2 of ISO 11922-1.

### 2 Performance Requirements at 20°C and 80°C

All batches of HDPE pipes shall be subjected to a single 100 h 20 °C pressure test. In addition, one randomly selected pipe shall be tested for 165 h 80°C pressure test using notched pipe. The 100 h test is as at 12.4 MPa, the 1000 h test at 5 MPa pipe hoop stress. All pipes must pass this test. The notched pipe test requires the pipe to have four (equally spaced around the circumferences), axial notches machined into the pipe wall to a minimum depth of 19% of the pipe wall thickness. Such notches simulate abused pipes that can bear site conditions and higher ambient temperatures. The test procedures shall be in accordance with ISO 1167.

### 3 Tensile Properties of PE Pipe

Tensile samples taken from the wall of PE 100 pipes shall exhibit a minimum failure strain of at least 500%. At a crosshead speed of 50 mm/minute, the tensile strength at yield shall be greater than 23.1 MPa for PE 100 pipes. Tests shall be undertaken at 20 °C using a sample shape defined in ASTM D638, and shall be made with each production run of pipe.

### 4 Offset Butt Joint Performance

For all pipe diameters one butt fusion joint shall be prepared with the two pipe axes parallel but offset by 20% of the pipe wall thickness. Jointing shall be undertaken using the butt fusion jointing parameters recommended by the manufacturer. The welded pipe shall be tested at a pipe hoop stress of 4 MPa at 80°C, and the lifetime shall be equal to or greater than 500 hours for black pipe. This test is a type test.

G. All fittings shall be manufactured by injection moulding. Fabricated HDPE fittings will not be permitted.

## H. Electrofusion Fittings

- 1 All fittings shall be packed in such a way to allow instant use on site without additional cleaning.
- 2 The heating coils contained in each individual fitting and saddle shall be so designed that only one complete process cycle is necessary to fully electrofuse the fitting to the adjoining pipe or pipes. Heating coils shall not be exposed and shall be fully imbedded into the body of the fitting for protection purposes during assembly.
- 3 An individual data carrier card in compliance with ISO standards containing a magnetic strip and an appropriate barcode or barcodes for data transfer purposes shall be supplied with each fitting. All fittings shall have moulded-in identification and product information.
- 4 Process voltage of all fittings must not exceed 40 volts. Insulated contacts for the terminal pins shall be provided. A limited path style fusion indicator acting for each fusion zone as visual recognition of completed fusion cycle shall be incorporated into the body of the fitting. The design of the indicators shall prevent the escape of fusion melt.
- 5 All internal or externally threaded transition adaptors in the outside sizes up to and including 50 mm shall be designed with an integral polyethylene collar from PE 100 and shall not rely on rubber or synthetic seals. Threaded adapter bodies may be from brass or stainless steel and shall be of modular type and shall not be moulded into an electrofusion fitting socket.

## I. Electrofusion Saddles

- 1 All saddles up to at least mains size outside diameter 200 mm shall be designed with two separate halves having a single hinge type attachment and shall be correctly processed without specialised external spring-loaded tooling. The top half of the saddle shall be equipped with an outlet which can accept various other system components such as tapping tees, adapters, valve tees, caps, stop-off attachments, and the like that are simultaneously fused together with the saddle to mains joint in one operation.
- 2 Each branch outlet shall be equipped with an integral clamping device.
- 3 All pipe saddle sizes from above outside diameter 63 x 40 mm shall allow a 360° rotation of the branch outlet.
- 4 Safe tapping into mains must be possible under the defined allowable maximum water pressure according to the respective pipe series and ambient temperature.
- 5 The tapping saddle cutter shall be designed to seal-off the central passage in the uppermost position and the cutter design must fully contain the cut-out coupon. The saddle shall be capable of permanently seal-off the top of the saddle with an electrofused cap in the mains sizes from outside diameter 63 mm and above.

## J. Requirements for Electrofusion Control Units

The Electrofusion Control Units in manufacturing electrofusion fittings and electrofusion saddles shall be required to meet the following conditions:

- 1 The control units shall operate with magnetic card and/or barcode data transfer method transmitted via a reader pen or a scanner.
- 2 The initial power supply to enable the control unit to function correctly for all fitting and saddle sizes up to outside diameter 200 mm shall not exceed 4 kVA.
- 3 The unit shall be designed with an automatic compensator so that it can fully operate within input tolerances of between 180V and 264 V, respectively 45 and 65 Hz. The units shall operate with a stabilised fusion voltage. The range of fusion voltage shall be between 8 and 42 volts.
- 4 A galvanic separation shall exist between the primary and secondary circuits by means of a high frequency transformer.
- 5 The unit liquid crystal display shall show information in English.
- 6 The display shall be backlit, be easily readable and give relevant information including:
  - a. recognition of fitting type, dimension and manufacturer
  - b. resistance of connected fitting
  - c. a check-system prior to commencement of fusion process
  - d. actual running and final fusion time in seconds
  - e. primary voltage and frequency
  - f. ambient temperature
  - g. individual fusion number and unit number
  - h. mode of data transfer
  - i. appropriate cooling time.
- 7 A temperature sensor shall be provided. The operating range of ambient temperatures shall be at least +50°C.
- 8 The unit shall be capable of processing various manufacturers' products.
- 9 A lightweight transport box with internal document pocket shall be provided. The complete control unit shall be fully contained and the weight including all primary and secondary cables shall not exceed 15 kg.
- 10 An external memory bank shall be able to record at least 300 fusion records and be easily accessible and exchangeable. The supplier shall provide a full range of system software and data transmission accessories as applicable for data processing. The ability to download fusion records from all memory systems via an RS 232 interface shall be provided. A back-up internal reserve memory with override shall

be provided. Peripheral information such as operator and job number shall be able to be coded-in for fusion record purposes.

- 11 A blocking system to prevent unauthorised use shall be incorporated into the design.
- 12 The protection class of the unit shall be at least IP 65. All control units shall fulfil the Electro-Magnetic Compatibility regulations in accordance with the latest Australian standards.

#### **PS 2.10 Installation of uPVC (unplasticised Polyvinyl Chloride) pipe and fittings**

- A. uPVC non-pressure pipes and fittings shall be manufactured and tested to BS 4660 for pipes up to and including 160 mm diameter and BS 5481 for pipes greater than 160 mm diameter; and to BS 3505 for pressure pipes.
- B. uPVC pipes and fittings shall be installed in accordance with the manufacturer's guidelines. Pipes shall be BS kite marked.
- C. uPVC pipes shall be capable of withstanding ultraviolet degradation. A rodent inhibitor shall be incorporated in the material of the pipe. Pipes shall be manufactured with integral flexible rubber ring joints.
- D. uPVC pipes for gravity pipelines shall have a standard dimension ratio, D: t (diameter to thickness), of between 35 and 45.
- E. The Contractor shall advise the manufacturer of the climatic and transporting conditions at the site of the works and shall seek his advice on the storage of uPVC materials on site. Subject to the Engineer's approval this advice shall be followed at all times.
- F. Any pipes exhibiting cracks, notches or deep scratches or other damage will be condemned and shall not be incorporated into the permanent work under any circumstances.

#### **PS 2.11 Installation of Ductile Iron pipe and fittings**

- A. The pipe shall be handled in such a way to prevent any damage to the cement lining or exterior coating and any damage shall be repaired promptly before installation. For large diameter ductile iron pipes (greater than 600 mm), the ends of the pipe shall have wooden stiffeners at quarter points of the spigot end to prevent any distortion of the pipe at its end. This blocking shall remain in the pipe until it is ready for installation. The pipe shall be stored on site without any stacking unless blocking is provided between layers of pipes. Any cutting of pipe shall be made by use of acceptable cutting tools and/or machines as required. Cutting of ductile iron pipe shall be by saws operated electrically or pneumatically. Cutters utilizing compression will not be allowed for cutting ductile iron pipe. All cuts shall be clean and perpendicular to the axis of the pipe. Any damage to the linings shall be repaired. The pipe shall be bedded in a layer of granular Material No. 2, except where designated on the drawings. Granular Material No. 2 shall be placed in 15 centimetres layers on both sides of the pipe and compacted by hand tools. This filling shall be carried up to the level as specified. Backfilling above the crown is specified elsewhere. No blocking will be allowed under the pipe. The entire length of the pipe shall be firmly and evenly bearing on the sand bedding. Bedding details shall be in accordance with the details shown on the drawings.
- B. Joints for cast iron-ductile iron will be rubber gasket mechanical or flanged. Joints shall be harnessed where specified. No deflections shall be allowed in excess of that allowed by the manufacturer's recommendations. Mechanical joints shall be in accordance with the manufacturer's recommendations. The joint surfaces and rubber gasket shall be

thoroughly cleaned with soapy water before fit-up. After fit-up the bolts shall be tightened alternately on opposite ends of joints diameters and in rotation around the pipe. When properly assembled, the gland shall be equidistant from the bell face at all points. Bolts shall be tightened to the following standard torques:

<u>Bolt Size (mm)</u>	<u>Range of Torque (N·m)</u>	<u>Pipe Size (mm)</u>
16	60	
20	100	100-600
24	140	700-800
30	200	900-2600

- C. If effective sealing is not attained at the maximum torque indicated above, the joint shall be disassembled, cleaned and reassembled. No overstressing of the bolts shall be allowed. Flanged joints shall be made up with a rubber gasket of 3 mm thickness. After cleaning all flanged surfaces, jointing materials shall be tightened with a suitable wrench to proper torque. Nuts spaced at an angle of 180 degrees apart shall be well smeared with grease. All nuts shall be confirmed to be tightened at the designated torque as shown below using a torque wrench.

<u>Bolt Size (mm)</u>	<u>Standard Torque (N·m)</u>	<u>Pipe Size (mm)</u>
16	60	75-200
20	90	250-300
22	120	350-400
24	180	450-600
30	330	700-1200
36	500	1350-1800
42	580	2000-2400
45	700	2600

## **PS 2.12 Installation of Steel pipe and fittings**

- A. The ends of the pipe shall have wooden stiffeners installed inside the pipe at quarter points at both ends of the pipe. This blocking shall remain inside the pipe until the pipe has been installed. The Contractor shall prevent any fires being made inside or adjacent to the pipe. While the pipe is stored on site the pipe sections shall be kept free of any objects being stored inside and the larger diameter pipe will be allowed only if blocking is provided between pipes. The pipe shall be evenly bedded throughout its entire length on a bed of granular Material No. 2. Modifications to this bedding shall only be as indicated on the drawings. Granular Material No. 2 shall be placed on both sides of the pipe and compacted with hand tools in 15 centimetres layers up to the level as specified. No blocking shall be allowed under the pipe. Bedding shall be in accordance with the details shown on the drawings.
- B. Joints for steel pipe and fittings shall be either welded, couplings (restrained or unrestrained) or flanged. The type of joint to be used is listed in the pipe schedule and/or on the drawings. Welded joints shall be butt weld and in conformance with AWWA C206, "Field Welding of Steel Water Pipe Joints" unless otherwise specified. After the welds have been inspected and approved by the Engineer the lining and exterior coating shall be repaired as specified. Joints using couplings with restraints shall be installed in compliance with the manufacturer's recommendations. Schedules and details of restraining lugs and rods are shown on the Drawings. The lugs shall be welded in compliance with the requirements outlined above for welded joints.
- C. Wherever possible the lugs shall be welded on, in the factory prior to lining. If field welding of lugs is done the coating and linings shall be repaired as described above for

welded joints. While the work is in progress and there is need for passage through the pipe, a layer of heavy tar paper shall be laid and maintained in the bottom of the pipe through the entire length. This paper shall be removed at the completion of the work. Field cutting and mitring of the pipe should be minimized. When such cutting is required it shall be done by a suitable cutting machine, leaving a smooth cut at right angles to the axis of the pipe.

#### D. Requirements for Steel Pipes and Fittings to be used for Pump House/Room

##### 1 General

Where specified in the Drawings, pipes and fittings to be used in the pump house/room shall be of mild steel conforming to the requirements specified in this section.

##### 2 Standard Specification References

The following standards are referred to:

BS 4504	Circular Flanges for Pipes, Valves, and Fittings
AWWA CI04	Cement Mortar Lining for Cast-Iron and Ductile-Iron Pipe and Fittings
AWWA C200	Steel Water Pipe 6 Inches and Larger
AWWA C203	Coal-Tar Protective Coatings and Linings for Steel Water Pipelines-Enamel and Tape-Hot Applied
AWWA C205	Cement-Mortar Lining for Steel Water Pipeline
AWWA C208	Dimensions for Steel Water Pipe Fittings
AWWA C210	Coal-Tar Epoxy Coating System for the Interior and Exterior of Steel Water Pipe
AWWA C602	Cement Mortar Lining of Water Pipelines 4 inch (100 mm) and larger-In Place
AWWA Manual	Steel Pipe Design and Installation M11
ASTM A185	Welded Steel Wire Fabric for Concrete Reinforcement
ASTM A283	Low and Intermediate Tensile Strength Carbon Steel Plates of Structural Quality
ASTM 307	Carbon Steel Externally Threaded Standard Fasteners
ASTM A570	Hot-rolled Carbon Steel Sheet and Strip, Structural Quality
BS 534	Flanges and Bolting for Pipes, Valves and Fittings
JIS G3101	Rolled Steel for General Structures
JIS G3443	Coated Steel Pipes for Water Service
JIS G3451	Fittings of Coating Steel Pipe for Water Service
JIS G3452	Carbon Steel Pipes for Ordinary Piping
JIS G3457	Arc Welded Carbon Steel Pipes
JWWA A109	Mortar-Lining of Steel Pipes for Water Works

##### 3 Materials

###### (a) Pipes and Fittings

Steel pipe and fittings shall conform to AWWA C200 or equivalent standards, subject to the exceptions and supplemental requirements contained in the following sections.

###### (b) Steel Cylinder

For pipe and fittings, cylinder shall be fabricated from hot-rolled carbon steel sheets or plates conforming to either ASTM A283 Grade D, or ASTM A570 Grade 33, or JIS G3101 Class 2 SS 400. The minimum yield point of steel used for fabrication of steel pipe and fittings shall not be less than 2,300 kg/sq.cm. Steel conforming to JIS G3457 is also acceptable.

Fabrication of steel pipe and fittings shall be in accordance with AWWA C200 or BS534. The weld shall be of reasonably uniform width and height for the entire length of the pipe and shall be made by automatic means.

All longitudinal seams or spiral seams and shop girth seams of pipe shall be butt



welded. The maximum allowable number of shop seams shall be one longitudinal seam and five girth seams per length of pipe. The longitudinal shall be staggered on opposite sides for adjacent section. No reinforcing ring, plate or saddle shall be provided on the exterior or interior of pipe.

All steel fittings except bends having a deflection angle less than 5 degrees shall be shop fabricated. Bends having a deflection angle less than 5 degrees may be field fabricated from shop fabricated steel pipe by means of field cutting and welding.

The pipe diameters shown on the drawings shall be of the nominal diameters.

(c) Fitting Dimensions

All fittings shall be of the same strength, outside diameter and wall thickness as that of pipes, and shall be provided with reinforcing rings and saddles when required in accordance with AWWA Manual M11 to meet the special high pressure.

The dimensions of fittings shall conform to either JIS G3451 or AWWA C208 or equivalent.

(d) Joints and Pipe Ends

Pipes and fittings to be jointed by flexible coupling shall have the plain end.

Where shown on the drawings, flanged joints shall be provided. Flanges shall be made as seamless drawings or cut and fabricated from steel plates and shall conform to BS4504. Class of flange shall be PN10 unless otherwise specified on the drawings.

Material for flanges, bolts and nuts shall be the same steel used for fabrication of steel pipes and fittings. Flanges shall be steel welding neck flanges, and shall be attached to pipes or fittings by means of single butt-weld. All flanges shall be flat faced with bolt holes straddling the vertical axis of the pipes or fittings, and all gaskets shall be of at least 3.0 mm thick asbestos or neoprene, full face with bolt holes correctly sized and spaced. Flanges shall be supplied complete with the required size, quantity and quality bolts, nuts and gaskets.

(e) Lining

Steel pipes and fittings shall be lined internally at the pipe manufacturer's works with two coats of bituminous epoxy enamel conforming to AWWA C210 or JWWA K135-1989 with the total uniform dry film thickness of at least 300 microns (0.3 mm).

Fittings larger than 600 mm in diameter shall be wire-fabric reinforced. The wire-fabric shall be 2 x 4 steel wire mesh, 13 gauge each way, and shall conform to the requirements of ASTM A185.

(f) Coating

The exterior of pipes and fittings shall be coated with non-breeding type coal tar epoxy at the total uniform dry film thickness of at least 200 microns.

(g) Lining and Coating at Pipe Ends

At all pipe and fitting ends, coating and lining shall be extended to the pipe ends.

(h) Manufacturer's Mark

Each pipe and fitting shall bear the mark of the manufacturer; the nominal diameter; wall thickness; year of manufacturer; the wordings "Steel Pipe" or "SP", and the owner's name "CWASA". The marking shall be conspicuously painted in non-toxic paint on the outside of each pipe and each fitting.

4. Mechanical Couplings and Flange Adapters

Couplings for jointing plain-ended pieces shall be of the Dresser Viking Johnson or similar type approved by the Engineer and may be steel or ductile iron at the option of the Contractor.

The middle ring (sleeve) and the follower rings (flanges) shall be of such materials and dimensions and that they are not stressed beyond half the yield stress of the material when the pipes connected by them are subjected to the stated hydraulic test

pressure.

Except where otherwise stated, the middle ring (sleeve) of the coupling shall be provided with a suitable pipe stop (centre register).

The joint rings used shall be of Class 'A' natural rubber and the physical properties of the mix shall meet the requirements of BS 2494.

Flange adapters for jointing flanged specials to plain-ended pipes shall conform to the foregoing contents of this clause.

Prior to the commencement of the manufacture the Contractor shall submit to the Engineer for approval detailed drawings of all mechanical couplings and flange adapters.

All couplings shall be supplied with a shop coat of quick drying primer approved by the Engineer which is compatible with the materials to be subsequently used for moulding or painting.

When harness is specified with coupling or flange adapter, the harnessing shall be provided as recommended by the manufacturer of couplings or flange adapters. Harness joint shall be designed to withstand for the pull-out force caused by the internal pressure of 10 bar at the joint.

## **PS 2.12 Shop Testing**

### **(a) Pipe**

Shop testing and inspection of the pipe shall be conducted in accordance with AWWA C200 in the presence of the representative of the Engineer/Employer. The minimum hydrostatic test pressure for straight pipe shall be determined in accordance with Section 3.4 of AWWA C200 using the design stress equal to 75 percent of the minimum yield point of the steel used. When approved by the Engineer, the hydrostatic test may be replaced by other appropriate non-destructive testing methods such as ultrasonic and/or radiographic testing methods.

During pressure test, all welds shall be thoroughly inspected and all parts showing leakage shall be marked. Pipes that show any leakage under test shall be re-welded at the points of leakage and subjected to further hydrostatic tests until satisfactory results are obtained.

### **(b) Fittings**

Upon completion of welding, but before lining and coating, each fitting shall be bulk headed and tested under the same hydrostatic pressure as for the pipe. Provided, however, that if fittings are fabricated from previously tested straight pipe, only those welding seams that were not previously tested in the straight pipe may be tested by means of ultrasonic or radiography method or other methods as approved by the Engineer, with no further hydrostatic test.

Any leakage and porous welds which may be revealed by the test shall be chipped out and re-welded and the fitting be retested until satisfactory results are obtained.

## **PS2.13 Inspection of Pipeline Materials**

- A. No HDPE pipe and fitting shall be ordered until all tests and Engineer's approvals have been obtained.
- B. After delivery to the site and before incorporation into the pipeline, each item of pipes and fittings shall be brushed out and carefully examined for soundness. Damaged items which, in the opinion of the Engineer, cannot be satisfactorily repaired at the site shall be rejected and removed from the site. If under line tests, the Engineer considers that an unacceptable proportion of the pipes within a test length has failed, the Contractor shall

be required to test hydraulically to the works test pressure each pipe and joint before pipe laying. In this event, test results shall be submitted to and approved by the Engineer before any further pipes are laid.

#### **PS2.14 Flotation of Pipework**

The Contractor shall be solely responsible for ensuring that flotation of pipework does not occur during construction.

#### **PS2.15 Jointing of PE Pipes**

- A. The Contractor shall employ only manufacturer's certified staff to perform all of the following jointing techniques to create PE pressure pipe systems. An approved subcontractor may be used only with the Engineer's approval. The original certificate of each certified staff shall have an individual registration number and shall be produced for the Engineer's inspection. The certificate shall have been issued not more than two years prior to commencing the work and shall remain valid for the duration that each staff is undertaking welding. If in the opinion of the Engineer any certified staff is not strictly following the manufacturer's instructions and procedures, the Engineer has the right to force the Contractor to immediately remove the certified staff from the site and replace with another approved certified staff.
- B. The manufacturer shall provide accurate and easy-to-understand assembly instructions in English which can be used at any subsequent time for reference purposes.
- C. Transition fittings manufactured specifically for that purpose shall be used to join PE pipes to metal pipes. Restrained flange adaptors for DI/HDPE pipe shall be used for joining HDPE pipe to DI pipe adjacent to valve chamber. Flanges shall be drilled to class designation PN 10 in accordance with ISO 2531. The restrained flange adaptor for DI/HDPE shall incorporate a gripping mechanism suitable to resist pipe pull-out of the HDPE pipe to the performance requirements of WIS 4-24-01 and ISO 14236.2 and the Contractor shall provide a warranty from the manufacturer to this effect. The flange adaptor must be supplied fully pre-assembled, not requiring disassembly prior to installation. The flange material of the exposed pipes, house connections and water service pipes shall be SUS444/316 or equivalent for corrosion-proof such as antirust. All metal surface and concrete surface included in footing portion shall be painted by vinyl ester resin or equivalent.
- D. The Contractor shall take all measures to prevent contamination of the pipe ends to be joined during the heating and fusion process. Fusion welding shall not be conducted on site under conditions where the wind causes sand to blow onto the joint to be joined.

#### **PS2.16 Pipe to Pipe Butt Fusion Jointing**

- A. The Contractor shall adhere to the following guidelines in respect of butt fusion jointing HDPE pressure pipes:
  - 1. All butt fusion welding shall be in accordance with the latest edition of DVS 2207 1 "Welding of Thermoplastics – Heated Tool Welding of Pipes, Pipeline Components and Sheets made from HDPE". The Contractor shall make available a complete copy of this document on the site.
  - 2. Pipes of the same outside diameter but either different wall thickness or different classes of resins shall not be joined by butt fusion.
  - 3. PE pipes made from very high molecular weight resins shall not be used.
  - 4. The Contractor shall use automatic butt fusion machines as specified herein.

- B. Butt fusion machines and equipment to be used for the butt fusion jointing shall meet the following requirements:
1. Butt fusion machines and equipment shall comply with the requirements of the latest edition of DVS 2208-1. The Contractor shall make available a complete copy of this document on the site.
  2. The equipment shall employ data storage and data retrieval to record the conditions used for butt fusion jointing.
  3. Any butt fusion machine and equipment that do not fully comply with this specification and DVS 2208-1 shall be indelibly marked as “in non-compliance” and shall be immediately removed from the site to substitute for an acceptable machine and equipment.

## Section 02712

### PS2.15 Execution of Piping Works for Main Trunk Sewer and Branch Sewer

- A. Where piping is subjected to vehicle loading concrete encasement shall be used in case earth cover is less than 600mm. Specifications for concrete encasement shall comply with Para. 1.06 of Section 02712 of the Standard Specifications.
- B. Levels of manhole cover (top) on the road shall be installed not higher than +5mm and not lower than existing road level and smoothly asphalted around the cover.
- C. Pipe installation level for construction shall be followed by invert level shown in the Drawings. However if the Contractor found existing facilities which are not shown on the Drawings or the levels of them are different from those indicated in the Drawings (most of existing levels are not sure), the Contractor can change the profile with the Engineer’s approval. Specially, the gravity flow sewer is very sensitive of slope and flow velocity to be maintained. In case of pressure main, waving profile causes the increase of air-valve and scour (drain)-valve, also sometimes it may cause the pump capacity increase. Therefore, the Contractor shall produce the minimum waving profile for the Construction Drawings with the Engineer’s approval. Especially when the profile level is dramatically change (more than 500 mm from original profile), he shall discuss with the Engineer immediately, then pump selection study including water hammer analysis shall be re-executed if required.
- D. The Contractor shall be responsible for restricting his workmen on the site of the work while working in private premises without landowner/administrator’s permission by written. No equipment and material shall be stored at places other than those areas allocated to him by the Engineer. Temporary fencing shall be erected to separate the worksite from the rest of the private premises at the Contractor’s own expense. If the landowner allows the Contractor to store the equipment and the material in his/her land, the Contractor shall follow his/her instruction with full responsibility. While the construction, the Contractor should not disturb anything of landowner/administrator. In case of the damage or accident happen, the Contractor shall pay full amount of repair or to solve the accident.
- E. Some of branch sewer sites are in private property or drain reserve (actually, this is public space) in fenced property. As indicated in the Drawings, the Contractor shall carry out survey and investigation of those sites with getting approval from the landowners, and carry out detailed design of the pipe-laying in these areas. The Contractor shall prepare

and submit to the Engineer for approval construction drawings based on the Contractor's detailed design within six (6) months after the commencement of the Works.

**PS2.16 House Collection Reserves**

- A. The Contractor shall carry out a survey of existing facilities and prepare individual shop drawings for each property for which a sewerage connection is required. The shop drawing shall show existing plot boundaries. These shall be marked up to show the details of the house connection reserve and shall be submitted to the Engineer for approval. Although service connection work itself is out of the scope of works, the Contractor is required to install an inspection shaft that serves more than one house connection reserve for some houses. The Contractor shall propose the locations of inspection shafts and the layout of house connections reserves in the shop drawings for the Engineer's approval. Service connections shall be laid at sufficient depths to allow for adequate gradient being continued throughout the properly drainage system without the pipelines becoming too shallow for adequate cover to be provided over the pipe. The Contractor shall design these systems by referring to the standard drawings given in the Drawings.
- B. The construction shall include the installation of house connection pipe in a length of about 5.0 to 10.0m for every manhole. The Contractor shall confirm the exact length and end-cap location at each site, prepare and submit to the Engineer for approval construction drawings of the house connection pipe installation for each reserve by following the standard drawing given in the Drawings, and execute these works in accordance with the construction drawings approved by the Engineer. The Contractor shall allow for all costs required for the site surveys, detailed design and execution of these works in his tender prices.
- C. The gradient of the house connection pipe shall be basically 1 in 40 (2.5%).

**PS2.17 Air Valve/Drainage Valve**

Air valves and drainage valves shall be provided as shown in the Drawings. The tee shall be made of ductile iron (DI) so that stiffness of the branching tee to the air valve or drainage valve can be maintained. To connect DI tee with HDPE trunk sewer pipeline, appropriate (HD)PE adapter and some fittings shall be applied as shown in the Drawings. The Contractor shall adjust any discrepancy in the bore size and bolting between DI tee and HDPE pipes by referring to the Drawings. The Contractor shall review the locations and number of the air valves and drainage valves to be installed, and shall finalize alignment of the air valves and drainage valves with the Engineer's approval.

**PS2.18 Construction of Manholes**

- A. The Contractor shall furnish, install and/or construct precast manholes or place-in-concrete manhole as shown in the Drawings.
- B. Specifications of the precast manholes and place-in-concrete manholes shall comply with the requirements stipulated in Section 02712 of the Standard Specifications.

**PS2.19 Connection to Existing Manhole**

- A. The location of existing manholes which require the modification, connection or replacement is shown in the Drawings. The Contractor shall be responsible to investigate and confirm the locations and details of existing manholes to which the sewer pipelines are connected. Invert level shall be check by the Contractor by using survey tools such as

Level or Total Stations (accuracy of the measurement should be in  $\pm 2.0\text{mm}$ ) prior to the construction. Invert level of new pipe should be 20mm or more higher than the existing pipe bottom level of down-stream and 20mm or more lower than the existing pipe bottom level of up-stream.

- B. In connecting the pipeline to the existing manhole, the Contractor shall do necessary measures to ensure a compatible fit between the pipes and the existing manholes, such that a circular hole large enough to accommodate the pipeline shall be made in the wall and the cut end of the pipe neatly rendered to form a smooth bore. If the Contractor identifies any existing manholes that require re-modelling for compatible fit, the Contractor shall immediately report it to the Engineer, design and carry out such re-modelling work with the Engineer's approval and at no extra charge to the Employer, unless substantial re-modelling are needed. Should substantial re-modelling be needed, the Engineer will give an instruction for appropriate measures to be taken by the Contractor, and it will be deemed to be a Variation.
- C. The Contractor shall ensure that there is no interruption to existing flows during the connection works. No debris shall be allowed to fall or be discharged into the existing sewers. Any debris which falls into the existing sewer and any obstructions thereby caused shall be removed at the Contractor's expense.
- D. If the existing manhole and pipes are in dirty or clogged condition, the Contractor shall clean up at the connection point with new pipes.
- E. The Contractor shall not allow sewage to flow into the newly constructed pipeline or seal off the existing pipelines until and unless the part of the pipeline concerned and the downstream pipelines have been completed, inspected and certified fit for use. Before doing so, the Contractor shall wait for direction from the Engineer in writing.
- F. The Contractor shall allow for all the above in his rates, except the costs for substantial re-modelling of the existing manholes to be carried out under the Engineer's instruction for a Variation as set out in Paragraph B above.

#### **PS2.20 Final Test and Inspection**

- A. Upon completion of the installation of the Sewer Pipelines, prior to hydraulic testing, the Contractor shall demonstrate and prove that the line is clear of debris and obstructions.
- B. The Contractor shall conduct hydraulic testing on the installed Sewer Pipelines in accordance with the test procedure approved in advance by the Engineer.
- C. After testing the pipelines, the Contractor shall flush out the main with clean water. The Contractor shall allow in his tender for the arrangement of a large volume of water required for hydraulic testing, flush-out of the pipelines at his responsibility and costs.
- D. The Contractor shall comply with the final inspection procedures set out in the Standard Specifications and other parts of the Contract.

### **Section 02850**

#### **PS 2.21 Gabions**

Box gabions shall be constructed for the slope protection on the site.

## **Part – B Pumping Stations and Sewage Treatment Plant (STP)**

**PS2.22 General**

- A. Part – B relates to the site works for the pumping stations and sewage treatment plant (STP).
- B. The Contractor shall carry out and complete the site works for the pumping stations and STP as shown in the Drawings and/or specified herein. The site works include, but are not limited to, those specified in the following sections of the Standard Specifications:
  - i. 2060: Demolition
  - ii. 2200: Earthworks and Site Preparation
  - iii. 2221: Trench Excavation and Backfill
  - iv. 2222: Structure Excavation and Backfill
  - v. 2520: Roadwork
  - vi. 2700: Pipework
  - vii. 2712: Sewerage
  - viii. 2830: Chain Link Fence and Gates
  - ix. 2850: Gabions
  - x. 2900: Landscaping and Planting

**Section 02060****PS 2.23 Demolition**

The Contractor shall demolish all structures as and when directed by the Engineer and as detailed on the Drawings.

**Section 02200****PS 2.24 General**

- A The works involve the supply of all plant, materials, tools and equipment, labour, supervision and everything else necessary for the execution and maintenance of the improvement works to be carried out over the site.
- B The scope of works include the following:-
  - 1 General
    - a Surveys

The execution of all necessary surveys by a licensed surveyor as described in the Specifications.
    - b Site Clearance

General clearing of the area of the site improvement works including the cutting down of all trees and vegetation therein to ground level, including destumping and grubbing of roots and their removal and disposal, and the excavation and removal of unsuitable material over the area of the site.

c Top Soil and Turf

The Contractor shall note that when excavating or utilizing turfing grounds, he must initially separate the turf and top-soil from the sub-soil and store them separately and neatly aside for re-use. Subsequently on completion of the work, the turf and top-soil shall be re-used to cover trenches, embankments, slopes, tips, verges, etc or any other area within the site as and when directed by the Engineer. All surfaces so covered shall be neatly trimmed to form uniform slopes or level surfaces.

The Contractor shall make good any damage to existing turfed area caused by or attributable in any way to his work. All costs incurred shall be borne by the Contractor.

d Inspection of Ground Below Areas of Proposed Replacement Fill and other Areas of Fill

Before the commencement of replacement-fill operations, the Contractor shall carry out a series of soil investigations by conducting a number of Mackintosh Probes / Hand auger holes, plate load tests, In-situ CBR tests, on ground conditions. The results of the tests shall be evaluated to ascertain the suitability, consistency or bearing capacity of the soil. All conclusions reached together with recommendations and a copy of the test results shall be submitted to the Engineer for further review and comment. In the event where the ground has low bearing capacity the Contractor shall request for a joint inspection with the Engineer for confirmation of depth of unsuitable material removal or confirmation of ground treatment and parameters required in the area.

In the assessment of the suitability of the ground, attention shall be given to the following particulars :-

- i. soft clays, peat or materials from swamp.
- ii. topsoil containing organic materials, rootlets, decomposed wood etc.
- iii. loose sand within abandoned mining or low-lying area.

2 Filling and Associated Works

The site filling and formation of the platforms with fill materials of the type and quality specified hereinafter or otherwise approved by the Engineer and obtained from approved source(s) in the quantities and at a rate compatible with the rate of filling proposed by the Contractor in his Programme of Work in compliance with the requirements of the Specification, including extracting and transporting the fill materials from the borrow area(s) to the Site, filling and spreading the fill materials in layers to the extent, grades and levels as specified on the Drawings or otherwise directed by the Engineer.

- a The fill materials to be used for the Works shall be the respective types which shall comply with the requirements of the Specification when the materials are placed in-situ in the areas of fill.
- b It shall be the sole responsibility of the Contractor to make all necessary investigations at the time of tendering to satisfy himself as to the availability, the suitability and adequacy of the fill materials available from the source(s) or other borrow area(s) nominated by him for use in the execution and completion of the Works.



- c The diversion of existing outlet drains affected by the Works and the provision of temporary drainage where necessary in the fill areas or in its vicinity to regulate the discharge of surface run-off to facilitate the execution of the site filling works, including drainage sumps, and pumping where required to keep the site of the works free of water.
- d The construction of stone revetment works, embankment retaining structures and / or turfing of slopes, platforms as shown on the drawings or otherwise directed by the Engineer.

### 3 Soil Tests, Field Testing and Instrumentation

The provision of approved laboratory facilities with approved laboratory and field equipment for sampling, field testing and instrumentation work including the execution, installation and monitoring of the Works as specified.

### 4 Other Incidental Works

The removal of all temporary works and the execution of all works incidental to the foregoing including any necessary modifications ordered in accordance with the terms of the Contract.

- C The finished surface levels of the areas of fill shall, for the purposes of measurement and payment, be those levels which are accepted at the time of issuing the Completion Certificate.

### D Works to be Completed

The Specification herein has been drawn up with all possible care and (except as otherwise provided in the General Specification) is intended to cover the supply of all materials and the execution of all works necessary to complete the site improvement works. In case there are any details of construction or materials which have not been referred to in the Specification, Bill of Quantities and Drawings or which are usual or essential to the completion of all works in all trades, the same shall be deemed to be included in the prices entered by the Contractor in the Bill of Quantities.

### E Site Information

#### 1 The Site

In general, the site is undulating, vegetated, traversed by streams and partially swampy. The top soils at the site comprise thin soft silty marine CLAY which is compressible and of low shear strength. The top soils must be stored for the landscaping and re-vegetation at the final stage of the Works, in case if it is difficult to secure commercial top soil.

#### 2 Availability of Site

The Contractor shall ascertain the areas on the Site available for his use to execute the site improvement works. The Contractor shall be deemed to have acquainted himself with the availability of the Site to carry out the Works and possible difficulties arising therefrom.

#### 3 Data from Engineering and Topographical Surveys

Data from the Engineering and topographical surveys of the Site carried out have been included in the Drawings. The Contractor shall however ascertain for himself on his own responsibility the accuracy and relevance of the data with respect to the Works.

#### 4 Soil Data

Soil Investigation has been carried out recently for this project. The factual report containing borelogs and soil data obtained from the soil investigation is made available to the Tenderer as a viewing document.

The Contractor shall ascertain for himself on his own responsibility the accuracy and the relevance of the soil data with respect to the Works. All interpretations, assumptions, extrapolations and interpolations that the Contractor may wish to make are solely his own responsibility.

#### 5 Existing Drainage System

In the execution of the Works, methods shall be adopted and care taken not to cause flooding to adjoining properties or the siltation of existing drains. The Contractor shall maintain and improve where necessary all existing drainage outlets within and adjacent to the limits of the proposed site of the works.

### F Programme Of Works

#### 1 Phasing of Works

The extent of the site improvement works to be carried out is shown generally in the relevant drawings to enable the Contractor to plan the execution and completion of the Works, if appropriate, within the time frame envisaged.

#### 2 Time of Completion

The time of completion of the works shall be taken to apply for the entire designated areas of the site improvement works and delayed completion of the site improvement works shall not relieve the Contractor of his liabilities in respect of the scheduled completion in the other stages of the Works.

### G Standards

- 1 Except where otherwise specified or authorised, materials and workmanship shall comply with the requirements of the latest versions of the relevant British Standards and Codes of Practice. Where other equivalent Standards are commonly used in PNG, such Standards shall prevail.
- 2 Materials not fully specified and for which there is no British Standard or other equivalent Standards shall be the best of their kind. No materials shall be used in the Works unless they have been first approved by the Engineer.
- 3 The Contractor may, when tendering, put forward for consideration other internationally accepted standards which will ensure equal or higher quality than the standards specified herein and two copies, in English, of each such standard proposed by the Contractor shall be submitted with the Tender. Such international standards, when authorised by the Engineer, shall substitute the corresponding standards specified herein.

## H Drawings To Be Submitted For Approval

- 1 As soon as practical after the acceptance of the Tender, the Contractor shall submit in triplicate to the Engineer the following for approval:-
  - a A detail Method Statement for the execution of the Site Improvement Works
  - b Drawings showing the general arrangement of Temporary Works including temporary drainage systems, silt traps, trash screens, wash troughs and wash water facilities for vehicles, drainage pump screens and pumping facilities etc. (if any);
  - c Drawings showing the proposed sequence of construction of the bund and the backfill operations;
  - d Drawings showing the proposed method of protection to sides of excavation and embankment formations.
  - e Survey plans and cross-sections of the Site as called for in the specifications, showing the existing ground levels as agreed with the Engineer before the commencement of works.
  - f Drawings showing arrangement for temporary drainage and dewatering where required.
  - g Drawings showing the sequence of construction of temporary and permanent drains.
- 2 The Contractor shall submit with these drawings, calculations and descriptions of works and sequence of works in such order as will enable the Engineer to consider simultaneously executed portions of the Works, and proposed progression of the works.
- 3 The Contractor shall not proceed with any work unless and until the related drawings named in Section H have been approved by the Engineer.
- 4 No deviation from the construction procedure and Temporary Works for which drawings have been approved by the Engineer will be permitted unless revised drawings and calculations for the relevant portions of work are submitted to and approved by the Engineer.
- 5 The approval by the Engineer of any drawings or documents submitted by the Contractor shall not relieve the Contractor of any of his responsibilities or liabilities under the Contract, and he shall be and remain entirely responsible for the proper execution, completion and maintenance of the Works in accordance with the provisions of the Contract.

## I Record Drawings

- 1 The Contractor shall prepare the following record drawings for the approval of the Engineer :
  - a Plans showing the locations of boundaries and boundary markers, and the locations and levels of temporary and permanent reference stations, setting out stations and lines;

- b Where site improvement works is to be carried out, the survey plans of the affected areas together with the necessary cross-sections recording the existing ground levels before the commencement of such site improvement works;
- c Drawings showing the locations and levels of settlement measuring devices and other instruments installed in the areas of fill as directed by the Engineer;
- d The survey plans similar to (b) above, with necessary cross-sections and levels taken after the execution of the said site improvement works;
- e Progress drawings, prepared fortnightly, showing the completed portions of the Works;
- f "As Built" Drawings of the Works shall be delivered to the Engineer within one month from the date of completion of the Works.  
Copies of each of these "As-built" drawings shall be produced on the following materials for submission to the Engineer :-
  - (i) two true-to-scale linen print;
  - (ii) three true-to-scale translucent print;
  - (iii) three soft copies in AutoCAD format or other electronic file as may be approved by the Engineer
- g Prior to the preparation of the final drawings described in (f) above, the Contractor shall first submit two (2) copies of the draft of the drawings in paper print and await the approval and comments of the Engineer.
- h The size of all drawings shall be A1 size 838 mm x 585 mm unless otherwise approved by the Engineer or his Representative.

## J Works To Meet Statutory Requirements

All the site improvement works including the provision of temporary and permanent works shall comply with the requirements of the various Statutory Authorities.

## K Surveys

### 1 Surveys to be Carried Out

The following surveys shall be carried out by the Contractor jointly with and as directed by the Engineer:-

- a Survey of the Works area to be excavated, cut or filled prior to the commencement of excavation or filling therein, including all existing features bordering and within the area;
- b Survey of the Works or Sections of the Works during the execution of same for the purpose of monitoring the progress of the Works or Sections of the Works as well as for interim measurements; and
- c Survey of Works area on Completion of the whole Works or Sections of the Works for the checking of same for compliance with the requirements of the Contract.

### 2 Surveys Prior to Commencement of Works

- a The survey of the designated site of the Works shall be carried out after the general site clearance has been completed to the satisfaction of the Engineer. Levels shall be taken on grid (s) approved by the Engineer and recorded on survey drawings drawn to an approved scale. Additional levels shall be taken where there are significant changes in level or for identifying ground features. All existing features to be buried shall be clearly located, marked and described.
- b The surveys and the construction of bench marks, and reference stations shall be carried out and completed to the satisfaction of the Engineer.
- c Sufficient bench marks shall be located off the Site on prominent permanent features which will not be displaced by the Works and to which references can be made.
- d These bench marks shall be made as permanent as possible and protected against displacement and they shall be marked on the drawings and identified on the ground. Grid references and reduced levels of bench marks shall be shown on drawings.
- e Settlement measuring devices and any other monitoring instruments provided as called for herein shall also be clearly marked on the ground and identified on the survey drawings.

### 3 Surveys During the Execution of the Site Improvement Works

During the execution of the site improvement works covering the whole or a part of the designated area, the Contractor may be asked to survey the Works as directed by the Engineer. Such surveys may be required for monitoring the progress of Works or sections of the Works as well as for interim measurements. The surveys shall provide sufficient data to indicate the level of the site filling works including the bund and the levels of settlement measuring devices.

### 4 Surveys on Completion of Works

On completion of the whole Works or Sections of the Works, the area of the site improvement works shall be re-surveyed and plotted to the same scale and covering the same total area as in sub section 2 hereof. The survey shall provide sufficient data to indicate the final levels of the site improvement works, including the levels of settlement measuring devices installed prior to filling.

## L Materials

### 1 Materials Unsuitable for Fill

Materials unsuitable for fill shall comprise :-

- a Materials from swamp, marshes or bogs, running silt, peat, logs, stumps, perishable or organic materials, slurry or mud;
- and
- b the following materials :
    - (i) Material consisting of high organic clay or silt;
    - (ii) Clay having a liquid limit exceeding 80 and/or plasticity index exceeding 55;

- (iii) Material which is susceptible to spontaneous combustion;
- (iv) Materials having a moisture content greater than the maximum permitted for such materials in the Contract, unless otherwise permitted by the Engineer.

## 2 Suitable Fill

Suitable fill materials shall mean those materials other than the unsuitable materials defined in subsection L 1.

## 3 The Contractor shall submit at the time of tendering evidence of the suitability and adequacy of the types of fill proposed for the Works as follows :-

- a The nature and full description of each of the various fill materials;
- b Representative grading curves of the fill materials available;
- c Locations(s) of source(s) of fill materials and volume of fill that can be obtained from each source;
- d Details of investigations already undertaken to verify the quantity and suitability of the fill materials;

## 4 Evidence to be Submitted After Award of Contract

Before commencement of the reclamation fill, the Contractor shall submit evidence of the quantity and suitability of the fill materials proposed for the Works to the satisfaction of the Engineer. This proof of suitability shall consist of a minimum of three (3) samples of 20 kg each per 50,000 cu.m. of fill. The Contractor must also provide evidence to show that the proposed source will be approved by the relevant authorities. No filling shall be permitted until this evidence has been submitted in full and accepted by the Engineer.

## 5 Fill Materials to be Approved

All fill materials to be used in the Works shall be to the approval of the Engineer. The Contractor shall supply to the Engineer, prior to the commencement of the Works, grading curves of the material tested in an established laboratory and reasonably sized samples of all types of fill materials for inspection, approval and retention of the Engineer. If materials from more than one source are to be used or there is a likely change in the nature of the material from the same source, additional samples along with grading curves shall be submitted for the approval of the Engineer or his Representative.

For quality control and to ensure consistency in the quality of fill material supplied, the Contractor shall carry out the following soil tests on the borrow materials at a frequency of three (3) samples per 50,000 cu.m. for every change in material types and submit the results to the Engineer for his approval.

- a BS 1377 : Part 2 : 1990 : Determination of the particle size distribution.
- b BS : 1377 : Part 3 : 1990 Determination of the organic matter content.
- c BS : 1377 : Part 4 : 1990

## 6 Hard Materials and Rock

- a 'Hard Material' shall mean material encountered in ledges or masses in its original position which would have to be loosened by ripping using not less than D9 tractor unit or net power rating of 385 horse power or more.
  - b The ripper to be mounted to the tractor unit shall be the most efficient parallelogram type recommended by the tractor or ripper manufacturer. The ripper shall have a single shank in good working condition with sharpened cutting point.
  - c 'Rock' shall mean the following :  
All hard materials that can only be loosened or excavated by blasting, wedging or drilling using pneumatics tools and cannot be removed by the teeth of a mechanical excavator or cannot be broken with a pickaxe.  
All solid boulders each exceeding 0.08 cu. m. (3 cu. ft.) if occurring in trenches or each exceeding 0.5 cu. m (19 cu. ft.) if occurring in general excavations.
- 7 No claim will be allowed for standing time of any labour, plant, equipment or vehicles due to cessation of operations as a result of the condition of approval of materials for filling.

## M Workmanship

### 1 Code of Practice

Unless otherwise specified herein, all Site Improvement Works shall be carried out in accordance with the recommendations contained in the British Standard Code of Practice BS 6031 : 1981.

### 2 Proposed Method Statement for Works to be Approved

Before commencement of the Works, the Contractor shall submit for the Engineer's approval his detailed proposals for temporary drainage of the Site, the methods of extraction, transportation and placing of fill and methods to trap silt from entering and silting water courses. Such detailed proposals shall include, but not be limited to the following :-

- a The sequence of operations complying with the requirements of the Specifications;
- b The general layout and detailed design of all temporary works, e.g. bunds, drains, construction access, silt traps, trash screens, vehicle wash troughs, etc. which the Contractor intends to establish;
- c The locations, dimensions, and elevations of any stockpile of materials which the Contractor intends to establish on Site;
- d The details of plant, equipment and machinery to be employed, their capacities and the manner in which they are to be deployed on the Works;
- e The details of plant and procedure to be adopted to ensure the compaction of in-situ fill to the required densities called for hereinafter;
- f Such other information as the Engineer may require for the proper control and supervision of the Works.  
The submission of such detailed proposals shall be made well in advance of the intended date for commencement of physical works so that any modification

which may be required by the Engineer may be given effect to. No claim for delay in the commencement of work arising from this requirement will be entertained. The approval by the Engineer of the Contractor's proposals shall not relieve the Contractor of his responsibilities or liabilities under the Contract.

### 3 Clearing of designated area for Site Improvement Works

The Contractor shall clear the designated area receive fill material by stripping of all turf, shrubs and removal of unsuitable materials, felling and removing all trees, stumps, shrubs and vegetative growth therein, grabbing up all roots, and disposal to approved tips.

All rubbish and debris resulting therefrom shall be removed from the Site and disposed off by the Contractor to approved dumps.

The Contractor shall obtain the prior approval of the relevant authorities for the felling and removal of all trees, pay all charges that may be levied or abide by conditions that may be imposed.

### 4 Extraction, Transportation, Laying and Compaction of Fill

The Contractor shall provide and maintain in good condition all necessary plant and equipment for the extraction of suitable materials for the reclamation, transporting same to the Site, placing and spreading of the fill, compacting the fill and also any rehandling and incorporating of the materials into the Works and for disposing of unsuitable materials from the Site.

The Contractor's method of transporting the fill materials shall be such as to obviate any deposition of the materials between the borrow areas and the reclamation site.

### 5 Sufficient Plant

Hauling of material from borrow pits to the place of deposition shall proceed only when sufficient plant is operating at the place of deposition to ensure compliance with the requirement of sub-section 2 hereof.

### 6 Manner and Rate of Placing of Fill

a Fill works shall be carried out in the approved order in which the different portions of the Site are to be filled.

After the entire area is filled and raised to the final platform level, the surcharge fill height as specified shall be placed over the fill area.

The fill material shall be placed in layers not exceeding 300mm and compacted with suitable compaction equipment to a thickness not more than 225mm. The thickness of compacted layers shall be confirmed on site after conducting a trial compaction on site.

#### *Silt Traps*

The Contractor shall submit proposals on the details and location of silt traps before commencement of earthworks for the approval of the Engineer and such approved silt traps shall be constructed immediately before commencement of earthworks.



The silt traps together with the earth drains and bunds shall be maintained by regular desilting until all earthworks for roads and platforms are completed, after which they shall be removed for construction of the permanent drains/works. The Contractor shall at all times prevent any silt or foreign debris from encroaching into any neighbouring property or being drained out of the Site. The slopes of the silt traps should be protected at all times with suitable measures such as close turfing, rip-rap etc.

General filling of the designated fill areas shall proceed in accordance with the agreed Programme of Works and in such manner and sequence as to ensure the stability and integrity of the entire Works.

The Contractor shall be fully responsible for ascertaining the strengths of the various strata upon which the fill are to be constructed and shall also be responsible in ensuring that filling proceeds at such a rate that the safety and stability of the Works is maintained.

The rates and prices entered by the Contractor shall be deemed to have allowed for any delay and standing time for controlled placing of fill materials for the smooth execution of the Works.

b Compaction Trials

The Sub-Contractor shall submit for the approval of the Engineer, his proposals for the compaction of each type of material to be used in the embankment. Such proposals shall include the types of constructional plants to be used, the number of passes for each type, and the maximum loose depth of each material layer. The Sub-Contractor shall carry out compaction trials to the satisfaction of the Engineer to support his proposals. These trials shall be supplemented by any necessary laboratory tests as may be required by the Engineer. Approval of the Engineer, for the Sub-Contractor's compaction proposals shall be obtained before physical work is commenced in constructing the embankments.

c The use of earth moving plant as equipment for compaction shall not be accepted.

7 Soil Failure and Remedial Works

Should slips, slides or displacements occur, the Contractor shall do everything necessary to rectify the defects and stabilise the ground to the satisfaction of the Engineer and shall bear all expenses, including the replacement at his own expense of any fill lost or rendered unsuitable as a consequence of the defects or of providing any additional fill which would not have been necessary had the defects not occurred.

All fill materials placed in the fill areas shall be built up evenly over the full width and shall be maintained at all times with a sufficient crossfall, and surface sufficiently even to enable surface water to drain off readily.

8 Compaction of Fill

The Contractor shall submit to the Engineer for his approval his proposed method and sequence of filling which will ensure uniformity of density throughout the fill deposited in the reclamation and that the fill so deposited shall have a minimum density of 90% of the maximum dry density of the fill material determined based on Modified Proctor Test.

## 9 Edgeworks

Particular attention shall be paid to edge-works along the toe of the slopes in order to ensure that compaction is carried out right up to the edge. Particular attention shall also be paid along the sides of slopes in order to ensure that compaction is carried out right up to the edge. For filling over existing slopes, the slopes shall be benched at every 600mm height before the fill can be placed.

## 10 Field Density Determination

In order to ascertain whether the required degree of compaction has been obtained at the end of filling for each layer, the Contractor shall when and where directed by the Engineer carry out field density determination tests on the fill.

## 11 Loss of Fill

The Contractor shall allow in his rates and prices quoted in the Bill of Quantities for all risks and for any loss of fill which may occur during the course of the Works, including but not limited to surface erosion, drainage, losses due to rain, losses in double handling, losses due to any settlement, slip and due to any cause whatsoever.

## 12 Finished Levels

The Works shall be completed to lines, levels, grades and shapes in accordance with the Drawings and subsequent revisions thereof as the Engineer may issue from time to time. On completion, the Works shall be left at such levels as the Engineer may decide and direct during the progress of the Works. In the case of protective embankment, the final surfaces shall be finished fair, free of pitholes, gullies and depressions.

The excavated, cut and fill areas shall be left, on completion of the Works, in a clean, clear and workman-like condition to the satisfaction of the Engineer.

## 13 Tolerance in Finished Levels

The Tolerance for finished level of an area of cut or fill shall be  $\pm 100$ mm from the level specified on the Drawings or otherwise directed, provided that negative variation shall not prevail consistently but shall be generally compensated by positive variation at adjacent positions where measurements are taken.

In the case of protective embankment the surfaces of slope shall be trimmed to an even profile. Slopes to receive stone revetment, if left with minor irregularities shall, however, be rectified at the Contractor's own expense by increasing the thickness of the revetments where necessary.

## 14 Temporary Works

The Contractor shall provide at his own expense all temporary haul roads, drains, silt traps / screens, sluices, culverts, sumps, pumps or any other works of an ancillary nature for the efficient and workman-like completion of the areas of reclamation to the approval of the Engineer.

The Contractor shall site all such works with the agreement of the Engineer and when requested shall remove such works as the Engineer may direct.

## 15 Routing of Construction Traffic

Generally, construction traffic shall be routed evenly over the area of fill to ensure adequate compaction everywhere. If due to the Contractor's method of transportation, placing and spreading of fill material, it is necessary to route construction traffic along certain paths such routing shall be subject to the approval of the Engineer.

## 16 Stockpiling of Fill Materials

The Contractor shall not stockpile any materials on Site without prior approval of the Engineer. Approval may be given only if the Engineer is satisfied that such stockpiling will not cause any damage to the Works or nuisance to the environment.

The cost of placing materials in stockpiles and their subsequent removal from there are deemed to be included in the rates. Should any stockpile cause a slip, the Contractor shall at his own expense clear up and repair all damages thereto to the satisfaction of the Engineer. The approval of the Engineer to the use of any area for stockpiling shall not relieve the Contractor of his responsibilities and liabilities in respect of any slip and damage to the Works.

## 17 Dispersal of Water from Formation Areas of Fill and Drainage

The Contractor shall arrange for the rapid dispersal of water shed onto the Works during construction or water which enters the formation areas of fill from any source. Adequate means for trapping silt shall be provided in the temporary drainage system. The surface of the fill shall be finished evenly and without depression which is likely to trap water. Any enclosed area which is to be left at a lower level than the general formation level of the fill shall be drained. The Contractor shall be deemed to have allowed in his rates for the provision and maintenance of temporary and permanent drains. The cost of any temporary bridges or culverts across such drains to provide access for the Contractor's plant, equipment and vehicles shall be provided and maintained by the Contractor and are deemed to be included in his rates for the Works.

## 18 Making Good Fill Material

In the event that fill material is rendered unsuitable for use by being allowed to stand in rain or ponded water, the Contractor shall at his own expense remove and replace such material or alternatively provide where necessary temporary drains, pumping or other means of draining off rain and ponded water to allow the material to dry out sufficiently for use as fill.

## N Surcharge Fill

### 1 Application of Fill

Surcharge fill shall mean the fill above the specified platform levels as shown on the drawings. Surcharge fill shall conform to the requirements of the fill under subsection L2 and L5.

Surcharge fill shall be placed at the locations and to the thickness shown on the Drawings. Placement of surcharge shall be evenly done over the area of reclamation and the height of the surcharge shall be as indicated in the drawings.

The time of placement of surcharge fill shall depend on the monitored results of settlement and shear strength of the underlying soft clay and shall be subject to the

approval of the Engineer. The contractor shall allow for in his programme any delay in placement and removal of surcharge on temporary bunds and the inner areas of reclamation due to the insufficient increase in the shear strength of the subsoil to satisfactorily support the surcharge.

If rotational failures or large lateral displacements of the fill occur during placement of the surcharge Sub-contractor shall do everything necessary to rectify the defect and stabilise the round.

At the end of the period of surcharging, the Contractor shall remove the excess surcharge fill above the specified formation levels.

#### O General

- 1 The Contractor shall provide and maintain on site or off site throughout the period of the completion of the Works soils laboratory facilities with suitably staffed personnel and fully equipped, to the approval of the Engineer.
- 2 The Contractor shall carry out as directed by the Engineer the following soils tests on materials placed in the fill areas, to check the properties of the fill placed in the site improvement works and embankments and the compaction of the fill under the works. The tests shall be carried out in compliance with the requirements of the following Standards:
  - a BS 1377 : Part 2 : 1990  
Determination of the particle size distribution;
  - b BS 1377 : Part 3 : 1990  
Determination of the organic matter content;
  - c BS 1377 : Part 4 : 1990  
Determination of the dry density/moisture content relationship (4.5 kg rammer method);
  - d BS 1377 : Part 4 : 1990 Clause 3.5  
Determination of the dry density/moisture content relationship of granular soil (vibrating hammer method);
  - e BS 1377 : Part 9 : 1990  
Determination of the in-situ density tests of soil at the Site;
  - f BS 1377 : Part 9 : 1990 Clause 4  
Determination of maximum dry density for granular materials;

#### 3 Soil Tests Laboratory

Requirements for Soil Laboratory are specified in **PS1.25**.

### **PS 2.25 Excavation**

#### A Dimensional Tolerances

Slopes in cutting shall be trimmed mechanically to neat and even surfaces which shall have gradients not steeper than those shown on the Drawings. Widths of excavations shall not exceed the dimensions shown on the Drawings by more than 300 mm, unless otherwise approved by the Engineer.

**B Separation and Stockpiling of Suitable Material**

Where excavation reveals a combination of suitable and unsuitable materials, the Contractor shall, wherever the Engineer considers it practicable, carry out the excavation in such manner that the suitable materials excavated separately for use in the Works is carried out and stock-piled without contamination by the unsuitable materials.

**C Removal of Excavated Material From Site**

No excavated material shall be removed from the Site except on the direction or with the approval of the Engineer. Should the Contractor be permitted to remove suitable materials from the site to suit his operational procedure, then he shall make good any consequent deficit of fill material arising therefrom at his cost and expense. Unless designated dumpsites have been shown on the Drawings, the Contractor shall dispose off surplus suitable material at his own dump areas outside the site as approved by the Engineer. In doing so, the Contractor shall comply with statutory requirements such as payment of royalties, environmental protection, etc.

**D Removal of Unsuitable Material**

Unsuitable material shall be excavated to such depth and over such area as directed by the Engineer and be transported and disposed off in an approved manner. Unless approval of the Engineer to dump and spread the unsuitable materials within the site is obtained, the Contractor shall be responsible for providing his own dumpsite for such unsuitable materials. The Contractor shall comply with statutory requirements such as payments of royalties, environmental protection, etc. Voids created due to removal of unsuitable materials shall be backfilled with suitable materials as directed by the Engineer.

**E Excavation and Replacement of Unsuitable Material Under Standing Water**

Where it is decided by the Engineer that replacement of unsuitable material shall be done under standing water, voids created due to removal of unsuitable materials shall be backfilled with approved granular materials complying with limits specified in the following table :

**Grading Limits for Granular Material**

<b>B. C. Sieve Size</b>	<b>Percentage by Mass Passing</b>
14 mm	100
6.3 mm	80 to 100
2 mm	40 to 90
600 µm	10 to 70
300 µm	3 to 40
150 µm	0 to 22
75 µm	0 to 5

Method statement for excavation below standing water shall be submitted for approval. Excavation below standing water shall be carried out under close supervision of the Engineer.

Requirements on the backfilling such as suitability of materials, thickness, density, required test, etc shall be as required for embankment fill.

F Use of Granular Material as Replacement Material in Dry Excavation

When it is specified on drawing that granular materials shall be used as replacement material in dry excavation, the granular materials shall be placed in loose layers not exceeding 300mm thick and compacted to 95% of Maximum Dry Density based on BS 1377: 1990: Part 4: Clause 4.

The granular materials shall comply with the limits specified in the previous table.

**PS 2.26 Slope Stabilisation Works**

A Soil Nailing

1 General Requirement

The installation of soil nails, including drilling and stressing shall be carried out in accordance with BS 8006: 1995 and this Specification. Typical soil nail details and nomenclature are as shown in the Drawings.

Sub-Contractor shall submit to the Engineer for approval the details of the soil nails and fixtures together with the proposed method of installation and testing. The information to be provided shall include full details of the components for the corrosion protection system, manufacturing arrangement, centralisers, grouting arrangements and grout characteristics. Sub-Contractor shall submit his proposal to the Engineer at least fourteen (14) days before the installation commences.

2 Sub-Contractor's Responsibilities

Sub-Contractor shall be responsible for providing and installing the soil nails. Sub-Contractor shall install trial soil nails at locations to be decided by the Engineer and carry out Pull Out Test (refer relevant section) prior to installation of any permanent soil nails. The maximum length of the trial soil nails shall be 8 m.

After each stage of excavation and installation, the Engineer shall select several soil nails for Proving Test (refer relevant section). Sub-Contractor shall replace any soil nail that fails to meet the test requirements specified by the Engineer

3 Materials

General Requirements

The requirements listed in the following Sub-section shall apply, wherever relevant, to materials used in all soil nailing systems. The handling, storage and use of materials shall comply with manufacturer's instructions.

a Cement, Water and Additives

Cement, water and additives used for grouting soil nails shall comply with BS8081: 1989.

b Nail bars

The nail bars shall be 32 mm diameter high yield steel reinforcing bars complying with BS 5950: 1990. The nails shall be threaded at the exposed end for a sufficient

length to facilitate fixing of nuts and stressing. Threaded ends of bars shall be treated to retain a film of lubricating oil on the threads.

Couplers for nail bar sections shall be capable of developing 95 percent of the actual characteristic strength of the nail bar.

c Plastics

Plastic material and sheath joints shall be in accordance with the Table below.

**Properties of Plastics**

Property	Test Method	Units	Acceptance Criterion	
			PVC	PP & PE
Density	Method 620A of BS2782:Part6:1980	kg / m <sup>3</sup>	≥ 1350	≥ 930
Tensile strength at yield at 23°C. Testing Speed 50 mm/min	Method 320C of BS2782:Part3:1976	MPa	≥ 45	≥ 29 for PE ≥ 30 for PP
Softening point	Method 120A of BS2782:Part1:1976	°C	≥ 75	≥ 110
Hardness (Shore D)	Method 365B of BS2782:Part3:1981	-	≥ 65	≥ 65
Brittleness temperature	ASTM-D-746	°C	≤ 5°	≤ 5°
Environmental stress-cracking resistance	ASTM-D-1693	Hour	200 (no cracking)	
Fungal resistance	ASTM-G-21	-	Rating 1 or less (see Note 3 below)	
Bacteria resistance	ASTM-G-22 procedure 'B'	-	No bacterial growth on surface of specimen	
Water absorption	ASTM-D-570, Long term immersion	% increase in weight	Max. 0.5 %	
Hydrostatic pressure resistance	Appendix 'E' of BS3796:1970 Batch test	-	No localized swelling, leakage or weeping	
<b>Notes :</b>	1. PVC = polyvinyl chloride; PP = polypropylene; PE = polyethylene 2. Observed traces of fungal growth shall not cover more than 10% of the surface area.			

4 Corrosion Protection

a General

Permanent soil nails shall be provided with an outer sheath of plastic material. The thickness of grout between the bar and sheath shall not be less than 5 mm.

The thickness of grout between the plastic sheath and the sides of the drill- hole or casing shall not be less than 20 mm.

b Centralisers

Centralisers shall be provided on the nails at maximum spacing of two (2) metres centre to centre. The centralisers shall be of a form to permit the free flow of grout. The nails shall be positioned in the grout column so that a minimum grout cover to the nails of 20mm is maintained.

## 5 Method of Installation

### a Drilling

Drilling shall be carried out in accordance with BS 8081: 1989.

A drilling record in an approved format shall be submitted to the Engineer soon after the drilling is carried out for each soil nail.

### b Insertion of Nail

The Engineer shall be given full assistance in its inspection of the drill-holes and be provided with the records of drilling prior to seeking approval for the insertion of the nails.

Once the drill-hole has been accepted, Sub-Contractor shall proceed to insert the nail. If the drill-hole proves unacceptable, Sub-Contractor shall seek instruction from the Engineer as to whether the hole is to be grouted and re-drilled, re-used as a drainage hole or grouted and abandoned. Any remedial work shall not be measured for payment.

The nail shall be inserted on the same day as drilling. The nail shall be handled with care. During insertion, it shall be installed at a controlled rate to avoid damage to itself and the drill-hole.

The nail shall be positioned in accordance with the requirements of this Specification and shall be secured to prevent further movement.

### c Grouting

Grouting operations shall be in accordance of BS 8081: 1989.

The proportion of grout and the minimum strength of work cubes shall comply with the following requirements:-

<b>Range of water/cement ratio (by weight)</b>	<b>0.40 to 0.50</b>
Cube Strength	
At 7 days	18 N/mm <sup>2</sup>
At 28 days	25 N/mm <sup>2</sup>

The quantities of cement in the mix shall be measured by weight in an approved weigh batching plant or as per bag.

The grout shall be free from segregation, slumping and bleeding of water and fine materials during and after placing. Grout shall be mixed adjacent to the area to be grouted and shall be pumped into its final position as soon as possible and in not more than an hour after mixing.

The drill-hole shall be grouted on the same day as the drilling is carried out. Grouting shall be placed by tremie under gravity or very low excess (less than 5 bar) pressure in one continuous operation. Fill operation shall continue until



injected grout of the same composition and consistency as that mixed emerges from the outlet for at least one (1) minute.

A record in an approved format giving full details of the grouting operation for each soil nail shall be supplied to the Engineer immediately after the grouting is completed.

## 6 Stressing

Bearing plates for soil nails shall be seated either on an epoxy or cement mortar bed, which shall be prepared to a plane normal to the nail axis.

Stressing can be carried out when the grout has reached the required seven (7) days strength as specified above.

The soil nails shall be stressed to a load of 5 kN with a torque wrench and lock nut arrangement.

The load shall be applied by means of hand operated torque wrenches.

Wrenches shall be calibrated by an approved laboratory and the calibration certificates submitted to the Engineer prior to any equipment being used for stressing.

## 7 Testing

### a General

Sub-Contractor shall provide all torque wrenches, jacks and other equipment required to test the soil nails.

Sub-Contractor shall also submit current test and calibration certificates to the Engineer for the equipment that is proposed for testing.

### b Pull Out Test

All trial soil nails shall be tested to destruction during the Pull Out Test and the mode of failure recorded. Modifications required as a result of Pull Out Tests shall be approved by the Engineer before Sub-Contractor commences the drilling for the working soil nails.

Sub-Contractor shall submit a proposed test procedure for the Pull Out Test to the Engineer for approval before the test commences.

### c Proving Test

The test loads shall be as determined by the Engineer.

Sub-Contractor shall submit a proposed test procedure to the Engineer for approval before the test commences.

### d Records

Sub-Contractor shall submit to the Engineer a full report on each soil nail and this shall include details of the nails, its installation and the results of all tests carried out.

e Adjacent Activities

Sub-Contractor shall ensure that any activities in the immediate vicinity such as blasting, piling etc. shall not affect the installed soil nails.

8 Sprayed Concrete

a General

This subsection is applicable to areas with or without soil nailing.

b General Requirements

The plant used for sprayed concrete shall be of the dry mix delivery type with water added at the nozzle and shall be equipped with weigh-batching facilities. Only skilled operators experienced in the use of sprayed concrete shall be employed as nozzle-men. Sub-Contractor shall submit the names and details of the experience of the operators who will be employed on the sprayed concrete works for approval by the Engineer not later than two weeks prior to the commencement of sprayed concrete works.

c Surface Preparation

Wherever sprayed concrete is required, the sub-contractor shall clean and prepare the surface to receive the sprayed concrete. Loose or shattered rock, rock debris, loose soil or any other loose material shall be removed completely from the surface.

d Test Panels for Spraying Method

Before sprayed concrete is applied, Sub-Contractor shall submit his mix design for approval and shall demonstrate the process by spraying trial panels to establish the suitability of the plant, the materials and the operators for the work. The trial panel shall consist of two types:

- i) A trial panel of 3000 mm x 3000 mm x 40 mm thick located within the Site.
- ii) A 1000 mm x 1000 mm x 100 mm thick test panel sprayed at the same time as the permanent sprayed concrete and cured as specified.

The test panels shall be made with the same air pressure, nozzle tip and hydration as the spray concrete for the work. Cores cut from trial panels shall be used to determine the density that can be achieved and the tolerance within which the density can be maintained. Tests shall be made to determine the average percentage of rebound for concrete of various thicknesses. The results of the rebound tests shall be used in calculations of the cement content of the applied concrete. Sub-Contractor shall provide two copies of all tests results to the Engineer. Once the trial panels have been approved, Sub-Contractor shall not alter the mix or means of application without prior written consent of Engineer.

e Construction

Sprayed concrete shall be applied in layers not exceeding 40 mm thick. Thickness measuring pins shall be installed on a 1.5m square grid. The pins shall be non-corrosive. Other methods to measure the thickness of shotcrete

may be approved if the Sub-Contractor can satisfactorily demonstrate the reliability of these other methods.

Construction joints as shown on drawing shall be allowed for where required. All materials used shall comply with and shall be stored, tested and used in accordance with the provisions of the relevant Sections in the Specification. Sub-Contractor shall ensure that a sufficient supply of material of uniform quality corresponding to the samples submitted is available.

The moisture content of the mix before use shall not exceed 10%, the remaining water being added at the instant of application. The rate of application of air and water and all other factors affecting the quality of the work shall be adjusted by the operator so as to produce dense concrete with no sloughing. No mix shall be used more than two hours after any water has been added to it. Rebound material shall not be reused and, shall be removed within 8 hours of spraying.

Surplus water shall be removed by air jet and if any water is flowing from or across the rock or existing sprayed concrete and is liable to reduce the adhesion of the concrete, it shall be diverted by pipes, hoses or other approved means before spraying starts. Weep holes shall be formed, where necessary or pipes and hoses built in to relieve water pressure behind the concrete and to divert the water from the face. Weepholes shall be 50 mm diameter and formed with PVC pipes at 1.2 m centres in each direction or otherwise as directed by Engineer.

Sprayed concrete shall be provided with mesh reinforcement as shown in the Drawings. A layer of spray concrete shall be applied on the slope before the reinforcement mesh is laid upon it. The mesh is then tied to the 12 mm diameter, 750 mm long mild steel reinforcement bars which are grouted into 25 mm predrilled holes. A 300 mm bent section shall be provided to enable the reinforcement mesh to be tied to the rod. A second layer of spray concrete is then applied to cover the reinforcement and to form the full designed thickness.

A record shall be kept of the quantities of all materials used at each slope and shall be submitted daily to Engineer.

f Protection from weather

Immediately after application and for 3 days thereafter, sprayed concrete shall be protected from the effects of weather, either after thorough wetting, by completely covering with approved waterproof paper or plastic membrane maintained in contact with the concrete; or by completely covering the concrete with layer of hessian, sacking, canvas or similar absorbent material which are kept constantly wet.

g Strength of Sprayed Concrete

The strength of the applied concrete shall be determined by crushing 100 mm diameter cores cut from 100 mm thick test panels sprayed at the same time and cured in the same manner as the in-situ concrete. One test panel shall be sprayed per 500 m<sup>2</sup> area.

Six cores shall be cut from each panel, three of which shall be crushed at seven (7) days and the other three (3) nos. at 28 days. Cores shall not be taken within 125 mm of the edges of the panel. Prior to crushing test, the density of each

core shall be determined. The minimum equivalent cube strength of the core shall be:

- (i) at 7 days : 10 MPa
- (ii) at 28 days : 20 Mpa

In addition to provision of test panels, complete areas of sprayed concrete shall be tested from time to time by sounding them with a wooden mallet. Hollow sounding areas shall be removed and resprayed or a second layer of sprayed concrete shall be added. Any such remedial work shall not be measured for payment.

## B Horizontal Drains

- 1 The scope of work for the installation of horizontal drains shall consist of supplying, drilling and inserting small diameter drains into slopes for the purposes of removing excess groundwater.
- 2 The drain holes shall be drilled at an inclined angle into the slope using a casing to support the hole unless otherwise approved by the Engineer. The drill holes shall then be lined with 75mm diameter perforated uPVC pipes (Class B) and wrapped in geotextile filter fabric Type A. The casing where required for support during drilling shall subsequently be withdrawn.
- 3 Drain locations, orientations and lengths to be installed are as shown on the Drawings or as directed by the Engineer.
- 4 The Contractor shall however submit proposals on the method of construction of horizontal drains to the Engineer and shall not construct the horizontal drains without the prior approval of the Engineer.

## C Subsoil Drains

- 1 The scope of work for the installation of subsoil drains shall include the supply and installation of subsoil drains constructed in accordance with this Specification at the locations and to lines, levels and grades as shown on the Drawings and/or as directed by the Engineer.

### 2 Materials

#### a Pipes

Porous concrete pipes for subsoil drains shall comply with MS 525 : 1977.

Clay pipes for subsoil drains shall comply with BS 1196 : 1989.

Polyvinyl Chloride (PVC) pipes for subsoil drains shall comply with Australian Standard Specification 2439.

#### b Coarse Filter Material

Coarse filter material used in the construction of sub-soil drains shall consist of hard, clean crushed rock or gravel having a grading within the limits given in Table 3.4 (B). The aggregate crushing value of material shall not exceed 30 percent. The material passing the 425 um sieve shall be non-plastic when tested in accordance with B.S. 1377 : 1975.

**Table 3.4 (b) – Grading Limits for Coarse Filter Material**

<b>B.S. Sieve Size</b>	<b>% Passing by Weight</b>
50 mm	100
37.5 mm	85 – 100
20 mm	0 – 20
10 mm	0 - 5

**PS 2.27 Plate Bearing Test**

- A Plate bearing test shall be carried out by Sub-contractor using the maintained load test method in accordance with the procedure given in Clause 29 of BS5930: 1981. A 1000 mm x 1000 mm plate shall be the minimum size to be used for the plate bearing test unless otherwise indicated in the Drawings. The test shall be carried out at locations selected by Engineer at an elevation of 500 mm below the proposed levels of foundation.

At least 48 hours notice prior to the commencement of each test shall be given to Engineer. Sub-contractor shall allow in its rates and programme of works for the time required in carrying out these tests.

**B Testing Equipment**

Sub-contractor shall supply and mobilise to Site all necessary equipment, labour and materials for the timely commencement of plate bearing tests. This includes but not limited to the following:

- 1 Kentledge or equivalent means of providing the total anticipated load reaction.
- 2 Hydraulic jack assembly and at least one device, such as a pressure gauge electronic load cell, or proving ring for measuring the force exerted by the hydraulic jack.
- 3 Minimum 25 mm thick steel plate of 1000 mm square unless otherwise indicated.
- 4 Settlement recording devices such as dial gauges capable of measuring settlement to an accuracy of at least 0.25 mm.
- 5 Miscellaneous apparatus including loading columns, steel shims and other construction tools and equipment required for preparation of test pits and loading apparatus.
- 6 All necessary facilities to enable the Engineer to check all readings during the progress of plate bearing test.

**C Loading Increments**

Test loads shall be applied by jacking against the kentledge in equal increments up to a maximum of two times the specified allowable soil bearing pressure. Each increment and decrement shall be carried out in stages as shown in the following Table : Loading Procedure for Plate Bearing Test.

Settlement of the plate shall be measured using dial gauges in at least four positions. Dial gauge and check-level readings shall be taken immediately before and after application of each load increment. Thereafter, at intervals of 1, 3, 6, 9, 12 and 15 minutes, dial gauge readings shall be recorded. No increment of load shall be applied until and unless the average rate of settlement decreases over the three (3) minutes intervals. For each load decrement, dial gauge readings shall be taken in the same manner as that for load increments. The settlement readings shall be taken continuously at 15 minutes intervals after the complete load is removed for a period not less than one (1) hour.

**Loading Procedure for Plate Bearing Test**

<b>Applied Load (as percent of Allowable Bearing Pressure)</b>	<b>Minimum Time Period of Holding Load (in minutes)</b>
25	15
50	15
75	15
100	60
75	15
50	15
25	15
0	60
50	15
100	15
125	15
150	180
100	15
50	15
0	60

**D Acceptance Criteria for Plate Bearing Test**

The allowable soil bearing capacity at the test area shall be deemed to have satisfied the requirement of this Specification if the settlement of the test plate at various stages of loading complies with the requirements given below:

- 1 When loaded to the allowable soil bearing capacity, the total settlement of the test plate shall not exceed twenty (20) mm.
- 2 When loaded to one and a half (1.5) times the allowable soil bearing capacity, the total settlement of test plate shall not exceed thirty (30) mm.

**PS 2.28 Structure Excavation and Backfill**

- A Where the formation of any excavation, being other than rock, is to support the foundations or floor of a structure, the bottom 150 mm of which shall be carefully excavated and trimmed immediately before placing the permanent work upon it.

**PS 2.06 Dumping of Unwanted Building Debris, etc.**

- A Contractor to find his own dumping grounds
- 1 The Contractor is required to seek his own dumping grounds at his own cost for the disposal of all unwanted materials excavated or otherwise and all other construction waste materials, resulting from the site clearance, excavation and all works under this Contract.
  - 2 The Contractor is prohibited from dumping unwanted building debris, excavated materials, etc, on any vacant plot of land, roadside or drains. The Engineer may employ workers, machinery and all else necessary for the removal and proper disposal of such dumping and all costs incurred thereof shall be deducted from any monies due or to be due to the Contractor.

- B At the start of the Contract

- 1 The Contractor shall declare the location of the disposal site for surplus earth or excavated materials. If the Contractor intends to dispose of excavated soil/materials to his own dumping grounds, he shall submit to the Engineer letters of consent from the management/owners of the disposal sites and, if the ground level of the disposal site would be raised, shall seek approvals from Local Authority.
- 2 Where the Contractor proposes to dispose of excavated materials at a private site, he shall produce letters of consent from the owner, photos showing the site before and after the disposal operation.
- 3 The Contractor shall clearly and prominently demarcate on site the boundary of the disposal site such that drivers transporting materials to the disposal site would not unload materials outside the disposal site.

C During the progress of the work

- 1 The Contractor shall seek the Engineer's prior approval for any change of disposal site during the contract.
- 2 Disposal of earth shall be carried out only during daylight hours unless approved otherwise by the Engineer and Local Authority.
- 3 If the volume of earth to be disposed of from any site exceeds 1000m<sup>3</sup>, and if the earth is to be disposed of at a private site, the Contractor shall employ a person, whose personal particulars and specimen signature shall be lodged with the Engineer, to be stationed at the disposal site to acknowledge receipt of excavated earth. The Contractor shall brief that person thoroughly and obtain a written statement from him to the effect that he fully understood that he would be liable for aiding and abetting illegal dumping if he made false acknowledgements.
- 4 The Contractor shall submit a list of registration numbers of the trucks that will be used in the transportation of excavated materials. All trucks shall have an up-to-date log book in which the driver shall enter all relevant details of trips made.
- 5 If the disposal site is a private site, the Contractor shall submit photographs monthly showing activities connected with the disposal of excavated materials to the Engineer.
- 6 The Contractor shall provide transport for the Engineer and his representatives to the disposal sites as and when required to conduct audit check on disposal operations.
- 7 The Contractor is deemed to have allowed all necessary costs and fees for the disposal of excavated materials and construction waste and for complying with all requirements stated in this clause in his pricing. No claim or variations by the Contractor shall be entertained by the Employer.

## **SECTION 02221**

### **PS 2.29 Trench Excavation**

- A Utility detection surveys have not been carried out at the STP site and along external utility installation corridors.
- B Presence of innumerable utilities is anticipated within the proposed corridor routes for the trending and laying of sewers and force mains, and for the external utility infrastructure

works in the trenching and laying of water supply mains, telecommunication ducts, power supply cables etc to the works.

- C Non-destructive methods of detection and mapping of buried utilities shall be employed. The underground utility information shall be presented in scale maps showing the in-situ positions of the individually identified utilities in vertical and horizontal alignment relative to existing platform levels and right-of-way boundaries.
- D In undertaking the utility detection survey, the contractor shall be responsible for locating the positions of the public utility installations, including but not limited to water mains, underground telecommunications and electric cables, gas mains, pipes, sewers and drains and all service connections to buildings, and shall adopt non-destructive methods of investigation and location as may be appropriate to ensure that no damage is caused to them.
- E The Contractor shall prepare and submit to the Engineer colour co-ordinated maps showing the identity and location of utilities, duly certified by the Contractor and the Engineer shall be satisfied that the plans have been diligently prepared.
- F The Contractor shall be required to liaise and coordinate with the utility agencies in the course of the search, and prepare and submit plans showing the nature and location of these utilities and the Engineer shall be satisfied that the plans have been diligently prepared.
- G In the course of execution of the external utility installation works, the Contractor shall provide all necessary protection to utilities where necessary such as temporary supports, barricading, signposting, night lighting, flagmen and/or traffic control devices inclusive of their management and maintenance throughout the duration of the whole of the works.
- H The Contractor shall allow for compliance with all laws and regulations of all relevant bodies which have jurisdiction or authority over the works, including payment of fees, obtaining approvals, site inspections, supervisory presence of utility personnel, inconvenience charges etc. and execute the diversion and/or the relocation of existing utilities onto the road shoulder as directed by the Engineer inclusive or all mobilisation and demobilisation, trenching, shoring, dewatering, supply of all labour materials and specials and installation of the works, backfill and reinstate trench to status quo.
- I The Contractor shall not be relieved of his obligations in exercising due care and attention in the execution of the works and protection of the utilities so as not to injure, damage, disrupt or inconvenience the use of utilities, as uninterrupted utility services is of vital importance at all times.

### **PS 2.30 Earth Works for Sewer Pipelines**

#### **A General**

- 1 Pipes and fittings shall be obtained from approved manufacturers and shall be inspected by the Engineer on arrival to Site. Defective pipes rejected shall be removed from Site immediately, all at the Contractor's own expense.
- 2 Manufacturer's test certificate for each consignment of pipes shall be produced for inspection when required by the Engineer. Notwithstanding the production of the manufacturer's test certificates, the Engineer shall have the right to draw samples to be tested independently in an approved laboratory in accordance with the relevant clauses of Specification. The cost of samples and tests shall be deemed to have been included in the Tender Price.

#### **B Vitrified Clay Pipe**



- 1 Vitrified Clay Pipes, bends and fittings shall be obtained from an approved manufacturer and shall comply in all respects with B.S. 65 and 540:1971 Parts I and II.
- 2 The pipe shall be tested for crushing strength, barrel impermeability and hydraulic proof in accordance with BS 65 and 540:1971. It also shall be tested for acid and alkali resistance in accordance with BS 1143.

#### C Setting Out

- 1 Before any excavation commences and throughout the period of construction, each manhole center shall be set out and marked by a center peg and three triangular peg markers situated outside the working area.
- 2 The levels are to be set out and inverts referred to protected level pegs near each manhole and change of grade or line. Properly painted, black and white sight rails 2.5m long are to be fixed and maintained at the changes of grade or line and not more than 100m apart.
- 3 Strongly constructed, clearly painted boning rods shall be provided at each length where work is in progress. Such boning rods shall be designed to show the pipeline invert level below the sight rails.
- 4 Excavation for trenches shall be straight lines and gradients required for the pipes and beds as specified. The trench shall be sufficient width to allow adequate working space for the pipe layers and jointers.
- 5 When excavation is completed and before any further work commences, wooden pegs are to be driven into the formation at not more than 4m centers, the level of each peg being adjusted to the proposed sewer or pipe invert by the use of the sight rails and boning rods.

#### D Prevention of Floating

Certain structures and portions of sewer pipelines may not be heavy enough to resist the possible uplift due to water pressure until the structures and pipelines, soil cover and backfilling have been completed. The Contractor shall make adequate arrangements to keep the excavation dry until the structure and filling are complete or shall adopt other approved means of ensuring the stability of the temporary or permanent works.

#### E Concrete Bed, Haunching and Surround to Pipes

Concrete for bedding, haunching and surround to pipes shall be to grade as shown on the Drawings. The concrete shall be well rammed or vibrated and worked under and around the pipes. No concrete shall be placed around the pipes until the pipe joints have been inspected and approved.

Concrete shall be placed right up against the trench excavation. Where the excavation has been carried out to a greater width than the required section or approved width, the Contractor shall provide the additional concrete at his own expenses.

#### F Cutting of Pipes

To allow for chambers, bends junctions and other pipes being constructed in the required positions, all pipes shall be cut where necessary to give a true, straight edge. The cut shall be made by an approved type of wheel cutter or high speed abrasive wheel cutter.

#### G Handling Pipes

At every point of loading or unloading, pipes or castings must be handled by approved lifting tackle. Unloading by rolling down planks or any other form of inclined ramp will not be allowed. Pipes are to be carefully stacked on Site with timber packing under and between the pipes.

#### H Pipelaying

All pipes shall be carefully brushed out inside and shall be tested for soundness before being laid. The pipes shall be laid separately to true invert, straight lines and falls, each pipe being separately boned between sight rails and bearing evenly upon the solid ground or concrete or its full length.

#### I Jointings

##### 1 Rubber Joint Rings

Rubber Joint Rings for use in jointing sewers shall comply with the requirements of BS 2494:Part 2:1967.

##### 2 Jointing Vitrified Clay Pipes

The spigot and socket ends of each pipe shall be throughout brushed clean before setting the rubber ring in the groove provided at the outer end of the socket. The spigot shall be carefully aligned axially and pushed with a firm uniform pressure into the socket fitted with a ring. Should the ring not roll uniformly, its final depth in the socket will be uneven, in which event, the pipe should be withdrawn and the joint remade.

#### J Testing of Sewers

##### 1 General

Testing of pipelines shall be performed in the presence of the Engineer. The Contractor shall provide complete plant, including portable hydraulic pumps, blank flanges, caps, plugs, pressure gauges, rubber hoses and shall provide all struts, thrush blocks etc., all as may be found necessary for effectively testing the pipelines to the required pressure and he shall keep the said plant in good order during the continuance, all at his own expense. The cost of all testing including materials, water pumps and labour shall be deemed to be included in the Tender Price.

##### 2 Retesting

Any pipe or length of pipes found to be defective shall be immediately removed, leaking joints remade and replaced at the Contractor's expense. The test shall then be repeated as often as necessary until the works length under test is approved by the Engineer.

##### 3 Water Test

Water test shall be applied after pipe laying and before backfilling or placing concrete bedding or surround and shall be repeated after backfilling. The test shall be as specified in C.P. 2005.

For this test a pressure head of 1.2m of water above the crown of the pipe is maintained at the high end of the pipeline under test, but not more than 6m at the low end. The test should be carried out by inserting suitably strutted plugs in the low end of the sewer and in connections if necessary and by filling the system with water. The loss of water over a period of 30 minutes should be measured by adding water from a measuring vessel at regular intervals of 10 minutes and noting the quantity required to maintain the original water level. The average quantity added should not exceed 1 liter per hour per linear meter per meter of nominal internal diameter.

#### 4 Air Test

Air test may be used as directed by the Engineer as an alternative to the water test. The length of pipe under air test should be effectively plugged as described above and air pumped in by suitable means (e.g. hand pump) until a pressure of 100mm of water is indicated in a glass U-tube connected to the system. The air pressure should not drop to less than 75mm during a period of 5 minutes without further pumping after allowing a suitable time for stabilisation of the air temperature.

#### 5 Test For Straightness and Obstruction

Test for straightness and freedom from obstruction shall be applied wherever possible. Such tests shall be carried out either:-

- a By inserting at high end of sewer a smooth ball of 12mm diameter less than pipe bore. The sewer will have passed the test if the ball can roll down pipe invert and emerge at lower end; or,
- b By means of a mirror at one end of sewer and a lamp at the other. The sewer will have passed the test if a full circle of light is observed.

### K Completion of Pipe Laying Works

#### 1 Cleaning Up

On completion of the Contract Works, sewer pipelines and manholes shall be thoroughly cleaned and washed throughout. No sewers or part of a sewer may be put into use until a detailed inspection has been carried out and the sewers cleaned and certified satisfactory by the Engineer.

All water retaining and other structures shall be pumped dry and washed and swept out free of all debris, mud, dirt and construction materials.

All equipment and fittings shall be cleaned, greased and oiled and all necessary adjustments made to ensure their full working efficiency.

All Site roads, paths and drains shall be swept clean and dry and all construction plants and materials removed from site.

#### 2 Inspection Upon Completion

Following the cleaning up of the whole or a section of the works to be taken over by the Employer a detailed inspection shall be carried out by the Engineer or his Representative who shall be accompanied by the Contractor or his Representative.

Any defects found during the detailed inspection of the Works shall be rectified as required by the Engineer. The Works shall then be cleaned again and reinspected. The cost of making good any defect shall be borne by the Contractor.

### 3 Maintenance Period Inspection

One month before the end of the Contract Maintenance period the Contractor shall inform the Engineer of the expiry date and arrange for the cleaning up and ventilation of the Works and the provision of all necessary ladders etc., required for inspection of the Works by the Engineer accompanied by the Contractor or his Representative. Any default resulting from faulty materials or workmanship used in the execution of the works shall be rectified by the Contractor at his own cost to the satisfaction of the Engineer.

#### **PS 2.31 Concrete Pipes and Fittings**

- A Reinforced concrete pipes shall comply with BS 5911 : including its latest amendments, additions and revisions. The pipes shall be obtained from approved manufacturer and shall be minimum class “Y”. All concrete pipes below 700 mm diameter shall be internally lined with 20 mm thick concrete sacrificial layer and pipes above 700 mm diameter shall be internally lined with plastic liner plate (PVC or HDPE).
- B Concrete pipes shall have spigot and socket rubber ring joints to BS 2494 : Part 2 : 1986 and subject to load and hydrostatic pressure tests in accordance to specified standards.

#### **PS 2.32 Sewer Manhole Requirements**

The interior face of the manholes shall be coal tar epoxy lined as detailed in the Drawings. Precast concrete manhole sections shall conform in all respects to BS 5911 Parts 1, 2 and 3. Ductile iron covers to details shown in the Drawings, shall be laid with their frames bedded on the precast concrete rings. Section PS 2.04 above shall also be applicable for vitrified clay pipe material used in backdrop constructions.

#### **PS 2.33 Soft Trench Bottom**

If soft spongy unstable material is encountered upon which the bedding material is to be placed, this unsuitable material shall be removed to a depth ordered by the Engineer and replaced with suitable granular bedding material, which shall be measured separately.

#### **PS 2.34 Testing of Sewers**

- A All gravity sewer shall be subject to water or air tests as specified in MS 1228: 1991 before backfilling, after backfilling and after completion of compaction.
- B If, in the construction of the sewer where excessive groundwater is encountered, a test for infiltration shall be conducted, if ordered by the Engineer. The infiltration shall not exceed 50 litres per millimetre diameter per kilometre of sewer per day.

**DIVISION 3.**

**CONCRETE**

## Division 3. Concrete

### PS 3.01 General

- A. Division 3 relates to concrete works for the sewer network, pumping stations and sewage treatment plant (STP).
- B. The Contractor shall carry out and complete the concrete works for the sewer network, pumping stations and STP as shown in the Drawings and/or specified herein and relevant provisions of Division 3 of the Standard Specifications. The concrete works include, but are not limited to, those specified in the following sections of the Standard Specifications:
- i. 03100: Formwork
  - ii. 03200: Concrete Reinforcement
  - iii. 03300: Cast-in-Concrete
  - iv. 03320: Concrete Topping
  - v. 03350: Linings and Protective Coatings to Concrete
  - vi. 03400: Precast Concrete
  - vii. 03600: Grout
  - viii. 03800: Architectural Concrete Finishes
  - ix. 03900: Testing of Water Retaining Structures

### Section 03200

#### PS 3.02 Concrete Reinforcement

- A. Reinforcing steel shall be deformed reinforcement Grade 60, conform to ASTM A 615 or BS 4449 and shall have minimum yield strength of 4200 kg/cm<sup>2</sup>.

### Section 03300

#### PS 3.03 Cast-in-place Concrete

- A. Unless otherwise specified, all cast-in-place concrete for civil works shall be a minimum compressive strength at 28 days of 280 kg/cm<sup>2</sup> or 4000 psi, with a maximum water/cement ratio of 0.45.
- B. All cast-in-place concrete for water retaining and water excluding structures shall be grade 35. All chambers and structures on the pipelines shall be considered as water retaining structures. All concrete for buildings shall be grade 25.

Concrete mix shall be as follows:

Concrete Grade	Max. Size Agg. mm	Min. Cement Content kg/m <sup>3</sup>	Max. Free Water/Cement Ratio	Cube Crushing at 28 days	
				Trial Mix N/mm <sup>2</sup>	Works Test N/mm <sup>2</sup>
21	20	315	0.5	35	21
28	20	350	0.5	45	28

- C. Unless otherwise specified all cast-in-place concrete for buildings structures shall be a minimum compressive strength at 28 days of 210 kg/cm<sup>2</sup> or 3000 psi.
- D. All lean and blinding concrete shall be a minimum compressive strength at 28 days of 140 kg/cm<sup>2</sup> or 2000 psi.
- E. All cement used on foundations, piles and underground structures shall be type V, conforming to ASTM C 150 or BS 4027.
- F. Unless otherwise specified all cement used for civil works and buildings structures shall be type I, conforming to ASTM C 150 or BS 12.
- G. Nominal maximum size of coarse aggregate shall be not larger than:
  - a) 1/5 the narrowest dimension between sides of forms, nor
  - b) 1/3 the depth of slabs, nor
  - c) 3/4 the minimum clear spacing between individual reinforcing bars

These limitations shall not apply if, in the judgment of the Engineer, workability and methods of consolidation are such that concrete can be placed without honeycomb or voids.

- G. All chambers and structures on the pipelines and all hydraulic structures, with the exception of building superstructures, shall be considered as water retaining structures.
- H. All concrete used in the permanent works shall be produced from a batching plant on the site or using ready mixed (pre-mix) in accordance with requirements of ASTM C 94 or ASTM C 685. The Contractor must therefore ensure that the on-site batching plant has adequate standby capacity to meet the Contractor's programme.
- I. A written record of the concrete works shall be made each day by the Contractor and kept available for inspection by the Engineer. The record shall contain the following:
  - 1 the names of the Contractor's engineers who are responsible for the different phases of the concrete work, and also the names of their assistants;
  - 2 the temperatures of air, water, cement, aggregates and concrete, together with the air humidity and type of weather;
  - 3 deliveries to Site of concrete materials (quantity, type & brand of cement etc.);
  - 4 inspections carried out, tests performed, etc., and their results;
  - 5 times of commencement and completion of different parts of the concrete works, and times of erection and striking formwork;
  - 6 quantity of cement, fine and coarse aggregate, water and admixture used for each section of work and the number and kind of test samples taken on these ingredients.
- J. For the sewer pipeline works, immediately upon completion of excavation, all excavated surfaces shall be covered with blinding concrete to prevent deterioration of the formation and to form a clean working surface for the structure as specified in Clause 3.06 C of Section 03300 of the Standard Specifications. The layer of blinding concrete shall be placed on the underside of all footings, ground beams and ground slabs. The underside of the blinding concrete shall be provided with a vapour barrier separation layer as specified in Clauses 2.12 A and 3.06 D of Section 03300 of the Standard Specifications.
- K. Immediately upon completion of excavation, all excavated surfaces upon which a structure is to be placed, shall be covered with blinding concrete to prevent deterioration of the formation and to form a clean working surface for the structure as specified in Clause 3.06

C of Section 03300 of the Standard Specifications. The layer of blinding concrete shall be placed on the underside of all footings, ground beams and ground slabs. The underside of the blinding concrete shall be provided with a vapour barrier separation layer as specified in Clauses 2.12 A and 3.06 D of Section 03300 of the Standard Specifications.

- L. The Contractor shall demonstrate the temperature/time relationship of setting concrete by means of casting a test panel 1m thick, 3m long and 3m high that his proposed concreting method, including shuttering will ensure that the maximum internal temperature of the concrete shall not exceed 70°C
- M. The concrete surface finish and tolerances of the sedimentation tank floors shall be either as specified in Section 03300 of the Standard Specifications or to the requirements of the scraper manufacturer, whichever are the more stringent

## **Section 03900**

### **PS 3.03 Testing of Water Retaining Structures**

- A. The testing of water retaining structures shall be carried out in accordance with the procedures stipulated in Section 03900 of the Standard Specifications to satisfy the requirements set out therein.
- B. All structures, excluding building superstructures, but including isolation valve chambers, washout boxes, sludge holding tanks, pump pit, air/vacuum chambers, access and sewer manholes, etc. are to be considered as watertight structures and are to be tested as specified.

### **END OF DIVISION 3 OF PARTICULAR SPECIFICATIONS**



**DIVISION 4.**

**MOSONRY**

## Division 4. Masonry

### PS 4.01 General

- A. Division 4 relates to masonry works for the pumping stations and sewage treatment plant (STP).
- B. The Contractor shall carry out and complete the masonry works for the pumping stations and STP as shown in the Drawings and/or specified herein and relevant provisions of Division 4 of the Standard Specifications. The masonry works include, but are not limited to, those specified in the following sections of the Standard Specifications:
  - i. 4220: Concrete Masonry
  - ii. 4400: Stone
- C. The works involve the supply of all plant, materials, tools and equipment, labour, supervision and everything else necessary for the execution and maintenance of the works to be carried out over the site.

**DIVISION 5.**

**METALS**

## Division 5. Metals

### PS 5.01 General

- A. Division 5 relates to metals work for the pumping stations and sewage treatment plant (STP).
- B. The Contractor shall carry out and complete the metals work for the pumping stations and STP as shown in the Drawings and/or specified herein and relevant provisions of Division 5 of the Standard Specifications. The metals work include, but are not limited to, those specified in the following sections of the Standard Specifications:
  - i. 5120: Structural Steel
  - ii. 5500: Miscellaneous Metals
- C. The works involve the supply of all plant, materials, tools and equipment, labour, supervision and everything else necessary for the execution and maintenance of the works to be carried out over the site.

**DIVISION 6.**

**WOODS AND PLASTIC**

## **Division 6. Wood and Plastic**

### **PS 6.01 General**

- A. Division 6 relates to wood and plastic works for the pumping stations and sewage treatment plant (STP).
- B. The Contractor shall carry out and complete the wood and plastic works for the pumping stations and STP as shown in the Drawings and/or specified herein and relevant provisions of Division 6 of the Standard Specifications. The wood and plastic works include, but are not limited to, those specified in the following sections of the Standard Specifications:
  - i. 6100: Carpentry
  - ii. 6400: Architectural Woodwork
  - iii. 6400: Fibreglass Reinforced Plastic Fabrications
- C. The works involve the supply of all plant, materials, tools and equipment, labour, supervision and everything else necessary for the execution and maintenance of the works to be carried out over the site.

**DIVISION 7.**

**THERMAL AND MOISTURE  
PROTECTION**

## Division 7. Thermal and Moisture Protection

### PS 7.01 General

- A. Division 7 relates to thermal and moisture protection works for the pumping stations and sewage treatment plant (STP).
- B. The Contractor shall carry out and complete the thermal and moisture protection works for the pumping stations and STP as shown in the Drawings and/or specified herein and relevant provisions of Division 7 of the Standard Specifications. The thermal and moisture protection works include, but are not limited to, those specified in the following sections of the Standard Specifications:
  - i. 7100: Waterproofing and Damp-proofing
  - ii. 7200: Building Insulation
  - iii. 7250: Cementitious Fireproofing
  - iv. 7270: Fire stops
  - v. 7500: Membrane Roofing
  - vi. 7600: Sheet Metal Flashing
  - vii. 7724: Access Hatches
  - viii. 7810: Metal Framed Skylights
  - ix. 7910: Joint Fillers and Gaskets
  - x. 7920: Sealants
- C. The works involve the supply of all plant, materials, tools and equipment, labour, supervision and everything else necessary for the execution and maintenance of the works to be carried out over the site.



## **DIVISION 8.**

# **DOORS AND WINDOWS**

## Division 8. Doors and Windows

### PS 8.01 General

- A. Division 8 relates to doors and windows work for the pumping stations and sewage treatment plant (STP).
- B. The Contractor shall carry out and complete the doors and windows work for the pumping stations and STP as shown in the Drawings and/or specified herein and relevant provisions of Division 8 of the Standard Specifications. The doors and windows work include, but are not limited to, those specified in the following sections of the Standard Specifications:
  - i. 8100: Metal Doors and Frames
  - ii. 8210: Wood Doors
  - iii. 8330: Rolling Shutters
  - iv. 8365: Rolling Service Doors
  - v. 8520: Aluminium Doors, Windows and Screens
  - vi. 8710: Finish Hardware
  - vii. 8800: Glazing
- C. The works involve the supply of all plant, materials, tools and equipment, labour, supervision and everything else necessary for the execution and maintenance of the works to be carried out over the site.

**DIVISION 9.**

**FINISHES**

## Division 9. Finishes

### PS 9.01 General

- A. Division 9 relates to finishes work for the pumping stations and sewage treatment plant (STP).
- B. The Contractor shall carry out and complete the finishes work for the pumping stations and STP as shown in the Drawings and/or specified herein and relevant provisions of Division 9 of the Standard Specifications. The finishes work include, but are not limited to, those specified in the following sections of the Standard Specifications:
  - i. 9200: Lath and Plaster
  - ii. 9250: Gypsum Board
  - iii. 9300: Tile Work
  - iv. 9320: Brick & Roof Tile Work
  - v. 9420: Precast Terrazzo
  - vi. 9510: Suspended Ceilings
  - vii. 9650: Resilient Flooring
  - viii. 9700: Special Flooring
  - ix. 9870: Coating Systems for Ferrous Metals
  - x. 9900: Architectural Painting
- C. The works involve the supply of all plant, materials, tools and equipment, labour, supervision and everything else necessary for the execution and maintenance of the works to be carried out over the site.

**DIVISION 10.**  
**SPECIALITIES**

## Division 10. Specialities

### PS 10.01 General

- A. Division 10 relates to specialities work for the pumping stations and sewage treatment plant (STP).
- B. The Contractor shall carry out and complete the specialities work for the pumping stations and STP as shown in the Drawings and/or specified herein and relevant provisions of Division 10 of the Standard Specifications. The specialities work include, but are not limited to, those specified in the following sections of the Standard Specifications:
  - i. 10160: Toilet and Shower Partitions
  - ii. 10210: Louvers and Vents
  - iii. 10270: Access Flooring
  - iv. 10400: Identifying Devices
  - v. 10520: Fire Protection Specialities
  - vi. 10670: Storage Equipment
  - vii. 10800: Sanitary Fittings and Toilet Accessories
- C. The works involve the supply of all plant, materials, tools and equipment, labour, supervision and everything else necessary for the execution and maintenance of the works to be carried out over the site.

**DIVISION 11.**

**MECHANICAL EQUIPMENT**

**DIVISION 11. EQUIPMENT****SECTION 11100 to 11681****PS11.01 GENERAL REQUIREMENTS**

- A. The Contractor shall furnish and complete the installation of all equipment as specified herein, fully complying with the requirements stated in Section 11000 of the Standard Specifications except any requirements contradicting those in this section of the Particular Specifications which shall take precedence.
- B. The Contractor shall arrange witness by the representatives of the Employer and Engineer, one person each during the shop test and inspection to be conducted in accordance with t.12 of Section 11000 of the Standard Specifications, for which the Contractor shall allow for bearing and paying the travelling expenses (i.e., round air fares from the home place to the destination, inland transport expenses, and accommodation charges during the travel) for the Employer's and Engineer's persons attending to the respective shop test and inspection in his tender price .

Equipment requiring witness by the Employer's and Engineer's representatives in shop tests and inspections are listed below:

**PS11.02 EQUIPMENT REQUIREMENTS FOR PUMPING STATIONS****M01. Equipment for Pumping Stations**

- A. There are 17 pumping stations (PSs) to be constructed, consisting of the construction of eight (8) new PSs; rehabilitation of five (5) existing PSs; and reconstruction of four (4) existing PSs. The mechanical components of the PSs shall consist of equipment listed in (a) below.
- B. The Contractor shall force the manufacturer of the proposed Submersible Sewage Pumps to conduct surge analysis on the force main on the basis of data of rotating element, characteristic of reflux valve and force main to ensure if moment of inertia of the rotating elements has to be increased or not. If the moment of inertia has to be increased, a flywheel shall be added. The magnitude of flywheel and detailed construction of the plummer block shall be proposed by the pump manufacturer for the Engineer's approval along with report of surge analysis. For this purpose, the Contractor shall be responsible to check and ensure the route plan and section of the Contract Drawings; provided, however, that the Contractor shall not entertain to claim any additional costs over the unit rates quoted for the relevant pumps in the Bill of Quantities.
- C. Coating and painting for equipment shall comply with the requirements specified in Section 11000 of the Standard Specifications.
- D. The Contractor shall also take the following measures in consideration of particular conditions that the PSs are located at the coastal areas...
  - (1) To make special painting in consideration of the conditions that equipment are installed nearby the sea
  - (2) To make the following special measures for corrosion protection of pumps:
    - a. Upgrading of materials for main parts such as impeller, shaft, foundation bolts and nuts, and guide pipes.
    - b. To equip sacrificial electrode on pump casing.



(3) FRP cover shall be lock type

E. List of equipment to be installed in PSs

M01-01 Kanudi PS (New Construction)

M01-01-01/02	Lifting Pump 1	: 2 units
M01-01-03	Monorail Hoist Unit	: 1 lot
M01-01-04	Piping	: 1 lot
M01-01-05	Steel Works	: 1 lot

M01-02 Idubada PS (New Construction)

M01-02-01/02	Lifting Pump 2	: 2 units
M01-02-03	Monorail Hoist Unit	: 1 lot
M01-02-04	Piping	: 1 lot
M01-02-05	Steel Works	: 1 lot

M01-03 Hagara PS (New Construction)

M01-03-01/02	Lifting Pump 3	: 2 units
M01-03-03	Monorail Hoist Unit	: 1 lot
M01-03-04	Piping	: 1 lot
M01-03-05	Steel Works	: 1 lot

M01-04 Hanuabada PS (New Construction)

M01-04-01/02	Lifting Pump 4	: 2 units
M01-04-03	Monorail Hoist Unit	: 1 lot
M01-04-04	Piping	: 1 lot
M01-04-05	Steel Works	: 1 lot

M01-05 Konedobu PS (Reconstruction)

M01-05-01/04	Lifting Pump 5	: 4 units
M01-05-05/07	Delivery Valve	: 3 units
M01-05-08	Monorail Hoist Unit	: 1 lot
M01-05-09	Piping	: 1 lot
M01-05-10	Steel Works	: 1 lot

M01-06 Old Yacht Club PS (Rehabilitation)

M01-06-01/02	Lifting Pump 6	: 2 units
M01-06-03	Monorail Hoist Unit	: 1 lot
M01-06-04	Piping	: 1 lot
M01-06-05	Steel Works	: 1 lot
M01-06-06	Dismantlement Works	: 1 lot

M01-07 Stanley Esplanade PS (Rehabilitation)

M01-07-01/02	Lifting Pump 7	: 2 units
M01-07-03	Monorail Hoist Unit	: 1 lot
M01-07-04	Piping	: 1 lot
M01-07-05	Steel Works	: 1 lot
M01-07-06	Dismantlement Works	: 1 lot

M01-08 Sea Park PS (Rehabilitation)		
M01-08-01/02	Lifting Pump 8	: 2 units
M01-08-03	Monorail Hoist Unit	: 1 lot
M01-08-04	Piping	: 1 lot
M01-08-05	Steel Works	: 1 lot
M01-08-06	Dismantlement Works	: 1 lot
M01-09 Davara PS (Rehabilitation)		
M01-09-01/04	Lifting Pump 9	: 4 units
M01-09-05/07	Delivery Valve	: 3 units
M01-09-08	Monorail Hoist Unit	: 1 lot
M01-09-09	Piping	: 1 lot
M01-09-10	Steel Works	: 1 lot
M01-09-11	Dismantlement Works	: 1 lot
M01-10 Lawes Road PS (Reconstruction)		
M01-10-01/04	Lifting Pump 10	: 4 units
M01-10-05/07	Delivery Valve	: 3 units
M01-10-08	Monorail Hoist Unit	: 1 lot
M01-10-09	Piping	: 1 lot
M01-10-10	Steel Works	: 1 lot
M01-11 Koki PS (Reconstruction)		
M01-11-01/02	Lifting Pump 11	: 2 units
M01-11-03	Monorail Hoist Unit	: 1 lot
M01-11-04	Piping	: 1 lot
M01-11-05	Steel Works	: 1 lot
M01-12 Badili PS (Rehabilitation)		
M01-12-01/04	Lifting Pump 12	: 4 units
M01-12-05	Monorail Hoist Unit	: 1 lot
M01-12-06	Piping	: 1 lot
M01-12-07	Steel Works	: 1 lot
M01-12-08	Dismantlement Works	: 1 lot
M01-13 Kila Police PS (New Construction)		
M01-13-01/02	Lifting Pump 13	: 2 units
M01-13-03	Monorail Hoist Unit	: 1 lot
M01-13-04	Piping	: 1 lot
M01-13-05	Steel Works	: 1 lot
M01-14 Konebada PS (New Construction)		
M01-14-01/02	Lifting Pump 14	: 2 units
M01-14-03	Monorail Hoist Unit	: 1 lot
M01-14-04	Piping	: 1 lot
M01-14-05	Steel Works	: 1 lot

M01-15 Gabutu PS (New Construction)

M01-15-01/02	Lifting Pump 15	: 2 units
M01-15-03	Monorail Hoist Unit	: 1 lot
M01-15-04	Piping	: 1 lot
M01-15-05	Steel Works	: 1 lot

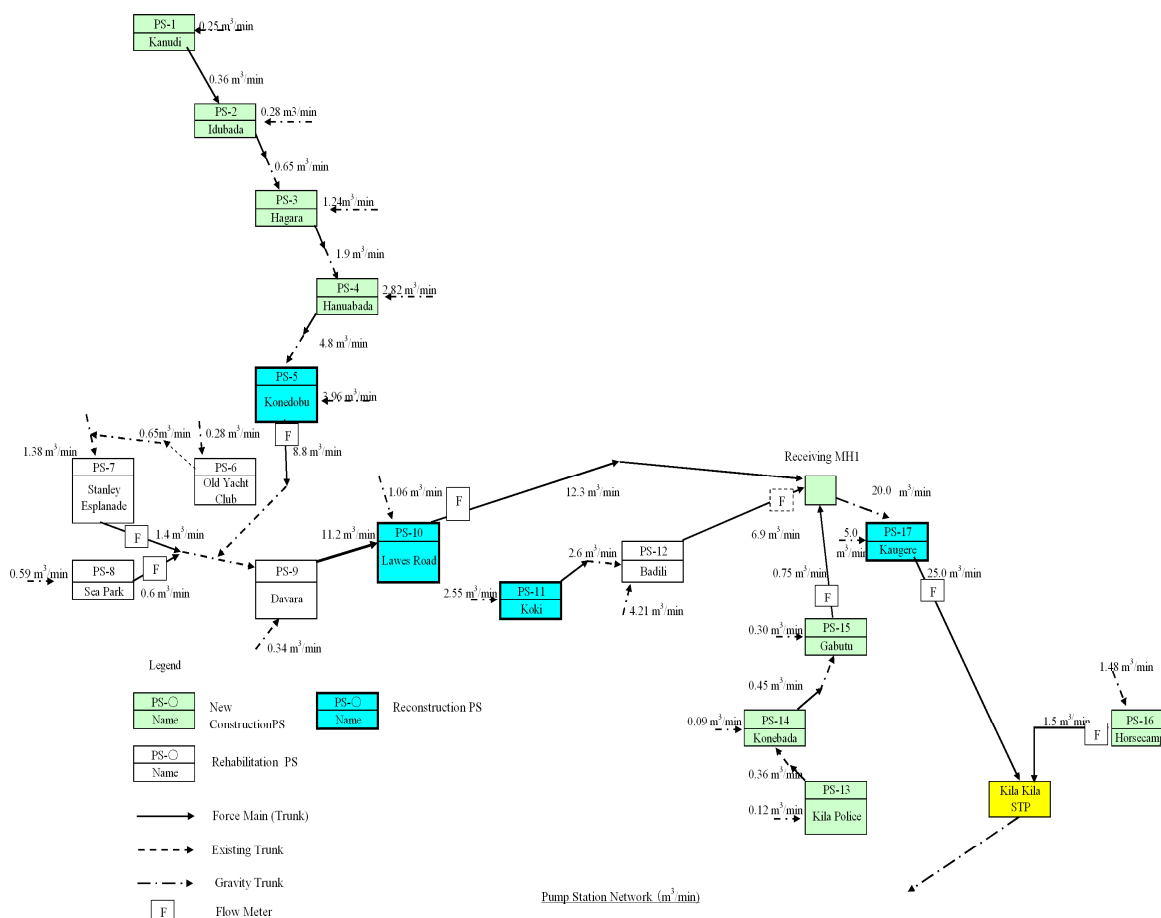
M01-16 Horsecamp PS (New Construction)

M01-16-01/02	Lifting Pump 16	: 2 units
M01-16-03	Monorail Hoist Unit	: 1 lot
M01-16-04	Piping	: 1 lot
M01-16-05	Steel Works	: 1 lot

M01-17 Kaugere PS (Reconstruction)

M01-17-01/04	Lifting Pump 17	: 4 units
M01-17-05/07	Delivery Valve	: 3 units
M01-17-08	Monorail Hoist Unit	: 1 lot
M01-17-09	Piping	: 1 lot
M01-17-10	Steel Works	: 1 lot
M01-17-11	Dismantlement Works	: 1 lot

F. The location and network of these PSs are illustrated below.



## G. Specifications of equipment to be installed in the respective PSs

**1. M01-01 Kanudi PS (New Construction)**

## (1) M01-01-01/02 Lifting Pump 1 (Refer to Section 11100 of Standard Specifications)

This pump shall be installed at the pump pit to lift up inlet sewage. A final capacity of flywheel shall be determined by the Contractor.

---

Type	: Submersible Sewage Pump (Non-clog type)
Quantity	: 2 units
Bore diameter	: Dia. 100 mm
Discharge flow	: 6 L/S
Total head	: 14 m
Motor output	: 5.5 kW
Power source	: 415 V × 50 Hz × 3 phase (Less than 1500 rpm)
Design pit depth	: 3.9 m
Flange	: ISO PN 10
Flywheel	: WR <sup>2</sup> more than 2.0 Nm <sup>2</sup>
Installation	: Outdoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 68
Insulation	: Class F
Others	: Equipped with pump removal unit and guide pipes

---

## (2) M01-01-03 Monorail Hoist Unit (Refer to Section 11190 of Standard Specifications)

This chain block shall be used for carry-in, carry-out, installation, assembly, maintenance, and check of the pump and basket.

---

Type	: Geared Trolley Chain Block
Quantity	: 1 lot
Rated load	: 0.5 Ton/ unit × 2 units
Lift	: More than 3.0 m
Others	: Equipped with two I beams and Steel Columns (Refer to the Contract Drawing)

---

Accessory: Guide pipes for basket x 1set

## (3) M01-01-04 Piping (Refer to Section 11000 of Standard Specifications)

The piping work shall include the piping systems as shown in the following table. The sizes and materials shall be as indicated in the Contract Drawings, and all piping systems shall comply with the requirements of Section 11000 of the Standard Specifications.

The piping shall include all necessary pipes, support, valves, expansion joints, insulations and necessary appurtenances, and shall be designed, furnished, installed, tested and adjusted by the Contractor.

(Piping system)

No	Piping Name	Diameter	Material	Scope of Works	
				From	To
1	Sewerage force main piping	100 mm	DIP	Lifting Pump	PE force main out of valve pit (Refer to the contract drawing)

(Major item with related to piping system)

No	Major item	Diameter (mm)	Flange	Quantity	Others
1	Gate Valve	100	ISO PN 10	2 units	
2	Check Valve	100	ISO PN 10	2 units	
3	Flexible Pipe	100	ISO PN 10	3 units	Eccentricity 200mm

(4) M01-01-05 Steel Works (Refer to Section 11000 of Standard Specifications)

This steel works shall include all necessary steel works for the maintenance of the plant such as FRP covers, manholes, stages, walkways, handrails, steps, ladders, etc., not necessarily limited to those given in the Drawings, which shall be designed, furnished, installed and adjusted by the Contractor.

No	Major item	Material	Quantity
1	Cover of Pump Pit	FRP	1 lot (Refer to the contract drawing)
2	Cover of Valve pit	FRP	1 lot (Refer to the contract drawing)

**2. M01-02 Idubada PS (New Construction)**

(1) M01-02-01/02 Lifting Pump 2 (Refer to Section 11100 of Standard Specifications)

This pump shall be installed at the pump pit to lift up inlet sewage. A final capacity of flywheel shall be determined by the Contractor.

---

Type	: Submersible Sewage Pump (Non-clog type)
Quantity	: 2 units
Bore diameter	: Dia. 100 mm
Discharge flow	: 10.8 L/S
Total head	: 40 m
Motor output	: 22 kW
Power source	: 415 V × 50 Hz × 3 phase (Less than 1500 rpm)
Design pit depth	: 7.0 m
Flange	: ISO PN 10
Flywheel	: WR <sup>2</sup> more than 15 Nm <sup>2</sup>
Installation	: Outdoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 68
Insulation	: Class F
Others	: Equipped with pump removal unit and guide pipes

---

(2) M01-02-03 Monorail Hoist Unit (Refer to Section 11190 of Standard Specifications)

This chain block shall be used for carry-in, carry-out, installation, assembly, maintenance, and check of the pump and basket.

---

Type	: Geared Trolley Chain Block
Quantity	: 1 lot
Rated load	: 0.5 Ton/ unit, 1.0Ton/ unit
Lift	: More than 3.0 m
Others	: Equipped with two I beams and Steel Columns (Refer to the Contract Drawing)

---

Accessory: Guide pipes for basket x 1set

(3) M01-02-04 Piping (Refer to Section 11000 of Standard Specifications)

The piping work shall include the piping systems as shown in the following table. The sizes and materials shall be as indicated in the Contract Drawings, and all piping systems shall comply with the requirements of Section 11000 of the Standard Specifications.

The piping work shall include all necessary pipes, support, valves, expansion joints, insulations and necessary appurtenances, and shall be designed, furnished, installed, tested and adjusted by the Contractor.

(Piping system)

No	Piping Name	Diameter	Material	Scope of Works	
				From	To
1	Sewerage force main piping	100 mm	DIP	Lifting Pump	PE force main out of valve pit (Refer to the contract drawing)

(Major item with related to piping system)

No	Major item	Diameter (mm)	Flange	Quantity	Others
1	Gate Valve	100	ISO PN 10	2 units	
2	Check Valve	100	ISO PN 10	2 units	
3	Flexible Pipe	100	ISO PN 10	3 units	Eccentricity 200mm

(4) M01-01-05 Steel Works (Refer to Section 11000)

This steel works shall include all necessary steel works for the maintenance of the plant such as FRP covers, manholes, stages, walkways, handrails, steps, ladders, etc., not necessarily limited to those given in the Drawings, which shall be designed, furnished, installed and adjusted by the Contractor.

No	Major item	Material	Quantity
1	Cover of Pump Pit	FRP	1 lot (Refer to the contract drawing)
2	Cover of Valve pit	FRP	1 lot (Refer to the contract drawing)

**3. M01-03 Hagara PS (New Construction)**

(1) M01-03-01/02 Lifting Pump 3 (Refer to Section 11100 of Standard Specifications)

This pump shall be installed at the pump pit to lift up inlet sewage. A final capacity of flywheel shall be determined by the Contractor.

---

Type	: Submersible Sewage Pump (Non-clog type)
Quantity	: 2 units
Bore diameter	: Dia.100 mm
Discharge flow	: 31.6 L/S
Total head	: 25 m
Motor output	: 22 kW
Power source	: 415 V × 50 Hz × 3 phase (Less than 1500 rpm)
Design pit depth	: 6.8 m
Flange	: ISO PN 10
Flywheel	: WR <sup>2</sup> more than 6.2 Nm <sup>2</sup>
Installation	: Outdoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 68
Insulation	: Class F
Others	: Equipped with pump removal unit and guide pipes

---

(2) M01-03-03 Monorail Hoist Unit (Refer to Section 11190 of Standard Specifications)

This chain block shall be used for carry-in, carry-out, installation, assembly, maintenance, and check of the pump and basket.

---

Type	: Geared Trolley Chain Block
Quantity	: 1 lot
Rated load	: 0.5 Ton/ unit, 1.0 Ton/ unit
Lift	: More than 3.0 m
Others	: Equipped with two I beams and Steel Columns (Refer to the Contract Drawing)

---

Accessory: Guide pipes for basket x 1set

(3) M01-03-04 Piping (Refer to Section 11000 of Standard Specifications)

The piping work shall include the piping systems as shown in the following table. The sizes and materials shall be as indicated in the Contract Drawings, and all piping systems shall comply with the requirements of Section 11000 of the Standard Specifications.

The piping shall include all necessary pipes, support, valves, expansion joints, insulations and necessary appurtenances, and shall be designed, furnished, installed, tested and adjusted by the Contractor.

(Piping system)

No	Piping Name	Diameter	Material	Scope of Works	
				From	To

1	Sewerage force main piping	100 mm	DIP	Lifting Pump	PE force main out of valve pit (Refer to the contract drawing)
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(Major item with related to piping system)

No	Major item	Diameter (mm)	Flange	Quantity	Others
1	Gate Valve	100	ISO PN 10	2 units	
2	Check Valve	100	ISO PN 10	2 units	
3	Flexible Pipe	100	ISO PN 10	3 units	Eccentricity 200mm

(4) M01-03-05 Steel Works (Refer to Section 11000 of Standard Specifications)

This steel works shall include all necessary steel works for the maintenance of the plant such as FRP covers, manholes, stages, walkways, handrails, steps, ladders, etc., not necessarily limited to those given in the Drawings, which shall be designed, furnished, installed and adjusted by the Contractor.

No	Major item	Material	Quantity
1	Cover of Pump Pit	FRP	1 lot (Refer to the contract drawing)
2	Cover of Valve pit	FRP	1 lot (Refer to the contract drawing)

**4. M01-04 Hanuabada PS (New Construction)**

(1) M01-04-01/02 Lifting Pump 4 (Refer to Section 11100 of Standard Specifications)

This pump shall be installed at the pump pit to lift up inlet sewage. A final capacity of flywheel shall be determined by the Contractor.

---

Type	: Submersible Sewage Pump (Non-clog type)
Quantity	: 2 units
Bore diameter	: Dia.200 mm
Discharge flow	: 80 L/S
Total head	: 17 m
Motor output	: 22 kW
Power source	: 415 V × 50 Hz × 3 phase (Less than 1500 rpm)
Design pit depth	: 8.05 m
Flange	: ISO PN 10
Flywheel	: WR <sup>2</sup> more than 20 Nm <sup>2</sup>
Installation	: Outdoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 68
Insulation	: Class F
Others	: Equipped with pump removal unit and guide pipes

---

(2) M01-04-03 Monorail Hoist Unit (Refer to Section 11190 of Standard Specifications)

This chain block shall be used for carry-in, carry-out, installation, assembly, maintenance, and check of the pump and basket.



Type	: Geared Trolley Chain Block
Quantity	: 1 lot
Rated load	: 0.5 Ton/ unit, 2.0 Ton/ unit
Lift	: More than 3.0 m
Others	: Equipped with two I beams and Steel Columns (Refer to the Contract Drawing)

Accessory: Guide pipes for basket x 1set

(3) M01-04-04 Piping (Refer to Section 11000 of Standard Specifications)

The piping work shall include the piping systems as shown in the following table. The sizes and materials shall be as indicated in the Contract Drawings, and all piping systems shall comply with the requirements of Section 11000 of the Standard Specifications.

The piping shall include all necessary pipes, support, valves, expansion joints, insulations and necessary appurtenances, and shall be designed, furnished, installed, tested and adjusted by the Contractor.

(Piping system)

No	Piping Name	Diameter	Material	Scope of Works	
				From	To
1	Sewerage force main piping	200 300	DIP	Lifting Pump	PE force main out of valve pit (Refer to the contract drawing)

(Major item with related to piping system)

No	Major item	Diameter (mm)	Flange	Quantity	Others
1	Gate Valve	200	ISO PN 10	2 units	
2	Check Valve	200	ISO PN 10	2 units	
3	Flexible Pipe	200 300	ISO PN 10	2 units 1 unit	Eccentricity 200mm

(4) M01-04-05 Steel Works (Refer to Section 11000 of Standard Specifications)

This steel works shall include all necessary steel works for the maintenance of the plant such as FRP covers, manholes, stages, walkways, handrails, steps, ladders, etc., not necessarily limited to those given in the Drawings, which shall be designed, furnished, installed and adjusted by the Contractor.

No	Major item	Material	Quantity
1	Cover of Pump Pit	FRP	1 lot (Refer to the contract drawing)
2	Cover of Valve pit	FRP	1 lot (Refer to the contract drawing)

**5. M01-05 Konedobu PS (Reconstruction)**

## (1) M01-05-01/04 Lifting Pump 5 (Refer to Section 11100 of Specifications)

This pump shall be installed at the pump pit to lift up inlet sewage. A final capacity of flywheel shall be determined by the Contractor.

---

Type	: Submersible Sewage Pump (Non-clog type)
Quantity	: 3 units and 1 unit as stock
Bore diameter	: Dia.200 mm
Discharge flow	: 73.3 L/S
Total head	: 42 m
Motor output	: 55 kW
Power source	: 415 V × 50 Hz × 3phase (Less than 1500 rpm)
Design pit depth	: 9.7 m
Flange	: ISO PN 10
Flywheel	: WR <sup>2</sup> more than 37 Nm <sup>2</sup>
Installation	: Outdoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 68
Insulation	: Class F
Others	: Equipped with pump removal unit and guide pipes

---

## (2) M01-05-05/07 Delivery Valve (Refer to Section 11121 of Standard Specifications)

This valve shall be installed at the outlet of the pump pit to control sewage flow.

---

Type	: Motorized Driven Gate Valve
Quantity	: 3 units
Bore Diameter	: Dia.200 mm
Flange	: ISO PN 10
Installation	: Outdoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 55
Insulation	: Class F
Others	: Equipped with control panel

---

## (3) M01-05-08 Monorail Hoist Unit (Refer to Section 11190 of Standard Specifications)

This chain block shall be used for carry-in, carry-out, installation, assembly, maintenance, and check of the pump and basket.

---

Type	: Geared Trolley Chain Block
Quantity	: 1 lot
Rated load	: 0.5 Ton/ unit, 2.5 Ton/ unit
Lift	: More than 3.0 m
Others	: Equipped with two I beams and Steel Columns (Refer to the Contract Drawing)

---

Accessory: Guide pipes for basket x 1set

## (4) M01-05-09 Piping (Refer to Section 11000 of Standard Specifications)

The piping work shall include the piping systems as shown in the following table. The sizes and materials shall be as indicated in the Contract Drawings, and all piping systems shall comply with the requirements of Section 11000 of the Standard Specifications.

The piping shall include all necessary pipes, support, valves, expansion joints, insulations and necessary appurtenances, and shall be designed, furnished, installed, tested and adjusted by the Contractor.

(Piping system)

No	Piping Name	Diameter (mm)	Material	Scope of Works	
				From	To
1	Sewerage force main piping	200 300 400	DIP	Lifting Pump	PE force main out of generator house (Refer to the contract drawing)

(Major item with related to piping system)

No	Major item	Diameter (mm)	Flange	Quantity	Others
1	Gate Valve	200 300	ISO PN 10	3 units 3 units	
2	Check Valve	200	ISO PN 10	3 units	
3	Flexible Pipe	400	ISO PN 10	2 units	Eccentricity 200mm
4	Automatic Air Release Valve	75	ISO PN 10	1 unit	
5	Air Release Valve Unit	32	ISO PN 10	1 set	(Refer to the contract drawing)

(5) M01-05-10 Steel Works (Refer to Section 11000 of Standard Specifications)

This steel works shall include all necessary steel works for the maintenance of the plant such as FRP covers, manholes, stages, walkways, handrails, steps, ladders, etc., not necessarily limited to those given in the Drawings, which shall be designed, furnished, installed and adjusted by the Contractor.

No	Major item	Material	Quantity
1	Cover of Pump Pit	FRP	1 lot (Refer to the contract drawing)

## 6. M01-06 Old Yacht Club PS (Rehabilitation)

(1) M01-06-01/02 Lifting Pump 6 (Refer to Section 11100 of Standard Specifications)

This pump shall be installed at the pump pit to lift up inlet sewage. A final capacity of flywheel shall be determined by the Contractor.

---

Type	: Submersible Sewage Pump (Non-clog type)
Quantity	: 2 units
Bore diameter	: Dia.100 mm
Discharge flow	: 10.8 L/S

Total head	: 17 m
Motor output	: 5.5 kW
Power source	: 415 V × 50 Hz × 3 phase (Less than 1500 rpm)
Design pit depth	: 3.02 m
Flange	: ISO PN 10
Installation	: Outdoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 68
Insulation	: Class F
Others	: Equipped with pump removal unit and guide pipes

## (2) M01-06-03 Monorail Hoist Unit (Refer to Section 11190)

This chain block shall be used for carry-in, carry-out, installation, assembly, maintenance, and check of the pump.

Type	: Geared Trolley Chain Block
Quantity	: 1 lot
Rated load	: 0.5 Ton/ unit
Lift	: More than 3.0 m
Others	: Equipped with I beams and Steel Columns (Refer to the Contract Drawing)

## (3) M01-06-04 Piping (Refer to Section 11000 of Standard Specifications)

The piping work shall include the piping systems as shown in the following table. The sizes and materials shall be as indicated in the Contract Drawings, and all piping systems shall comply with the requirements of Section 11000 of the Standard Specifications.

The piping shall include all necessary pipes, support, valves, expansion joints, insulations and necessary appurtenances, and shall be designed, furnished, installed, tested and adjusted by the Contractor.

(Piping system)

No	Piping Name	Diameter	Material	Scope of Works	
				From	To
1	Sewerage force main piping	100 150	DIP	Lifting Pump	PE force main out of valve pit (Refer to the contract drawing)

(Major item with related to piping system)

No	Major item	Diameter (mm)	Flange	Quantity	Others
1	Gate Valve	100	ISO PN 10	2 units	
2	Check Valve	100	ISO PN 10	2 units	
3	Flexible Pipe	100 150	ISO PN 10	2 units 1 unit	Eccentricity 200mm

## (4) M01-06-05 Steel Works (Refer to Section 11000 of Standard Specifications)

This steel works shall include all necessary steel works for the maintenance of the plant such as FRP covers, manholes, stages, walkways, handrails, steps, ladders, etc., not necessarily limited to those given in the Drawings, which shall be designed, furnished, installed and adjusted by the Contractor.

No	Major item	Material	Quantity
1	Cover of Pump Pit	FRP	1 lot (Refer to the contract drawing)
2	Cover of Valve pit	FRP	1 lot (Refer to the contract drawing)

## (5) M01-06-06 Dismantlement Works (Refer to Section 11000 of Standard Specifications)

No	Major item	Material	Quantity
1	Sewerage force main piping Set	DIP	1 lot (Refer to the contract drawing)
2	Cover of Valve pit	Steel	1 lot (Refer to the contract drawing)

**7. M01-07 Stanley Esplanade PS (Rehabilitation)**

## (1) M01-07-01/02 Lifting Pump 7 (Refer to Section 11100)

This pump shall be installed at the pump pit to lift up inlet sewage. A final capacity of flywheel shall be determined by the Contractor.

---

Type	: Submersible Sewage Pump (Non-clog type)
Quantity	: 2 units
Bore diameter	: Dia. 100 mm
Discharge flow	: 23.3 L/S
Total head	: 24 m
Motor output	: 15 kW
Power source	: 415 V × 50 Hz × 3 phase (Less than 1500 rpm)
Design pit depth	: 5.05 m
Flange	: ISO PN 10
Flywheel	: WR <sup>2</sup> more than 5 Nm <sup>2</sup>
Installation	: Outdoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 68
Insulation	: Class F
Others	: Equipped with pump removal unit and guide pipes

---

## (2) M01-07-03 Monorail Hoist Unit (Refer to Section 11190 of Standard Specifications)

This chain block shall be used for carry-in, carry-out, installation, assembly, maintenance, and check of the pump.

---

Type	: Geared Trolley Chain Block
Quantity	: 1 lot
Rated load	: 1.0 Ton/ unit
Lift	: More than 3.0 m
Others	: Equipped with I beam and Steel Columns (Refer to the Contract Drawing)

(3) M01-07-04 Piping (Refer to Section 11000 of Standard Specifications)

The piping work shall include the piping systems as shown in the following table. The sizes and materials shall be as indicated in the Contract Drawings, and all piping systems shall comply with the requirements of Section 11000 of the Standard Specifications.

The piping shall include all necessary pipes, support, valves, expansion joints, insulations and necessary appurtenances, and shall be designed, furnished, installed, tested and adjusted by the Contractor.

(Piping system)

No	Piping Name	Diameter (mm)	Material	Scope of Works	
				From	To
1	Sewerage force main piping	100	DIP	Lifting Pump	PE force main out of generator house (Refer to the contract drawing)

(Major item with related to piping system)

No	Major item	Diameter (mm)	Flange	Quantity	Others
1	Gate Valve	100	ISO PN 10	5 units	
2	Check Valve	100	ISO PN 10	2 units	
3	Flexible Pipe	100	ISO PN 10	4 units	Eccentricity 200mm
4	Automatic Air Release Valve	75	ISO PN 10	1 unit	
5	Air Release Valve Unit	32	ISO PN 10	1 set	(Refer to the contract drawing)

(4) M01-07-05 Steel Works (Refer to Section 11000 of Standard Specifications)

This steel works shall include all necessary steel works for the maintenance of the plant such as FRP covers, manholes, stages, walkways, handrails, steps, ladders, etc., not necessarily limited to those given in the Drawings, which shall be designed, furnished, installed and adjusted by the Contractor.

No	Major item	Material	Quantity
1	Cover of Pump Pit	FRP	1 lot (Refer to the contract drawing)
2	Cover of Valve pit	FRP	1 lot (Refer to the contract drawing)

(5) M01-07-06 Dismantlement Works (Refer to Section 11000 of Standard

Specifications)

No	Major item	Material	Quantity
1	Sewerage force main piping Set	DIP	1 lot (Refer to the contract drawing)
2	Cover of Valve pit	Steel	1 lot (Refer to the contract drawing)

### 8. M01-08 Sea Park PS (Rehabilitation)

#### (1) M01-08-01/02 Lifting Pump 8 (Refer to Section 11100 of Standard Specifications)

This pump shall be installed at the pump pit to lift up inlet sewage. A final capacity of flywheel shall be determined by the Contractor.

---

Type	: Submersible Sewage Pump (Non-clog type)
Quantity	: 2 units
Bore diameter	: Dia.100 mm
Discharge flow	: 10 L/S
Total head	: 24 m
Motor output	: 7.5 kW
Power source	: 415 V × 50 Hz × 3 phase (Less than 1500 rpm)
Design pit depth	: 6.04 m
Flange	: ISO PN 10
Flywheel	: WR <sup>2</sup> more than 4.5 Nm <sup>2</sup>
Installation	: Outdoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 68
Insulation	: Class F
Others	: Equipped with pump removal unit and guide pipes

---

#### (2) M01-08-03 Monorail Hoist Unit (Refer to Section 11190 of Standard Specifications)

This chain block shall be used for carry-in, carry-out, installation, assembly, maintenance, and check of the pump.

---

Type	: Geared Trolley Chain Block
Quantity	: 1 lot
Rated load	: 0.5 Ton/ unit
Lift	: More than 3.0 m
Others	: Equipped with I beam (Refer to the Contract Drawing)

---

#### (3) M01-08-04 Piping (Refer to Section 11000 of Standard Specifications)

The piping work shall include the piping systems as shown in the following table. The sizes and materials shall be as indicated in the Contract Drawings, and all piping systems shall comply with the requirements of Section 11000 of the Standard Specifications.

The piping shall include all necessary pipes, support, valves, expansion joints,

insulations and necessary appurtenances, and shall be designed, furnished, installed, tested and adjusted by the Contractor.

(Piping system)

No	Piping Name	Diameter (mm)	Material	Scope of Works	
				From	To
1	Sewerage force main piping	100	DIP	Lifting Pump	PE force main out of valve pit (Refer to the contract drawing)

(Major item with related to piping system)

No	Major item	Diameter (mm)	Flange	Quantity	Others
1	Gate Valve	100	ISO PN 10	5 units	
2	Check Valve	100	ISO PN 10	2 units	
3	Flexible Pipe	100	ISO PN 10	3 units	Eccentricity 200mm
4	Automatic Air Release Valve	75	ISO PN 10	1 unit	
5	Air Release Valve Unit	32	ISO PN 10	1 set	(Refer to the contract drawing)

(4) M01-08-05 Steel Works (Refer to Section 11000 of Standard Specifications)

This steel works shall include all necessary steel works for the maintenance of the plant such as FRP covers, manholes, stages, walkways, handrails, steps, ladders, etc., not necessarily limited to those given in the Drawings, which shall be designed, furnished, installed and adjusted by the Contractor.

No	Major item	Material	Quantity
1	Cover of Pump Pit	FRP	1 lot (Refer to the contract drawing)
2	Cover of Valve pit	FRP	1 lot (Refer to the contract drawing)

(5) M01-08-06 Dismantlement Works (Refer to Section 11000 of Standard Specifications)

No	Major item	Material	Quantity
1	Sewerage force main piping Set	DIP	1 lot (Refer to the contract drawing)
2	Cover of Valve pit	Steel	1 lot (Refer to the contract drawing)

## 9. M01-09 Davara PS (Rehabilitation)

(1) M01-09-01/04 Lifting Pump 9 (Refer to Section 11100 of Standard Specifications)

This pump shall be installed at the pump pit to lift up inlet sewage



Type	: Submersible Sewage Pump (Non-clog type)
Quantity	: 3 units and 1 unit as stock
Bore diameter	: Dia.200 mm
Discharge flow	: 93.3 L/S
Total head	: 11 m
Motor output	: 15 kW
Power source	: 415 V × 50 Hz × 3 phase (Less than 1500 rpm)
Design pit depth	: 4.68 m
Flange	: ISO PN 10
Installation	: Outdoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 68
Insulation	: Class F
Others	: Equipped with pump removal unit and guide pipes

(2) M01-09-05 Monorail Hoist Unit (Refer to Section 11190 of Standard Specifications)

This chain block shall be used for carry-in, carry-out, installation, assembly, maintenance, and check of the pump.

Type	: Geared Trolley Chain Block
Quantity	: 1 lot
Rated load	: 1.0 Ton/ unit
Lift	: More than 3.0 m
Others	: Equipped with I beam and Steel Columns (Refer to the Contract Drawing)

(3) M01-09-06 Piping (Refer to Section 11000 of Standard Specifications)

The piping work shall include the piping systems as shown in the following table. The sizes and materials shall be as indicated in the Contract Drawings, and all piping systems shall comply with the requirements of Section 11000 of the Standard Specifications.

The piping shall include all necessary pipes, support, valves, expansion joints, insulations and necessary appurtenances, and shall be designed, furnished, installed, tested and adjusted by the Contractor.

(Piping system)

No	Piping Name	Diameter	Material	Scope of Works	
				From	To
1	Sewerage force main piping	200 350	DIP	Lifting Pump	PE force main out of valve pit (Refer to the contract drawing)

(Major item with related to piping system)

No	Major item	Diameter (mm)	Flange	Quantity	Others
1	Gate Valve	200	ISO PN 10	3 units	
2	Check Valve	200	ISO PN 10	3 units	

3	Flexible Pipe	200 350	ISO PN 10	3 units 1 unit	Eccentricity 200mm
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## (4) M01-09-07 Steel Works (Refer to Section 11000 of Standard Specifications)

This steel works shall include all necessary steel works for the maintenance of the plant such as FRP covers, manholes, stages, walkways, handrails, steps, ladders, etc., not necessarily limited to those given in the Drawings, which shall be designed, furnished, installed and adjusted by the Contractor.

No	Major item	Material	Quantity
1	Cover of Pump Pit	FRP	1 lot (Refer to the contract drawing)
2	Cover of Valve pit	FRP	1 lot (Refer to the contract drawing)

## (5) M01-09-08 Dismantlement Works (Refer to Section 11000 of Standard Specifications)

No	Major item	Material	Quantity
1	Sewerage force main piping Set	DIP	1 lot (Refer to the contract drawing)
2	Cover of Valve pit	Steel	1 lot (Refer to the contract drawing)

**10. M01-10 Lawes Road PS (Reconstruction)**

## (1) M01-10-01/04 Lifting Pump 10 (Refer to Section 11100 of Standard Specifications)

This pump shall be installed at the pump pit to lift up inlet sewage. A final capacity of flywheel shall be determined by the Contractor.

---

Type	: Submersible Sewage Pump (Non-clog type)
Quantity	: 3 units and 1 unit as stock
Bore diameter	: Dia.250 mm
Discharge flow	: 103.3 L/S
Total head	: 42 m
Motor output	: 75 kW
Power source	: 415 V × 50 Hz × 3 phase (Less than 1500 rpm)
Design pit depth	: 8.5 m
Flange	: ISO PN 10
Surge Tank	: Approx. 20 m <sup>3</sup> Closed Surge Tank equipped with two Compressors
Installation	: Outdoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 68
Insulation	: Class F
Others	: Equipped with pump removal unit and guide pipes

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## (2) M01-10-05/07 Delivery Valve (Refer to Section 11121 of Standard Specifications)

This valve shall be installed at the outlet of the pump pit to control sewage flow.

---

Type	: Motorized Driven Gate Valve
Quantity	: 3 units
Bore Diameter	: Dia.200 mm
Flange	: ISO PN 10
Installation	: Outdoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 55
Insulation	: Class F
Others	: Equipped with control panel

---

(3) M01-10-08 Monorail Hoist Unit (Refer to Section 11190 of Standard Specifications)

This chain block shall be used for carry-in, carry-out, installation, assembly, maintenance, and check of the pump and basket.

---

Type	: Geared Trolley Chain Block
Quantity	: 1 lot
Rated load	: 0.5 Ton/ unit, 2.5 Ton/ unit
Lift	: More than 3.0 m
Others	: Equipped with two I beams and Steel Columns (Refer to the Contract Drawing)

---

Accessory: Guide pipes for basket x 1set

(4) M01-10-09 Piping (Refer to Section 11000 of Standard Specifications)

The piping work shall include the piping systems as shown in the following table. The sizes and materials shall be as indicated in the Contract Drawings, and all piping systems shall comply with the requirements of Section 11000 of the Standard Specifications.

The piping shall include all necessary pipes, support, valves, expansion joints, insulations and necessary appurtenances, and shall be designed, furnished, installed, tested and adjusted by the Contractor.

(Piping system)

No	Piping Name	Diameter (mm)	Material	Scope of Works	
				From	To
1	Sewerage force main piping	200 300 350 450	DIP	Lifting Pump	PE force main out of generator house (Refer to the contract drawing)

(Major item with related to piping system)

No	Major item	Diameter (mm)	Flange	Quantity	Others
1	Gate Valve	200 300 350	ISO PN 10	3 units 1 unit 3 units	

2	Check Valve	200	ISO PN 10	3 units	
3	Flexible Pipe	450	ISO PN 10	2 units	Eccentricity 200mm
4	Automatic Air Release Valve	75	ISO PN 10	1 unit	
5	Air Release Valve Unit	32	ISO PN 10	1 set	(Refer to the contract drawing)
6	Surge Tank Unit	-	ISO PN 10	1 set	One 20m <sup>3</sup> Tank, two compressors (5.5 kW/ unit × 2units), and connection pipe set (Refer to the contract drawing)

## (5) M01-10-10 Steel Works (Refer to Section 11000 of Standard Specifications)

This steel works shall include all necessary steel works for the maintenance of the plant such as FRP covers, manholes, stages, walkways, handrails, steps, ladders, etc., not necessarily limited to those given in the Drawings, which shall be designed, furnished, installed and adjusted by the Contractor.

No	Major item	Material	Quantity
1	Cover of Pump Pit	FRP	1 lot (Refer to the contract drawing)

**11. M01-11 Koki PS (Reconstruction)**

## (1) M01-11-01/02 Lifting Pump 11 (Refer to Section 11100 of Standard Specifications)

This pump shall be installed at the pump pit to lift up inlet sewage.

---

Type	: Submersible Sewage Pump (Non-clog type)
Quantity	: 2 units
Bore diameter	: Dia.200 mm
Discharge flow	: 43.3 L/S
Total head	: 31 m
Motor output	: 37 kW
Power source	: 415 V × 50 Hz × 3 phase (Less than 1500 rpm)
Design pit depth	: 5.8 m
Flange	: ISO PN 10
Installation	: Outdoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 68
Insulation	: Class F
Others	: Equipped with pump removal unit and guide pipes

---

## (2) M01-11-03 Monorail Hoist Unit (Refer to Section 11190 of Standard Specifications)

This chain block shall be used for carry-in, carry-out, installation, assembly, maintenance, and check of the pump and basket.

---

Type	: Geared Trolley Chain Block
Quantity	: 1 lot
Rated load	: 0.5 Ton/ unit, 1.5 Ton/ unit

Lift	: More than 3.0 m
Others	: Equipped with two I beams and Steel Columns (Refer to the Contract Drawing)

---

Accessory: Guide pipes for basket x 1set

(3) M01-11-04 Piping (Refer to Section 11000 of Standard Specifications)

The piping work shall include the piping systems as shown in the following table. The sizes and materials shall be as indicated in the Contract Drawings, and all piping systems shall comply with the requirements of Section 11000 of the Standard Specifications.

The piping shall include all necessary pipes, support, valves, expansion joints, insulations and necessary appurtenances, and shall be designed, furnished, installed, tested and adjusted by the Contractor.

(Piping system)

No	Piping Name	Diameter	Material	Scope of Works	
				From	To
1	Sewerage force main piping	200	DIP	Lifting Pump	PE force main out of valve pit (Refer to the contract drawing)

(Major item with related to piping system)

No	Major item	Diameter (mm)	Flange	Quantity	Others
1	Gate Valve	200	ISO PN 10	2 units	
2	Check Valve	200	ISO PN 10	2 units	
3	Flexible Pipe	200	ISO PN 10	3 units	Eccentricity 200mm

(4) M01-11-05 Steel Works (Refer to Section 11000 of Standard Specifications)

This steel works shall include all necessary steel works for the maintenance of the plant such as FRP covers, manholes, stages, walkways, handrails, steps, ladders, etc., not necessarily limited to those given in the Drawings, which shall be designed, furnished, installed and adjusted by the Contractor.

No	Major item	Material	Quantity
1	Cover of Pump Pit	FRP	1 lot (Refer to the contract drawing)
2	Cover of Valve pit	FRP	1 lot (Refer to the contract drawing)

## 12. M01-12 Badili PS (Rehabilitation)

(1) M01-12-01/04 Lifting Pump 12 (Refer to Section 11100 of Standard Specifications)

This pump shall be installed at the pump pit to lift up inlet sewage. A final capacity of flywheel shall be determined by the Contractor.

---

Type	: Submersible Sewage Pump (Non-clog type)
Quantity	: 3 units and 1 unit as stock
Bore diameter	: Dia.200 mm
Discharge flow	: 58.3 L/S
Total head	: 33 m
Motor output	: 45 kW
Power source	: 415 V × 50 Hz × 3 phase (Less than 1500 rpm)
Design pit depth	: 5.45 m
Flange	: ISO PN 10
Flywheel	: WR <sup>2</sup> more than 45 Nm <sup>2</sup>
Installation	: Outdoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 68
Insulation	: Class F
Others	: Equipped with pump removal unit and guide pipes

(2) M01-12-05 Monorail Hoist Unit (Refer to Section 11190 of Standard Specifications)

This chain block shall be used for carry-in, carry-out, installation, assembly, maintenance, and check of the pump.

Type	: Geared Trolley Chain Block
Quantity	: 1 lot
Rated load	: 2.5 Ton/ unit
Lift	: More than 3.0 m
Others	: Equipped with I beam and Steel Columns (Refer to the Contract Drawing)

(3) M01-12-06 Piping (Refer to Section 11000 of Standard Specifications)

The piping work shall include the piping systems as shown in the following table. The sizes and materials shall be as indicated in the Contract Drawings, and all piping systems shall comply with the requirements of Section 11000 of the Standard Specifications.

The piping shall include all necessary pipes, support, valves, expansion joints, insulations and necessary appurtenances, and shall be designed, furnished, installed, tested and adjusted by the Contractor.

(Piping system)

No	Piping Name	Diameter	Material	Scope of Works	
				From	To
1	Sewerage force main piping	200 350	DIP	Lifting Pump	PE force main out of valve pit (Refer to the contract drawing)

(Major item with related to piping system)

No	Major item	Diameter (mm)	Flange	Quantity	Others
1	Gate Valve	200	ISO PN 10	2 units	

2	Check Valve	200	ISO PN 10	2 units	
3	Flexible Pipe	350	ISO PN 10	1 unit	Eccentricity 200mm

(4) M01-12-07 Steel Works (Refer to Section 11000 of Standard Specifications)

This steel works shall include all necessary steel works for the maintenance of the plant such as FRP covers, manholes, stages, walkways, handrails, steps, ladders, etc., not necessarily limited to those given in the Drawings, which shall be designed, furnished, installed and adjusted by the Contractor.

No	Major item	Material	Quantity
1	Cover of Pump Pit	FRP	1 lot (Refer to the contract drawing)
2	Cover of Valve pit	FRP	1 lot (Refer to the contract drawing)

(5) M01-12-08 Dismantlement Works (Refer to Section 11000 of Standard Specifications)

No	Major item	Material	Quantity
1	Sewerage force main piping Set	DIP	1 lot (Refer to the contract drawing)
2	Cover of Valve pit	Steel	1 lot (Refer to the contract drawing)

### 13. M01-13 Kila Police PS (New Construction)

(1) M01-13-01/02 Lifting Pump 13 (Refer to Section 11100 of Standard Specifications)

This pump shall be installed at the pump pit to lift up inlet sewage.

---

Type	: Submersible Sewage Pump (Non-clog type)
Quantity	: 2 units
Bore diameter	: Dia. 100 mm
Discharge flow	: 6.0 L/S
Total head	: 20 m
Motor output	: 5.5 kW
Power source	: 415 V × 50 Hz × 3 phase (Less than 1500 rpm)
Design pit depth	: 4.5 m
Flange	: ISO PN 10
Installation	: Outdoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 68
Insulation	: Class F
Others	: Equipped with pump removal unit and guide pipes

---

(2) M01-13-03 Monorail Hoist Unit (Refer to Section 11190 of Standard Specifications)

This chain block shall be used for carry-in, carry-out, installation, assembly, maintenance, and check of the pump and basket.

Type	: Geared Trolley Chain Block
Quantity	: 1 lot
Rated load	: 0.5 Ton/ unit × 2 units
Lift	: More than 3.0 m
Others	: Equipped with two I beams and Steel Columns (Refer to the Contract Drawing)

---

Accessory: Guide pipes for basket x 1set

(3) M01-13-04 Piping (Refer to Section 11000 of Standard Specifications)

The piping work shall include the piping systems as shown in the following table. The sizes and materials shall be as indicated in the Contract Drawings, and all piping systems shall comply with the requirements of Section 11000 of the Standard Specifications.

The piping shall include all necessary pipes, support, valves, expansion joints, insulations and necessary appurtenances, and shall be designed, furnished, installed, tested and adjusted by the Contractor.

(Piping system)

No	Piping Name	Diameter	Material	Scope of Works	
				From	To
1	Sewerage force main piping	100	DIP	Lifting Pump	PE force main out of valve pit (Refer to the contract drawing)

(Major item with related to piping system)

No	Major item	Diameter (mm)	Flange	Quantity	Others
1	Gate Valve	100	ISO PN 10	2 units	
2	Check Valve	100	ISO PN 10	2 units	
3	Flexible Pipe	100	ISO PN 10	3 units	Eccentricity 200mm

(4) M01-13-05 Steel Works (Refer to Section 11000 of Standard Specifications)

This steel works shall include all necessary steel works for the maintenance of the plant such as FRP covers, manholes, stages, walkways, handrails, steps, ladders, etc., not necessarily limited to those given in the Drawings, which shall be designed, furnished, installed and adjusted by the Contractor.

No	Major item	Material	Quantity
1	Cover of Pump Pit	FRP	1 lot (Refer to the contract drawing)
2	Cover of Valve pit	FRP	1 lot (Refer to the contract drawing)

#### 14. M01-14 Konebada PS (New Construction)

(1) M01-14-01/02 Lifting Pump 14 (Refer to Section 11100 of Standard Specifications)



This pump shall be installed at the pump pit to lift up inlet sewage. A final capacity of flywheel shall be determined by the Contractor.

---

Type	: Submersible Sewage Pump (Non-clog type)
Quantity	: 2 units
Bore diameter	: Dia. 100 mm
Discharge flow	: 7.5 L/S
Total head	: 24 m
Motor output	: 7.5 kW
Power source	: 415 V × 50 Hz × 3 phase (Less than 1500 rpm)
Design pit depth	: 6.0 m
Flange	: ISO PN 10
Flywheel	: WR <sup>2</sup> more than 1.5 Nm <sup>2</sup>
Installation	: Outdoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 68
Insulation	: Class F
Others	: Equipped with pump removal unit and guide pipes

---

(2) M01-14-03 Monorail Hoist Unit (Refer to Section 11190 of Standard Specifications)

This chain block shall be used for carry-in, carry-out, installation, assembly, maintenance, and check of the pump and basket.

---

Type	: Geared Trolley Chain Block
Quantity	: 1 lot
Rated load	: 0.5 Ton/unit × 2 units
Lift	: More than 3.0 m
Others	: Equipped with two I beams and Steel Columns (Refer to the Contract Drawing)

---

Accessory: Guide pipes for basket x 1set

(3) M01-14-04 Piping (Refer to Section 11000 of Standard Specifications)

The piping work shall include the piping systems as shown in the following table. The sizes and materials shall be as indicated in the Contract Drawings, and all piping systems shall comply with the requirements of Section 11000 of the Standard Specifications.

The piping shall include all necessary pipes, support, valves, expansion joints, insulations and necessary appurtenances, and shall be designed, furnished, installed, tested and adjusted by the Contractor.

(Piping system)

No	Piping Name	Diameter	Material	Scope of Works	
				From	To
1	Sewerage force main piping	100	DIP	Lifting Pump	PE force main out of valve pit (Refer to the contract drawing)

(Major item with related to piping system)

No	Major item	Diameter (mm)	Flange	Quantity	Others
1	Gate Valve	100	ISO PN 10	2 units	
2	Check Valve	100	ISO PN 10	2 units	
3	Flexible Pipe	100	ISO PN 10	3 units	Eccentricity 200mm

(4) M01-14-05 Steel Works (Refer to Section 11000 of Standard Specifications)

This steel works shall include all necessary steel works for the maintenance of the plant such as FRP covers, manholes, stages, walkways, handrails, steps, ladders, etc., not necessarily limited to those given in the Drawings, which shall be designed, furnished, installed and adjusted by the Contractor.

No	Major item	Material	Quantity
1	Cover of Pump Pit	FRP	1 lot (Refer to the contract drawing)
2	Cover of Valve pit	FRP	1 lot (Refer to the contract drawing)

**15. M01-15 Gabutu PS (New Construction)**

(1) M01-15-01/02 Lifting Pump 15 (Refer to Section 11100 of Standard Specifications)

This pump shall be installed at the pump pit to lift up inlet sewage.

---

Type	: Submersible Sewage Pump (Non-clog type)
Quantity	: 2 units
Bore diameter	: Dia.100 mm
Discharge flow	: 12.5 L/S
Total head	: 43 m
Motor output	: 22 kW
Power source	: 415 V × 50 Hz × 3 phase (Less than 1500 rpm)
Design pit depth	: 6.1 m
Flange	: ISO PN 10
Flywheel	: WR <sup>2</sup> more than 25 Nm <sup>2</sup>
Installation	: Outdoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 68
Insulation	: Class F
Others	: Equipped with pump removal unit and guide pipes

---

(2) M01-15-03 Monorail Hoist Unit (Refer to Section 11190 of Standard Specifications)

This chain block shall be used for carry-in, carry-out, installation, assembly, maintenance, and check of the pump and basket.

---

Type	: Geared Trolley Chain Block
Quantity	: 1 lot
Rated load	: 0.5 Ton/ unit, 1.0 Ton/ unit

---

Lift	: More than 3.0 m
Others	: Equipped with two I beams and Steel Columns (Refer to the Contract Drawing)

---

Accessory: Guide pipes for basket x 1set

(3) M01-15-04 Piping (Refer to Section 11000 of Standard Specifications)

The piping work shall include the piping systems as shown in the following table. The sizes and materials shall be as indicated in the Contract Drawings, and all piping systems shall comply with the requirements of Section 11000 of the Standard Specifications.

The piping shall include all necessary pipes, support, valves, expansion joints, insulations and necessary appurtenances, and shall be designed, furnished, installed, tested and adjusted by the Contractor.

(Piping system)

No	Piping Name	Diameter (mm)	Material	Scope of Works	
				From	To
1	Sewerage force main piping	100	DIP	Lifting Pump	PE force main out of generator house (Refer to the contract drawing)

(Major item with related to piping system)

No	Major item	Diameter (mm)	Flange	Quantity	Others
1	Gate Valve	100	ISO PN 10	5 units	
2	Check Valve	100	ISO PN 10	2 units	
3	Flexible Pipe	100	ISO PN 10	2 units	Eccentricity 200mm
4	Automatic Air Release Valve	75	ISO PN 10	1 unit	
5	Air Release Valve Unit	32	ISO PN 10	1 set	(Refer to the contract drawing)

(4) M01-15-05 Steel Works (Refer to Section 11000 of Standard Specifications)

This steel works shall include all necessary steel works for the maintenance of the plant such as FRP covers, manholes, stages, walkways, handrails, steps, ladders, etc., not necessarily limited to those given in the Drawings, which shall be designed, furnished, installed and adjusted by the Contractor.

No	Major item	Material	Quantity
1	Cover of Pump Pit	FRP	1 lot (Refer to the contract drawing)

## 16. M01-16 Horsecamp PS (New Construction)

(1) M01-16-01/02 Lifting Pump 16 (Refer to Section 11100 of Standard Specifications)

This pump shall be installed at the pump pit to lift up inlet sewage

Type	: Submersible Sewage Pump (Non-clog type)
Quantity	: 2 units
Bore diameter	: Dia.100 mm
Discharge flow	: 25 L/S
Total head	: 21 m
Motor output	: 11 kW
Power source	: 415 V × 50 Hz × 3 phase (Less than 1500 rpm)
Design pit depth	: 6.1 m
Flange	: ISO PN 10
Installation	: Outdoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 68
Insulation	: Class F
Others	: Equipped with pump removal unit and guide pipes

(2) M01-16-03 Monorail Hoist Unit (Refer to Section 11190 of Standard Specifications)

This chain block shall be used for carry-in, carry-out, installation, assembly, maintenance, and check of the pump and basket.

Type	: Geared Trolley Chain Block
Quantity	: 1 lot
Rated load	: 0.5 Ton/ unit × 2 units
Lift	: More than 3.0 m
Others	: Equipped with two I beams and Steel Columns (Refer to the Contract Drawing)

Accessory: Guide pipes for basket x 1set

(3) M01-16-04 Piping (Refer to Section 11000 of Standard Specifications)

The piping work shall include the piping systems as shown in the following table. The sizes and materials shall be as indicated in the Contract Drawings, and all piping systems shall comply with the requirements of Section 11000 of the Standard Specifications.

The piping shall include all necessary pipes, support, valves, expansion joints, insulations and necessary appurtenances, and shall be designed, furnished, installed, tested and adjusted by the Contractor.

(Piping system)

No	Piping Name	Diameter (mm)	Material	Scope of Works	
				From	To
1	Sewerage force main piping	100	DIP	Lifting Pump	PE force main out of generator house (Refer to the contract drawing)

(Major item with related to piping system)

No	Major item	Diameter (mm)	Flange	Quantity	Others
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1	Gate Valve	100	ISO PN 10	5 units	
2	Check Valve	100	ISO PN 10	2 units	
3	Flexible Pipe	100	ISO PN 10	2 units	Eccentricity 200mm
4	Automatic Air Release Valve	75	ISO PN 10	1 unit	
5	Air Release Valve Unit	32	ISO PN 10	1 set	(Refer to the contract drawing)

(4) M01-16-05 Steel Works (Refer to Section 11000 of Standard Specifications)

This steel works shall include all necessary steel works for the maintenance of the plant such as FRP covers, manholes, stages, walkways, handrails, steps, ladders, etc., not necessarily limited to those given in the Drawings, which shall be designed, furnished, installed and adjusted by the Contractor.

No	Major item	Material	Quantity
1	Cover of Pump Pit	FRP	1 lot (Refer to the contract drawing)

**17. M01-17 Kaugere PS (New Construction)**

(1) M01-17-01/04 Lifting Pump 17 (Refer to Section 11100 of Standard Specifications)

This pump shall be installed at the pump pit to lift up inlet sewage. A final capacity of flywheel shall be determined by the Contractor

---

Type	: Submersible Sewage Pump (Non-clog type)
Quantity	: 3 units and 1 unit as stock
Bore diameter	: Dia.350 mm
Discharge flow	: 208.3 L/S
Total head	: 15 m
Motor output	: 55 kW
Power source	: 415 V × 50 Hz × 3 phase (Less than 1500 rpm)
Design pit depth	: 8.7 m
Flange	: ISO PN 10
Flywheel	: WR <sup>2</sup> more than 50 Nm <sup>2</sup> in case of 1000 rpm : Without Flywheel in case of 1500 rpm
Installation	: Outdoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 68
Insulation	: Class F
Others	: Vibration pen × 2 sets, Infrared thermometer × 2sets, equipped with pump removal unit and guide pipes

---

(2) M01-17-05/07 Delivery Valve (Refer to Section 11121 of Standard Specifications)

This valve shall be installed at the outlet of the pump pit to control sewage flow.

---

Type	: Motorized Driven Gate Valve
Quantity	: 3 units

Bore Diameter	: Dia.300 mm
Flange	: ISO PN 10
Installation	: Outdoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 55
Insulation	: Class F
Others	: Equipped with control panel

## (3) M01-17-08 Monorail Hoist Unit (Refer to Section 11190 of Standard Specifications)

This chain block shall be used for carry-in, carry-out, installation, assembly, maintenance, and check of the pump and basket.

Type	: Geared Trolley Chain Block
Quantity	: 1 lot
Rated load	: 0.5 Ton/ unit, 2.5Ton/ unit
Lift	: More than 3.0 m
Others	: Equipped with two I beams and Steel Columns (Refer to the Contract Drawing)

Accessory: Guide pipes for basket x 1set

## (4) M01-17-09 Piping (Refer to Section 11000 of Standard Specifications)

The piping work shall include the piping systems as shown in the following table. The sizes and materials shall be as indicated in the Contract Drawings, and all piping systems shall comply with the requirements of Section 11000 of the Standard Specifications.

The piping shall include all necessary pipes, support, valves, expansion joints, insulations and necessary appurtenances, and shall be designed, furnished, installed, tested and adjusted by the Contractor.

(Piping system)

No	Piping Name	Diameter (mm)	Material	Scope of Works	
				From	To
1	Sewerage force main piping	300 400	DIP	Lifting Pump	PE force main out of generator house (Refer to the contract drawing)

(Major item with related to piping system)

No	Major item	Diameter (mm)	Flange	Quantity	Others
1	Gate Valve	300 400	ISO PN 10	3 units 3 units	
2	Check Valve	300	ISO PN 10	3 units	
3	Flexible Pipe	400	ISO PN 10	2 units	Eccentricity 200mm
4	Automatic Air Release Valve	75	ISO PN 10	1 unit	
5	Air Release Valve Unit	32	ISO PN 10	1 set	(Refer to the contract drawing)

## (5) M01-17-10 Steel Works (Refer to Section 11000 of Standard Specifications)

This steel works shall include all necessary steel works for the maintenance of the plant such as FRP covers, manholes, stages, walkways, handrails, steps, ladders, etc., not necessarily limited to those given in the Drawings, which shall be designed, furnished, installed and adjusted by the Contractor.

No	Major item	Material	Quantity
1	Cover of Pump Pit	FRP	1 lot (Refer to the contract drawing)

## (6) M01-17-11 Dismantlement Works (Refer to Section 11000 of Standard Specifications)

No	Major item	Material	Quantity
1	Sewerage force main piping Set	DIP	1 lot (Refer to the contract drawing)
2	Cover of Valve pit	Steel	1 lot (Refer to the contract drawing)

### PS11.03 EQUIPMENT REQUIREMENTS FOR SEWAGE TREATMENT PLANT (STP)

#### M02. Grit Chamber Facility

- A. The vortex type of grit chamber shall be installed. The mechanical components of the grit chamber facility shall consist of the following equipment. Details of each equipment shall be designed using the following conditions and in accordance with the specification set forth hereinafter in this section.
- B. Coating and painting for equipment shall comply with the requirements of Section 11000 of the Standard Specifications.
- C. The Contractor shall take the following measures in consideration of particular conditions that STP is located in the coastal area.
- To make special painting in consideration of the conditions that equipment are installed nearby the sea

#### D. Equipment List of Grit Chamber Facility

M02-01-01/02	Grit Chamber Inlet Gate	: 2 units
M02-02-01/02	Medium Screen	: 2 units
M02-03-01/02	Grit Collector	: 2 units
M02-04-01/02	Grit Pump	: 2 units
M02-05-01/02	Sump Drain Pump	: 2 units
M02-06	Grit Separator	: 1 unit
M02-07	Oil Skimmer	: 1 unit
M02-08-01/02	Oil Discharge Pump	: 2 units
M02-09	Scum Screen	: 1 unit
M02-10	Conveyor	: 1 unit
M02-11-01/02	Coarse Screen	: 2 units
M02-12	Bypass Gate	: 1 unit
M02-13	Grit Chamber Outlet Weir	: 1 unit
M02-14	Piping	: 1 lot

M02-15 Steel Works : 1 lot

E. Design Condition

Flow Rate

(Ultimate)

- Hourly maximum : 36,800 m<sup>3</sup>/ day (18,400 m<sup>3</sup>/ day /channel)

F. Specification of equipment to be installed in the Grit Chamber

**1. M02-01-01/02 Grit Chamber Inlet Gate** (Refer to Section 11140 of Standard Specifications)

This gate shall be installed at the inlet of the grit chamber and shall be capable of sealing and controlling incoming sewage.

---

Type	: Manually Operated Cast Iron Gate
Quantity	: 2 units
Dimension	: W 500 mm x H 750 mm
Design water depth	: 2.45 m (bottom to floor)
Installation	: Outdoor

---

**2. M02-02-01/02 Medium Screen** (Refer to Section 11220 of Standard Specifications)

Screen shall be installed at the inlet of the grit chamber, and shall be capable of removing screenings in incoming sewage.

[Inclined shaft type]

---

Type	: Automatic Drum Screen
Quantity	: 2 units
Flow rate	: More than 36,800 m <sup>3</sup> / day/ unit
Drum Diameter	: Dia. 1.4 m
Opening	: 20 mm
Motor output	: 2.2 kW
Power source	: 415 V × 50 Hz × 3 phase
Installation	: Outdoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 55
Insulation	: Class F

---

Accessory: Chute x 1set

**3. M02-03-01/02 Grit Collector** (Refer to Section 11242 of Standard Specifications)

Grit collector shall be installed on the bottom of the grit chamber and shall be used for collecting sand deposited in a pit for grit chamber.

---

Type	: Vortex Type
Quantity	: 2 units
Dimension	: Dia. 1,600 mm
Motor output	: 0.75 kW
Power source	: 415 V × 50 Hz × 3 phase

---



Others	: Equipped with pressure nozzles
Installation	: Outdoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 55
Insulation	: Class F
Others	: Equipped with jet nozzle unit

---

4. **M02-04-01/02 Grit Pump** (Refer to Section 11103 of Standard Specifications)

Grit pump shall be installed at the pump pit of the grit chamber to remove the deposited sand to the grit separator.

---

Type	: Centrifugal Sludge Pump (Non-clog type)
Quantity	: 2 units
Suction bore diameter	: Dia.80 mm
Discharge flow	: 0.5 m <sup>3</sup> / min
Total head	: 7 m
Motor output	: 2.2 kW
Power source	: 415 V × 50 Hz × 3 phase
Installation	: Indoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 44
Insulation	: Class F
Impeller	: HCrFC or SCS13 or equivalent

---

5. **M02-05-01/02 Sump Drain Pump** (Refer to Section 11100 of Standard Specifications)

This pump shall be used to lift up the drain collected from the floor drain pit to the grit chamber.

---

Type	: Submersible Sludge Pump (Non-clog type)
Quantity	: 2 units
Discharge bore diameter	: Dia.80 mm
Discharge flow	: 0.3 m <sup>3</sup> / min
Total head	: 6 m
Motor output	: 1.5 kW
Power source	: 415 V × 50 Hz × 3 phase
Installation	: Indoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 68
Insulation	: Class F
Others	: Equipped with pump removal unit, guide pipes, and lifting device

---

6. **M02-06 Grit Separator** (Refer to Section 11250 and 11610 of Standard Specifications)

Grit separator shall be installed at the outlet of the grit removal pump and shall be used for separating deposited sand and returning separated liquid to the grit chamber.

---

Type	: Screw Grit Conveyor (Compact type)
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Quantity	: 1 unit
Discharge flow from grit pump	: 0.5 m <sup>3</sup> / min
Motor output	: 0.75 kW
Power source	: 415 V × 50 Hz × 3 phase
Others	: Container 0.5 m <sup>3</sup> / unit x 4 units
Installation	: Outdoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 55
Insulation	: Class F

---

Accessory: Chute x 1set

**7. M02-07 Oil Skimmer** (Refer to Section 11620 of Standard Specifications)

The oil skimmer shall be used to separate oil and grease generated on the water surface in the distribution tank of grit chamber.

---

Type	: Manually Operated Slot Skimmer
Quantity	: 1 unit
Dimension	: Dia.200 mm x L 4.2 m
Installation	: Outdoor

**8. M02-08-01/02 Oil Discharge Pump** (Refer to Section 11101 of Standard Specifications)

This pump shall be installed in the oil drain pit and shall be used to transfer oil drain to the sand bed of the grit chamber.

---

Type	: Submersible Sludge Pump
Quantity	: 2 units
Discharge bore diameter	: Dia.65 mm
Discharge flow	: 0.2 m <sup>3</sup> / min
Total head	: 6 m
Motor output	: 0.75 kW
Power source	: 415 V × 50 Hz × 3 phase
Installation	: Outdoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 68
Insulation	: Class F
Others	: Equipped with pump removal unit and guide pipes

**9. M02-09 Scum Screen** (Refer to Section 11221 and 11610 of Standard Specifications)

The scum screen shall be installed on the slab for grit chamber and shall be used to divide scum and sewage water.

---

Type	: Automatic Drum Screen (Wedge wire)
Quantity	: 1 unit
Flow Rate	: 0.5 m <sup>3</sup> / min
Opening	: Less than 2 mm
Motor output	: 0.4 kW
Power source	: 415 V × 50 Hz × 3 phase

Others	: Container 0.1 m <sup>3</sup> / unit x 2 units
Installation	: Outdoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 55
Insulation	: Class F

---

Accessory: Chute x 1set

**10. M02-10 Screenings Conveyor** (Refer to Section 11172 and 11610 of Standard Specifications)

The screenings conveyor shall be installed for conveying screenings to the screenings container for grit chamber.

---

Type	: Shaft -less Screw Conveyor
Quantity	: 1 unit
Dimensions	: Dia.200 mm x Approx. L 5.5 m
Motor output	: 2.2 kW
Power source	: 415 V × 50 Hz × 3 phase
Others	: Container 0.5 m <sup>3</sup> / unit × 4 units
Installation	: Outdoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 55
Insulation	: Class F

---

Accessory: Chute x 1set

**11. M02-11-01/02 Coarse Screen** (Refer to Section 11223 and 11610 of Standard Specifications)

The screen shall be installed at the sewage inlet channel and shall be used to protect the fine screen.

---

Type	: Manually Operated Bar Screen
Quantity	: 2 units
Flow rate	: 36,800 m <sup>3</sup> / day/ unit
Dimensions	: W 1.6 m × H 2.45 m
Opening	: 100 mm
Others	: Container 0.1 m <sup>3</sup> / unit × 2 units
Installation	: Outdoor

**12. M02-12 Bypass Gate** (Refer to Section 11140 of Standard Specifications)

This gate shall be installed at the inlet of the grit chamber and shall be capable of sealing and controlling incoming sewage.

---

Type	: Manually Operated Cast Iron Gate
Quantity	: 1 unit
Dimension	: W 500 mm × H 500 mm
Design water depth	: 2.45 m (bottom to floor)
Installation	: Outdoor

---

**13. M02-13 Grit Chamber Outlet Weir** (Refer to Section 11150 of Standard Specifications)

This weir shall be used for effluent weir of the grit chamber outlet waterway.

---

Type	: Fixed Weir Plate
Quantity	: 1 unit
Dimension	: W 1.5 m
Weir type	: Rectangular (FRP)
Installation	: Outdoor

---

**14. M02-14 Piping** (Refer to Section 11000 of Standard Specifications)

The piping work shall include the piping systems as shown in the following table. The sizes and materials shall be as indicated in the Contract Drawings, and all piping systems shall comply with the requirements of Section 11000 of the Standard Specifications.

The piping shall include all necessary pipes, support, valves, expansion joints, insulations and necessary appurtenances, and shall be designed, furnished, installed, tested and adjusted by the Contractor.

(Piping system)

No	Piping Name	Diameter (mm)	Material	Scope of Works	
				From	To
1	Grit suction and transfer piping	100 80	SS SS	Vortex Chamber Grit Pump	Grit Pump Grit Separator
2	Grit separator drainage piping	150	DIP	Grit Separator	Grit Chamber
3	Oil transfer piping	65 75	SS HDPE	Oil Discharge Pump	Sand bed and Scum Screen
4	Scum transfer piping	80	DIP	Scum Pump	Scum Screen
5	Scum drainage piping	150	DIP	Scum Screen	Grit Chamber
6	Sump Drain piping	80 90	SGPW HDPE	Sump Drain Pump	Grit Chamber
7	TE Utility Water piping	25 to 32 40 to 50 32 to 110	SS SGPW HDPE	Connection point of underground	Each equipment, grit pipe and sprinkler stop cocks, etc
8	Deodorization piping	125 to 300 355	FRP HDPE	Connection point of underground	Each equipment, Grit Chamber, etc
9	Waste water piping	200 225	DIP HDPE	Connection point of underground	Grit Chamber

(Major item with related to piping system)

No	Major item	Diameter (mm)	Flange	Quantity	Piping Name
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1	Gate Valve	80	ISO PN 10	2 units	Grit transfer piping Grit suction piping Grit separator drainage piping Oil transfer piping Scum transfer piping Scum drainage piping Sump drainage piping Utility water transfer piping
		100		3 units	
		150		2 units	
		65		4 units	
		100		1 unit	
		150		1 unit	
		80		2 units	
25 to 50	1 lot				
2	Check Valve	80	ISO PN 10	2 units	Grit transfer piping Oil transfer piping Sump drainage piping
		65		2 units	
		80		2 units	
3	Flexible Pipe and Damper	125	ISO PN 10	9 sets	Deodorization piping
4	Flexible Pipe	25 to 300	ISO PN 10		Connection point of underground pipe if necessary
5	Air Release Valve Unit	32	ISO PN 10	3 sets	(Refer to the contract drawing)

### 15. M02-015 Steel Works (Refer to Section 11000 of Standard Specifications)

This steel works shall include all necessary steel works for the maintenance of the plant such as FRP covers, manholes, stages, walkways, handrails, steps, ladders, etc., not necessarily limited to those given in the Drawings, which shall be designed, furnished, installed and adjusted by the Contractor. FRP cover shall be lock type.

No	Major item	Material	Quantity
1	Cover of Grit Chamber	FRP	1 lot (Refer to the contract drawing)

### M03. Distribution Chamber Facility

- A. The mechanical components of the Distribution Chamber shall consist of the following equipment. Details of each equipment shall be designed using the following conditions and in accordance with the specification set forth hereinafter in this section.
- B. Coating and painting for Weirs shall comply with the requirements of Section 11000 of the Standard Specifications.
- C. The Contractor shall take the following measures in consideration of particular conditions that STP is located in the coastal area.
- To make special painting in consideration of the conditions that equipment are installed nearby the sea

#### D. Equipment List of Distribution Chamber Facility

M03-01-01/04	Distribution Weir	: 4 units
M03-02	Piping	: 1 lot
M03-03	Steel Works	: 1 lot

#### E. Design Condition

Flow Rate (Ultimate) - Hourly maximum	: 36,800 m <sup>3</sup> / day
---	-------------------------------

#### F. Specification of equipment

**1. M03-01-01/04 Distribution Weir (Refer to Section 11151 of Standard Specifications)**

This adjustable weir shall be used for controlling the quantity of sewage flowing into the oxidation ditch tank.

---

Type	: Manually Operated Cast Iron Adjustable Weir
Quantity	: 4 units
Dimension	: W 800 mm × ST 400 mm
Design water depth	: 1.3 m
Installation	: Outdoor

---

**2. M03-02 Piping (Refer to Section 11000 of Standard Specifications)**

The piping work shall include the piping systems as shown in the following table. The sizes and materials shall be as indicated in the Contract Drawings, and all piping systems shall comply with the requirements of Section 11000 of the Standard Specifications.

The piping shall include all necessary pipes, support, valves, expansion joints, insulations and necessary appurtenances, and shall be designed, furnished, installed, tested and adjusted by the Contractor.

(Piping system)

No	Piping Name	Diameter (mm)	Material	Scope of Works	
				From	To
1	TE Utility Water piping	25 32	SS HDPE	Connection point of underground	sprinkler stop cocks
2	Deodorization piping	125 160	FRP HDPE	Connection point of underground	Distribution Chamber

(Major item with related to piping system)

No	Major item	Diameter (mm)	Flange	Quantity	Piping Name
1	Gate Valve	25	ISO PN 10	1 lot	Utility water transfer piping
2	Flexible Pipe and Damper	125	ISO PN 10	1 set	Deodorization piping

**3. M03-03 Steel Works (Refer to Section 11000)**

This steel works shall include all necessary steel works for the maintenance of the plant such as covers, manholes, stages, walkways, handrails, steps, ladders, etc., not necessarily limited to those given in the Drawings, which shall be designed, furnished, installed and adjusted by the Contractor. FRP cover shall be lock type.

No	Major item	Material	Quantity
1	Cover of Distribution Chamber	FRP	1 lot (Refer to the contract drawing)

**M04. Oxidation Ditch Facility**

- A. The mechanical components of the Oxidation Ditch Facility shall consist of the following equipment. Details of each equipment shall be designed using the following conditions and in accordance with the specification set forth hereinafter in this section.
- B. Coating and painting for Weirs shall comply with the requirements of Section 11000 of the Standard Specifications.
- C. The Contractor shall take the following measures in consideration of particular conditions that STP is located in the coastal area.
- To make special painting in consideration of the conditions that equipment are installed nearby the sea

D. Equipment List of Oxidation Ditch Facility

M04-01-01/03 Air Diffuser	: 3 lots
M04-02-01/12 Reactor Tank Mixer	: 12 units
M04-03-01/03 Outlet Gate	: 3 units
M04-04-01 Isolation Gate	: 1 unit
M04-05-01/05 Aeration Blower	: 5 units
M04-06-01/02 Hoist Block for Blower	: 2 units
M04-07-01/03 Air Supply Valve	: 3 units
M04-08-01/07 Waste Sludge Pump	: 7 units
M04-09 Piping	: 1 lot
M04-10 Steel Works	: 1 lot

E. Design Condition

Flow Rate

(Proposed)

- Daily average : 13,800 m<sup>3</sup>/ day
- Hourly maximum : 27,600 m<sup>3</sup>/ day

(Ultimate)

- Daily average : 18,400 m<sup>3</sup>/ day
- Hourly maximum : 36,800 m<sup>3</sup>/ day

Inlet Condition

- BOD : 190 mg/ L
- SS : 180 mg/ L
- MLSS : 3,000 mg/ L

F. Specification of equipment

**1. M04-01-01/03 Air Diffuser** (Refer to Section 11370 or 11371 of Standard Specifications)

This air diffuser shall be used for feeding oxidation for the sewage treatment in the oxidation ditch tank under aerobic condition.

---

Type	: Air Diffuser (Fine membrane)
Quantity	: 3 lots
Air flow	: 42 Sm <sup>3</sup> / min/ train (lot)
Oxygen dissolution	: More than 194.7 kg-O <sub>2</sub> / hr/ lot (SOR)
Oxygen Dissolutive Efficiency	: Not less than 30% (at 5m depth)

Water Depth	: 6.0 m (Design Water Depth of Diffuser: 5.7m)
Installation	: Outdoor
Others	: Equipped with removal unit, lifting chain, guide bar, flow meter 10sets/ lot, butterfly valve 10sets/ lot, riser pipe, and header pipe. Preventive countermeasure against clogging manually, Header pipe and riser pipe and support should be Stainless Steel 304.

---

**2. M04-02-01/12 Reactor Tank Mixer** (Refer to Section 11603 of Standard Specifications)

This mixer shall be used for making the mixing for the sewage treatment in the oxidation ditch tank under aerobic condition.

---

Type	: Submersible Propeller Mixer
Quantity	: 12 units
Tank volume	: Approx. 4,600m <sup>3</sup>
Propeller diameter	: Approx. 2.4 m
Motor output	: Approx. 2.3 kW
Power source	: 415 V × 50 Hz × 3 phase
Installation	: Outdoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 68
Insulation	: Class F
Others	: Equipped with guide bar and lifting device

---

**3. M04-03-01/03 Outlet Gate** (Refer to Section 11140 of Standard Specifications)

This gate shall be used for sealing the flow of effluent water from the oxidation ditch tank.

---

Type	: Manually Operated Cast Iron Gate
Quantity	: 3 units
Dimension	: W 500 mm × H 500 mm
Design water depth	: 4.1m (bottom to floor)
Installation	: Outdoor

---

**4. M04-04-01 Isolation Gate** (Refer to Section 11140 of Standard Specifications)

This gate shall be used for bypassing the flow of effluent water from the oxidation ditch tank.

---

Type	: Manually Operated Cast Iron Gate
Quantity	: 1 unit
Dimension	: W 500 mm × H 500 mm
Design water depth	: 4.1m (bottom to floor)
Installation	: Outdoor

---

**5. M04-05-01/05 Aeration Blower** (Refer to Section 11290 of Standard Specifications)



This blower shall be installed at the blower room.

---

Type	: Rotary type with air cooling
Quantity	: 5 units
Gas handled	: Air
Connection bore diameter	: Dia.200 mm
Air flow	: 42 m <sup>3</sup> / min/ unit (20 degrees C, 101.3kPa, 65%RH)
Pressure	: 70 kPa (20 degrees C, 65%RH)
Motor output	: 75 kW
Power source	: 415 V × 50 Hz × 3 phase
Installation	: Indoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 44
Insulation	: Class F
Others	: Equipped with check valve (inside of blower)

---

Accessory; - Silencer (each suction and discharge side), Air Filter (Flange type): 1set / unit

**6. M04-06-01/02 Hoist Block for Blower** (Refer to Section 11190 of Standard Specifications)

This chain block shall be used for carry-in, carry-out, installation, assembly, maintenance, and check of the blower and the materials necessary therefore.

---

Type	: Geared Trolley Chain Block
Quantity	: 2 units
Rated load	: 2 Ton
Lift	: 5.0 m
Installation	: Indoor

---

**7. M04-07-01/03 Air Supply Valve** (Refer to Section 11123 of Standard Specifications)

This valve shall be for control of aeration flow.

---

Type	: Motorized Driven Butterfly Valve
Quantity	: 3 units (1 unit is manual, 2 units are motorized)
Bore Diameter	: Dia.300 mm
Flange	: ISO PN 10
Motor output	: 0.2 kW
Power source	: 415 V × 50 Hz × 3 phase
Installation	: Outdoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 55
Insulation	: Class F
Others	: Equipped with two Control Panel, of which one unit to be motorized in future. Preventive countermeasure against maximum temperature.

---

**8. M04-08-01/07 Waste Sludge Pump** (Refer to Section 11101 of Standard Specifications)

This pump shall be used for transferring the waste sludge from the oxidation ditch into the sludge dewatering unit.

---

Type	: Submersible Sludge Pump
Quantity	: 6 units and 1 stock
Discharge bore diameter	: Dia. 100 mm
Discharge flow	: 1.1 m <sup>3</sup> / min
Total head	: 14 m
Motor output	: 5.5 kW
Power Source	: 415 V × 50 Hz × 3 phase
Installation	: Outdoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 68
Insulation	: Class F
Sump Level	: 2 m depth from bottom of oxidation ditch
Others	: Equipped with the base stand, guide pipes, guide bar, and lifting device

---

#### 9. M04-09 Piping (Refer to Section 11000 of Standard Specifications)

The piping work shall include the piping systems as shown in the following table. The sizes and materials shall be as indicated in the Contract Drawings, and all piping systems shall comply with the requirements of Section 11000 of the Standard Specifications.

The piping shall include all necessary pipes, support, valves, expansion joints, insulations and necessary appurtenances, and shall be designed, furnished, installed, tested and adjusted by the Contractor.

(Piping system)

No	Piping Name	Diameter (mm)	Material	Scope of Works	
				From	To
1	Air piping	80 to 300	SGPW	Blower	Air Diffuser
2	Waste sludge piping	100 160	DIP HDPE	Waste Sludge Pump	Connection point of underground
3	Return sludge piping	250 280	DIP HDPE	Connection point of underground	Discharge point of return sludge
4	Defoaming piping	50 to 100 110	SS HDPE	Connection point of underground	Spray nozzle
5	Drain water piping	32	SS	Each air pipe	Oxidation ditch
6	TE Utility Water piping	25 to 32 40 to 50 32 to 50	SS SGPW HDPE	Connection point of underground	sprinkler stop cocks

(Major item with related to piping system)

No	Major item	Diameter (mm)	Flange	Quantity	Piping Name
1	Gate Valve	200 100 25	ISO PN 10	5 units 6 units 1 lot	Air piping Waste sludge piping Utility water transfer piping
2	Check Valve	100	ISO PN 10	2 units	Waste sludge piping

3	Butterfly Valve	300 250	ISO PN 10	4 units 4 units	Air piping
4	Flexible Pipe	25 to 300	ISO PN 10	3 units 1 lot	Air piping, Connection point of underground pipe if necessary
5	Air Release Valve Unit	32	ISO PN 10	3 sets	Each header pipe of Waste Sludge Pump

#### 10. M04-10 Steel Works (Refer to Section 11000 of Standard Specifications)

This steel works shall include all necessary steel works for the maintenance of the plant such as FRP covers, manholes, stages, walkways, handrails, steps, ladders, etc., not necessarily limited to those given in the Drawings, which shall be designed, furnished, installed and adjusted by the Contractor. FRP cover shall be lock type.

No	Major item	Material	Quantity
1	Cover of Distribution Chamber	FRP	1 lot (Refer to the contract drawing)

#### M05. Clarifier Facility

- A. The mechanical components of the Clarifier Facility shall consist of the following equipment. Details of each equipment shall be designed using the following conditions and in accordance with the specification set forth hereinafter in this section.
- B. Coating and painting for Weirs shall comply with the requirements of Section 11000 of the Standard Specifications.
- C. The Contractor shall take the following measures in consideration of particular conditions that STP is located in the coastal area.
- To make special painting in consideration of the conditions that equipment are installed nearby the sea

#### D. Equipment List of Clarifier Facility

M05-01-01/03 Clarifier	: 3 units
M05-02-01/06 Return Sludge Pump	: 6 units
M05-03-01/02 Hoist Block for Sludge Pump	: 2 units
M05-04-01/04 Sump Drain Pump	: 4 units
M05-05-01/04 Scum Pump	: 4 units
M05-06 Piping	: 1 lot
M05-07 Steel Works	: 1 lot

#### E. Design Condition

Flow Rate (Proposed)	
- Daily average	: 13,800 m <sup>3</sup> / day
- Hourly maximum	: 27,600 m <sup>3</sup> / day
(Ultimate)	
- Daily average	: 18,400 m <sup>3</sup> / day
- Hourly maximum	: 36,800 m <sup>3</sup> / day

#### F. Specification of equipment

**1. M05-01-01/03 Clarifier** (Refer to Section 11333 of Standard Specifications)

This clarifier shall be used for scraping the sludge settled in the clarifier into the hopper provided by centre of the clarifier.

---

Type	: Centre Driven Column Type
Quantity	: 3 units
Tank Dimensions	: Dia.25 m × H 5 m × Side Water Depth 3.5 m
Scraping Speed	: (Perimeter speed) Approx. 1.5 to 2.5 m/ min
Motor Output	: 0.75 kW
Power Source	: 415 V × 50 Hz × 3 phase
Installation	: Outdoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 55
Insulation	: Class F

---

Note: This clarifier shall include the box scum skimmer, scum pipe, over flow weir, trough, walkway and stair.

**2. M05-02-01/06 Return Sludge Pump** (Refer to Section 11103 of Standard Specifications)

This pump shall be used for transferring the sludge from the clarifier hopper portion into the oxidation ditch tank.

---

Type	: Centrifugal Sludge Pump (Screw type)
Quantity	: 6 units
Suction bore diameter	: Dia.150 mm
Discharge flow	: 3.2 m <sup>3</sup> / min
Total head	: 9 m
Motor output	: 11 kW
Power Source	: 415 V × 50 Hz × 3 phase
Installation	: Indoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 44
Insulation	: Class F

---

**3. M05-03-01/02 Hoist Block for Sludge Pump** (Refer to Section 11190 of Standard Specifications)

This chain block shall be used for carry-in, carry-out, installation, assembly, maintenance, and check of the sludge pumps and the materials necessary therefor.

---

Type	: Geared Trolley Chain Block
Quantity	: 2 units
Rated load	: 1 Ton
Lift	: 5.0m
Installation	: Indoor

---

**4. M05-04-01/04 Sump Drain Pump** (Refer to Section 11100 of Standard Specifications)

This pump shall be used for lifting up the drain collected from the floor drain pit to the scum

pit.

Type	: Submersible Sludge Pump (Non-clog type)
Quantity	: 4 units
Discharge bore diameter	: Dia.80 mm
Discharge flow	: 0.3 m <sup>3</sup> / min
Total head	: 6 m
Motor output	: 1.5 kW
Power source	: 415 V × 50 Hz × 3 phase
Installation	: Indoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 68
Insulation	: Class F
Others	: Equipped with pump removal unit, guide pipes, and lifting device

**5. M05-05-01/04 Scum Pump (Refer to Section 11101 of Standard Specifications)**

This pump shall be used for transferring the scum from the scum pump pit into the scum screen.

Type	: Submersible Sludge Pump (Non-clog type)
Quantity	: 4 units
Discharge bore diameter	: Dia.80 mm
Discharge flow	: 0.5 m <sup>3</sup> / min
Total head	: 14 m
Motor output	: 3.7 kW
Power Source	: 415 V × 50 Hz × 3 phase
Installation	: Outdoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 68
Insulation	: Class F
Others	: Equipped with pump removal unit and guide pipes

**6. M05-06 Piping (Refer to Section 11000 of Standard Specifications)**

The piping work shall include the piping systems as shown in the following table. The sizes and materials shall be as indicated in the Contract Drawings, and all piping systems shall comply with the requirements of Section 11000 of the Standard Specifications.

The piping shall include all necessary pipes, support, valves, expansion joints, insulations and necessary appurtenances, and shall be designed, furnished, installed, tested and adjusted by the Contractor.

(Piping system)

No	Piping Name	Diameter (mm)	Material	Scope of Works	
				From	To
1	Return sludge suction piping	150 to 300	DIP	Each connection point of underground of suction pipe	Each Return Sludge Pump
2	Return sludge transfer piping	250 280	DIP HDPE	Each Return Sludge Pump	Each connection point of underground of transfer pipe

3	Scum transfer piping	100 110	DIP HDPE	Scum Pump	Connection point of underground
4	Sump drainage piping	80	DIP	Sump Drain Pump	Scum pit
5	TE Utility water piping	25 to 32 40 to 50 50	SS SGPW HDPE	Connection point of underground	Spray nozzle, sludge pipe and sprinkler stop cocks
6	Deodorization piping	125 160	FRP HDPE	Connection point of underground	Scum pit

(Major item with related to piping system)

No	Major item	Diameter (mm)	Flange	Quantity	Piping Name
1	Gate Valve	150 200 300 80 25 to 50	ISO PN 10	12 units 6 units 3 units 4 units 1 lot	Return sludge transfer and suction piping Return sludge transfer piping Return sludge suction piping Scum transfer piping Utility water transfer piping
2	Check Valve	150 80	ISO PN 10	6 units 4 units	Return sludge transfer piping Scum transfer piping
3	Flexible Pipe	25 to 300	ISO PN 10	1 lot	Connection point of underground pipe if necessary
4	Air Release Valve Unit	32	ISO PN 10	2 sets	Each header pipe of Scum Pump
5	Flexible Pipe and Damper	125	ISO PN 10	2 sets	Deodorization piping

#### 7. M05-07 Steel Works (Refer to Section 11000 of Standard Specifications)

This steel works shall include all necessary steel works for the maintenance of the plant such as FRP covers, manholes, stages, walkways, handrails, steps, ladders, etc., not necessarily limited to those given in the Drawings, which shall be designed, furnished, installed and adjusted by the Contractor. FRP cover shall be lock type.

No	Major item	Material	Quantity
1	Cover of Scum Pit	FRP	3 sets (Refer to the contract drawing)

#### M06. Utility Water and Disinfection Facility

- A. The mechanical components of the Utility Water and Disinfection Facility shall consist of the following equipment. Details of each equipment shall be designed using the following conditions and in accordance with the specification set forth hereinafter in this section.
- B. Coating and painting for Weirs shall comply with the requirements of Section 11000 of the Standard Specifications.
- C. The Contractor shall take the following measures in consideration of particular conditions that STP is located in the coastal area.
  - To make special painting in consideration of the conditions that equipment are installed nearby the sea

#### D. Equipment List of Utility Water and Disinfection Facility

M06-01 Chlorine Solution Tank : 1 unit

M06-02	Chlorine Solution Storage Tank	: 1 unit
M06-03-01/02	Chlorine Solution Dosing Charger	: 2 units
M06-04	Utility TE Water Supply Unit	: 1 lot
M06-05-01/04	Auto. Strainer	: 4 units
M06-06-01/02	Deforming Pump	: 2 units
M06-07-01/02	Ultra Violet Disinfection Unit	: 2 lots
M06-08-01/03	Disinfection Inlet Gate	: 3 units
M06-09	Hoist Block of UV Unit	: 1 unit
M06-10	Hoist Block of Utility Pump	: 1 unit
M06-11	Disinfection Outlet Weir	: 1 unit
M06-12	Piping	: 1 lot
M06-13	Steel Works	: 1 lot

#### E. Design Condition

Flow rate (Ultimate)	
- Daily average	: 18,400 m <sup>3</sup> / day
- Hourly maximum	: 36,800 m <sup>3</sup> / day

Inlet treated water quality	
- BOD	: 20 mg/ L
- SS	: 20 mg/ L

Chemical	: Calcium Hypochlorite Powder
- Dosage rate (Reference)	: Ave. 3mg/L (Effective rate)

#### F. Specification of equipment

##### 1. M06-01 Chlorine Solution Tank (Refer to Section 11390 and 11683 of Standard Specifications)

This tank shall be used for the dissolution of the calcium hypochlorite powder supplied by manual to the specified concentration and storing the solution in it.

---

Type	: Cylindrical PE or steel Tank
Quantity	: 1 unit
Capacity	: 7 m <sup>3</sup> (Effective volume is more than 4.6 m <sup>3</sup> )
Motor output	: 1.5 kW (Agitator)
Power source	: 415 V × 50 Hz × 3 phase
Installation	: Indoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 55
Insulation	: Class F
Others	: Internal surface shall be painted for corrosion resistance treatment in case of steel tank

---

(Note) Including: - Stainless base plate/fittings for mixer: 1 set for each tank  
- Stainless bolts and nuts: 1 set/unit

##### 2. M06-02 Chlorine Solution Storage Tank (Refer to Section 11684 of Standard Specifications)

The Storage tank shall be used for feeding chlorine solution at constant flow into the treated water tank.

---

Type	: Open top cylindrical tank
Quantity	: 1 unit
Tank effective volume	: 0.1m <sup>3</sup>
Installation	: Indoor

---

(Note) Including:

- Ball tap device, and stainless bolts and nuts: 1 set/unit
- Base plate/fittings for Tank
- Valve and pipe to be installed between Solution Tank and Storage Tank

3. **M06-03-01/02 Chlorine Solution Dosing Charger** (Refer to Section 11684 of Standard Specifications)

The Dosing charger shall be for feeding chlorine solution at variable rates by manual operation into the treated water tank.

---

Type	: Manual flow control and gravity flow type
Quantity	: 2 units
Measuring range	: 0 to 0.26 m <sup>3</sup> / hr/ unit
Accuracy	: Within ±10% of full scale
Installation	: Indoor

---

(Note) Including:

- Ball tap device, and stainless bolts and nuts: 1 set/unit
- Base plate/fittings for Tank
- Valve and pipe including suction and discharge pipe and 1 set/unit of flow regulating valve

4. **M06-04 Utility TE Water Supply Unit** (Refer to Section 11640 of Standard Specifications)

This pump shall be used for sending the treated water for utility water.

---

Type	: Submersible Pumps with pressure tank
Quantity	: 1 lot
Discharge bore diameter	: Approx. Dia.50 mm
Discharge flow	: 0.6 m <sup>3</sup> / min
Total head	: 42 m
Motor output	: 3.7 kW/ unit x 2 units
Power source	: 415 V × 50 Hz × 3 phase
Others	: Equipped with control panel
Installation	: Indoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 68
Insulation	: Class F

---

5. **M06-05-01/04 Auto Strainer** (Refer to Section 11450 of Standard Specifications)

Auto Strainer shall be installed on the discharge side of the utility supply water unit and the deforming pump, and shall be capable of removing suspended articles in treated water.

---



Type	: Automatic Washing Type
Quantity	: 4 units
Bore diameter	: Approx. Dia.50 mm
Capacity	: 0.6 m <sup>3</sup> / min
Opening	: Mesh. Approx. 0.4 mm
Motor output	: Approx. 0.1 kW
Power source	: 415 V × 50 Hz × 3 phase
Others	: Equipped with Control Panel
Installation	: Indoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 44
Insulation	: Class F

---

6. **M06-06-01/02 Defoaming Pump** (Refer to Section 11100 of Standard Specifications)

This pump shall be used for sending the treated water for defoaming of the oxidation ditch tank.

---

Type	: Submersible Turbine Pump
Quantity	: 2 units
Discharge bore diameter	: Approx. Dia.50 mm
Discharge flow	: 0.6 m <sup>3</sup> / min
Total head	: 29 m
Motor output	: 3.7 kW
Power source	: 415 V × 50 Hz × 3 phase
Installation	: Indoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 68
Insulation	: Class F

---

7. **M06-07-01/02 Ultra Violet Disinfection Unit** (Refer to Section 11682 of Standard Specifications)

Ultra violet disinfection unit shall be used for disinfection for treated water.

---

Type	: Low Pressure High Intensity Type
Quantity	: 2 lots
Flow rate (Ultimate)	
- Daily average	: 9,200 m <sup>3</sup> / day/ lot
- Hourly maximum	: 18,400 m <sup>3</sup> / day/ lot
Inlet treated water quality	
- BOD	: 20 mg/ L
- SS	: 20 mg/ L
UV Transmittance	: Not less than 70 %
Coliform reduction	: 99 %
Motor output	: Approx. 15.0 kW
Power source	: 415 V × 50 Hz × 3 phase
Installation	: Indoor
Others	: Equipped with Control Panel, Scrubbing unit for lump

---

**8. M06-08-01/03 Disinfection Inlet Gate** (Refer to Section 11140 of Standard Specifications)

This gate shall be installed at the inlet of disinfection tank and shall be capable of sealing and controlling incoming sewage.

---

Type	: Manually Operated Cast Iron Gate
Quantity	: 3 units
Dimension	: W 400 mm × H 600 mm
Design water depth	: 1.8 m (bottom to floor)
Installation	: Indoor

---

**9. M06-09 Hoist Block for UV Unit** (Refer to Section 11190 of Standard Specifications)

This hoist block shall be used for carry-in, carry-out, assembly, maintenance and check of the UV unit and apparatus installed in the building and the materials necessary therefor.

---

Type	: Geared Trolley Chain Block
Quantity	: 1 unit
Rated load	: 0.5 Ton
Lift	: 5.0 m
Installation	: Indoor

---

**10. M06-10 Hoist Block for Utility Pump** (Refer to Section 11190 of Standard Specifications)

This hoist block shall be used for the carry-in, carry-out, assembly, maintenance and check of the Utility TE pump and the Defoaming pump and apparatus installed in the building and the materials necessary therefore.

---

Type	: Geared Trolley Chain Block
Quantity	: 1 unit
Rated load	: 0.5 Ton
Lift	: 5.0 m
Installation	: Indoor

---

**11. M06-11 Disinfection Outlet Weir** (Refer to Section 11150 of Standard Specifications)

This weir shall be installed at the outlet of the measuring tank to measure the effluent flow rate.

---

Type	: Fixed Weir Plate
Quantity	: 1 unit
Dimension	: W 1.5 m
Weir type	: Rectangular (FRP)
Installation	: Indoor

---

**12. M06-12 Piping** (Refer to Section 11000 of Standard Specifications)

The piping work shall include the piping systems as shown in the following table. The sizes and materials shall be as indicated in the Contract Drawings, and all piping systems shall comply with the requirements of Section 11000 of the Standard Specifications.

The piping shall include all necessary pipes, support, valves, expansion joints, insulations and necessary appurtenances, and shall be designed, furnished, installed, tested and adjusted by the Contractor.

(Piping system)

No	Piping Name	Diameter (mm)	Material	Scope of Works	
				From	To
1	Utility TE water supply piping	50 to 150 25 to 50 160	SGPW SS HDPE	Utility TE Water Supply Unit	Sprinkler stop cocks, washing water for necessary piping, Chlorine Solution Tank, , and to Connection point of underground
2	Auto strainer drainage piping	65 to 100	DIP HDPE	Auto Strainer	Drainage Pipe
3	Defoaming water supply piping	50 to 150 50 to 150 160	SGPW SS HDPE	Defoaming Pump	Connection point of underground
4	Utility Potable Water supply piping	80	SGP-VA	Connection point of underground	Chlorine Solution Tank
5	Chlorine Solution piping	50	HIVP	Chlorine Solution Tank	Injection point
6	Over flow and drain piping of Chlorine Solution Tank	100	HIVP	Chlorine Solution Tank	Drainage Pipe

(Major item with related to piping system)

No	Major item	Diameter (mm)	Flange	Quantity	Piping Name
1	Gate Valve	65 65 25 to 100	ISO PN 10	8 units 5 units 1 lot	Utility TE water piping Defoaming piping Utility TE water transfer piping
2	Diaphragm Valve	50	ISO PN 10	8 units	Chlorine solution piping
3	Flexible Pipe	25 to 300	ISO PN 10	1 lot	Connection point of underground pipe if necessary
4	Strainer	50	ISO PN 10	1 unit	Chlorine solution piping

### 13. M06-13 Steel Works (Refer to Section 11000 of Standard Specifications)

This steel works shall include all necessary steel works for the maintenance of the plant such as FRP covers, manholes, stages, walkways, handrails, steps, ladders, etc., not necessarily limited to those given in the Drawings, which shall be designed, furnished, installed and adjusted by the Contractor. FRP cover shall be lock type.

No	Major item	Material	Quantity
1	Cover of Disinfection Tank	FRP	1 lot (Refer to the contract drawing)

**M07 Sludge Treatment Facility**

- A. The mechanical components of the Sludge Treatment Facility shall consist of the following equipment. Details of each equipment shall be designed using the following conditions and in accordance with the specification set forth hereinafter in this section.
- B. Coating and painting for Weirs shall comply with the requirements of Section 11000 of the Standard Specifications.
- C. The Contractor shall take the following measures in consideration of particular conditions that STP is located in the coastal area.
- To make special painting in consideration of the conditions that equipment are installed nearby the sea

## D. Equipment List of Sludge Treatment Facility

M07-01-01/02 Sludge Dewatering Unit	: 2 units
M07-02 Sludge Cake Conveyor	: 1 unit
M07-03 Sludge Cake Hopper	: 1 unit
M07-04-01/02 Polymer Dissolving Tank	: 2 units
M07-05-01/02 Polymer Feeder	: 2 units
M07-06-01/02 Polymer Feed Pump for Dewatering	: 2 units
M07-07-01/02 Air Compressor	: 2 units
M07-08-01/02 Air Dryer	: 2 units
M07-09-01/02 Hoist Block for Sludge Dewatering Unit	: 2 units
M07-10-01/02 Hoist Block for Sludge Treatment Building	: 2 units
M07-11-01/04 Sump Drain Pump	: 2 units
M07-12-01/02 Waste Water Mixer	: 2 units
M07-13-01/02 Waste Water Pump	: 2 units
M07-14 Biological Odour Control	: 1 unit
M07-15-01/02 Deodorization Fan	: 2 units
M07-16 Utility Potable Water Supply Unit	: 1 lot
M07-17 Hoist Block for Utility Pump	: 1 unit
M07-18 Piping	: 1 lot
M07-19 Steel Works	: 1 lot

## E. Design Condition

## Inlet Condition

- Sludge Volume	: 799 m <sup>3</sup> / day
- Sludge SS Load	: 2,397 kg/ day

## F. Specification of equipment

1. **M07-01-01/02 Sludge Dewatering Unit** (Refer to Section 11502 of Standard Specifications)

Sludge dewatering unit shall be installed in the sludge treatment building, and shall be capable of dewatering sludge transferred from the oxidation ditches.

---

Type	: Multi-Diskplate Screw Press
Quantity	: 2 units
Screw diameter	: Dia.350mm/ screw × 3 screws/ unit
Capacity	: 180 kg-dS/ hr/ unit
Sludge properties	: Activated sludge from oxidation ditches

Chemical dosing rate	Concentration	: 0.3 to 0.4%
Motor output	: Polymer	: Approx. 1.0% to 1.5% per DS
Speed control method		: Approx. 6.0 kW
Power source		: VVVF
Others		: 415 V × 50 Hz × 3 phase
Installation		: Equipped with Control Panel
Ambient temperatures		: Indoor
Motor encl. protection		: From minus 0 degrees C to plus 50 degrees C
Insulation		: IP 44
		: Class F or equivalent

---

Accessory: Chute x 1set

2. **M07-02 Sludge Cake Conveyor** (Refer to Section 11171 of Standard Specifications)

Sludge cake conveyor shall be used for conveying sludge cakes from the sludge dewatering unit.

---

Type	: Shaft-less Screw Conveyor
Quantity	: 1 unit
Dimension	: Dia.400 mm x L 10 m
Motor output	: 5.5 kW
Power source	: 415 V × 50 Hz × 3 phase
Installation	: Indoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 44
Insulation	: Class F

---

Accessory: Chute x 1set

3. **M07-03 Sludge Cake Hopper** (Refer to Section 11160 of Standard Specifications)

This hopper shall be used for storing the sludge cakes sent from the sludge cake conveyor.

---

Type	: Motor Driven Cut-gate Type
Quantity	: 1 unit
Effective capacity	: 15 m <sup>3</sup>
Motor output	: 2.2 kW × 2
Power source	: 415 V × 50 Hz × 3 phase
Installation	: Indoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 44
Insulation	: Class F
Others	: Contractor should be considered countermeasure of maintenance of motor driven

4. **M07-04-01/02 Polymer Dissolving Tank** (Refer to Section 11390 of Standard Specifications)

This tank shall be used for dissolution of the polymer supplied by the polymer feeder to the specified concentration and storing the solution in it.

---

Type	: Cylindrical Steel Tank
------	--------------------------

Quantity	: 2 units
Capacity	: 17 m <sup>3</sup>
Motor output	: 11 kW (Agitator)
Power source	: 415 V × 50 Hz × 3 phase
Installation	: Indoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 55
Insulation	: Class F

---

5. **M07-05-01/02 Polymer Feeder** (Refer to Section 11420 of Standard Specifications)

This equipment shall be used for temporary storage of polymer and continuous constant –rate supply of water and chemical to the polymer dissolving tank.

---

Type	: Constant Chemical Feeder
Quantity	: 2 units
Feeding rate	: 2.3 kg/ min
Motor output	: 0.4 kW
Power source	: 415V × 50Hz × 3phase
Capacity of hopper	: Approx. 0.2m <sup>3</sup>
Installation	: Indoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 55
Insulation	: Class F

---

6. **M07-06-01/02 Polymer Feed Pump for Dewatering** (Refer to Section 11104 of Standard Specifications)

This pump shall be used for feeding the polymer solution at constant-rate to the sludge dewatering unit.

---

Type	: Progressive Cavity Pump
Quantity	: 2 units
Bore diameter	: Dia.50 mm
Discharge flow	: 0.7 to 2.0 m <sup>3</sup> / hr
Total head	: 20 m
Fluid handled	: Polymer (Concentration: 0.2 %)
Motor output	: 1.5 kW (with variable speed gear)
Power source	: 415 V × 50 Hz × 3 phase
Installation	: Indoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 44
Insulation	: Class F

---

7. **M07-07-01/02 Air Compressor** (Refer to Section 11320 of Standard Specifications)

This air compressor shall be used for polymer feeder.

---

Type	: Pressure -switch Type
Quantity	: 2 units

Delivery air flow	: 400 NL/ min
Normal working pressure	: 0.83 MPa
Motor output	: 3.7 kW
Power source	: 415 V × 50 Hz × 3 phase
Installation	: Indoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 44
Insulation	: Class F
Others	: Equipped with control panel

---

8. **M07-08-01/02 Air Dryer** (Refer to Section 11321 of Standard Specifications)

This air dryer shall be used for removing the humidity contained in the instrumentation compressed air so as to obtain dry air.

Type	: Refrigerating Type
Quantity	: 2 units
Air flow	: 400 NL/ min
Normal working pressure	: 0.83 MPa
Motor output	: 0.2 kW
Power source	: 240 V × 50 Hz × Single phase
Installation	: Indoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 44
Insulation	: Class F

---

9. **M07-09-01/02 Hoist Block for Sludge Dewatering Unit** (Refer to Section 11190 of Standard Specifications)

This hoist block shall be used for carry-in, carry-out, assembly, maintenance and check of the sludge dewatering unit and apparatus installed in the building and the materials necessary therefor.

Type	: Geared Trolley Chain Block
Quantity	: 2 units
Rated load	: 2.0 Ton/ unit
Lift	: 5.0m
Installation	: Indoor

---

10. **M07-10-01/02 Hoist Block for Sludge Treatment Building** (Refer to Section 11190 of Standard Specifications)

This hoist block shall be used for carry-in, carry-out, assembly, maintenance and check of the feeder, tank and apparatus installed in the building and the materials necessary therefor.

Type	: Geared Trolley Chain Block
Quantity	: 2 units (1 unit manual, 1 unit motorized)
Rated load	: 2.0 Ton/ unit
Lift	: 5 m
Motor output	: 2.8 kW (lifting) and 0.4 kW (traveling)
Power source	: 415V × 50Hz × 3phase

Installation	: Indoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 44
Insulation	: Class F

---

11. **M07-11-01/04 Sump Drain Pump** (Refer to Section 11100 of Standard Specifications)

This pump shall be used for lifting up the wastewater collected in the floor drain pit.

---

Type	: Submersible Sewage Pump (Non -clog type)
Quantity	: 2 units
Discharge bore diameter	: Dia.80 mm
Discharge flow	: 0.3 m <sup>3</sup> / min
Total head	: 6 m
Motor output	: 1.5 kW
Power source	: 415 V × 50 Hz × 3 phase
Installation	: Indoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 68
Insulation	: Class F
Others	: Equipped with pump removal unit, guide pipes and lifting device

---

12. **M07-12-01/02 Waste Water Mixer** (Refer to Section 11600 of Standard Specifications)

This mixer shall be used for mechanical agitation to prevent sludge settling in the waste water tank.

---

Type	: Submersible Propeller Mixer
Quantity	: 2 units
Tank dimensions	: Approx. W 5 m × L 5 m v Water depth 4.5 m
Propeller diameter	: Approx. 220 mm
SS concentration	: Approx. 1,500 mg/ L
Motor output	: 1.5 kW
Power source	: 415 V × 50 Hz × 3 phase
Installation	: Outdoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 68
Insulation	: Class F
Others	: Equipped with guide bar and lifting device

---

13. **M07-13-01/02 Waste Water Pump** (Refer to Section 11101 of Standard Specifications)

This pump shall be used for transferring the waste water from the waste water tank into the grit chamber.

---

Type	: Submersible Sludge Pump (Non-clog Type)
Quantity	: 2 units
Suction bore diameter	: Dia.100 mm
Discharge flow	: 2.0 m <sup>3</sup> / min



Total head	: 14 m
Motor output	: 11 kW
Power source	: 415 V × 50 Hz × 3 phase
Installation	: Outdoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 68
Insulation	: Class F
Others	: Equipped with pump removal unit and guide pipes

---

14. **M07-14 Biological Odour Control** (Refer to Section 11520 of Standard Specifications)

The Control Unit shall be installed at the side of the sludge treatment building, and shall be capable of removing high concentrated odour coming out from the grit chamber, scum pits, waste water tank, and sludge dewatering.

---

Type	: Biological Odour Control Unit
Quantity	: 1 unit
Capacity	: 40 m <sup>3</sup> / min
Target Facilities	: Grit Chamber, Distribution Chamber Scum Pit, Sludge Treatment Building, Waste Water Tank
Odour intensity value of treated air	: Approx. 2.5
Installation	: Indoor
Others	: Equipped with control panel (Approx. 5.0kW)

---

15. **M07-15-01/02 Deodorization Fan** (Refer to Section 11521 of Standard Specifications)

The exhaust fan shall be installed at the inlet of the Biological Odour Control Unit, and shall be capable of absorbing odour gas from necessary point.

---

Type	: FRP Centrifugal Fan
Quantity	: 2 units
Capacity	: 40 m <sup>3</sup> / min
Pressure	: 2.5 kPa
Motor output	: 5.5 kW
Power source	: 415 V × 50 Hz × 3 phase
Others	: Vibration pen × 2 sets, Infrared thermometer × 2 sets
Installation	: Indoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 44
Insulation	: Class F

---

16. **M07-16 Utility Potable Water Supply Unit** (Refer to Section 11640 of Standard Specifications)

This pump shall be used to send the treated water for utility water.

---

Type	: Submersible Pumps with pressure tank
Quantity	: 1 lot
Discharge bore diameter	: Approx. Dia.50 mm

Discharge flow	: 0.45m <sup>3</sup> / min
Total head	: 25 m
Motor output	: 2.2 kW/ unit x 2 units
Power source	: 415 V × 50 Hz × 3 phase
Others	: Equipped with control panel
Installation	: Indoor
Ambient temperatures	: From minus 0 degrees C to plus 50 degrees C
Motor encl. protection	: IP 68
Insulation	: Class F

#### 17. M07-17 Hoist Block for Utility Pump (Refer to Section 11190 of Standard Specifications)

This hoist block shall be used for carry-in, carry-out, assembly, maintenance and check of the utility potable water pump and apparatus installed in the building and the materials necessary therefor.

Type	: Geared Trolley Chain Block
Quantity	: 1 unit
Rated load	: 0.5 Ton/ unit
Lift	: 5.0m
Installation	: Indoor

#### 18. M07-18 Piping (Refer to Section 11000 of Standard Specifications)

The piping work shall include the piping systems as shown in the following table. The sizes and materials shall be as indicated in the Contract Drawings, and all piping systems shall comply with the requirements of Section 11000 of the Standard Specifications.

The piping shall include all necessary pipes, support, valves, expansion joints, insulations and necessary appurtenances, and shall be designed, furnished, installed, tested and adjusted by the Contractor.

(Piping system)

No	Piping Name	Diameter (mm)	Material	Scope of Works	
				From	To
1	Waste sludge piping	150 160	DIP HDPE	Connection point of underground	Sludge Dewatering Unit
2	Drainage piping of the Sludge Dewatering Unit	200	DIP	Sludge Dewatering Unit	Waste Water Tank
3	Waste water discharge piping	100 to 200 225	DIP HDPE	Waste Water Tank	Grit Chamber
4	Sump drainage piping	80	DIP	Sump drain pump	Waste Water Tank
5	Polymer feed piping	50 to 100	HIVP	Polymer Dissolving Tank	Sludge Dewatering Unit
6	Over flow and drain piping of Polymer Dissolving Tank	100	HIVP	Polymer Dissolving Tank	Waste Water Tank
7	Utility TE water transfer piping	40 to 150 25 to 32 160	SGPW SS HDPE	Connection point of underground	Each equipment, washing water for necessary piping, sprinkler stop cocks and Water cocks for Polymer Dissolving tank, Biological Odor Control

8	Utility potable water piping	50	HIVP	Connection point of underground	Utility Potable Water Tank
9	Utility potable water transfer piping	80	SGP-VA	Utility Potable Water Tank	Water cocks for Polymer Dissolving tank
10	Deodorization piping	125 125 to 350 355	FRP VU HDPE	Each equipment, Waste Water Tank and Sludge Cake Hopper Room (1F)	Exhaust point of Biological Odor Control
11	Biological Odor Control drainage piping	50	HIVP	Biological Odor Control	Waste Water Tank
12	Air piping	25	STPG	Air Compressor	Polymer Feeder

(Major item with related to piping system)

No	Major item	Diameter (mm)	Flange	Quantity	Piping Name
1	Gate Valve	100 150 25 to 80	ISO PN 10	4 units 2 units 1 lot	Waste sludge transfer piping Waste sludge transfer piping Utility TE water transfer piping
2	Diaphragm Valve	100 50	ISO PN 10	5 units 8 units	Polymer solution piping
3	Flexible Pipe	150 to 350	ISO PN 10	1 lot	Connection point of underground pipe if necessary
4	Flexible Pipe and Damper	125	ISO PN 10	8 sets	Deodorization piping
5	Damper	350	ISO PN 10	7 units	Deodorization piping
6	Strainer	100	ISO PN 10	1 unit	Polymer solution piping

#### 19. M07-19 Steel Works (Refer to Section 11000 of Standard Specifications)

This steel works shall include all necessary steel works for the maintenance of the plant such as FRP covers, manholes, stages, walkways, handrails, steps, ladders, etc., not necessarily limited to those given in the Drawings, which shall be designed, furnished, installed and adjusted by the Contractor. FRP cover shall be lock type.

No	Major item	Material	Quantity
1	Necessary covers	FRP	1 lot (Refer to the contract drawing)

#### M08 Other Works

The piping work shall include the piping systems as shown in the following table. The sizes and materials shall be as indicated in the Contract Drawings, and all piping systems shall comply with the requirements of Section 11000 of the Standard Specifications.

The piping shall include all necessary pipes, support, valves, expansion joints, insulations and necessary appurtenances, and shall be designed, furnished, installed, tested and adjusted by the Contractor.

(Piping system of underground in STP)

No	Piping Name	Diameter (mm)	Material	Scope of Works	
				From	To

1	Oil discharge piping	75	HDPE	Nearby Scum Pit	Oil removal sand bed and nearby Scum Screen
2	Sump Drainage piping	90	HDPE	Nearby Sump Drain Pit	Vortex Grit Chamber
3	Scum suction and transfer piping	160 110	HDPE	Clarifier Nearby Scum Pit	Scum Pit Grit Chamber
4	Return sludge suction piping	300	DIP	Center bottom of Clarifier	Sludge Pump Room
5	Return sludge suction piping	280	HDPE	Sludge Pump Room	Oxidation Ditch
6	Waste sludge transfer piping	160	HDPE	Oxidation Ditch	Sludge Treatment Building
7	Utility TE water transfer piping	32 to 160	HDPE	Disinfection Facility	Grit Chamber, Distribution Chamber, Oxidation Ditch, Clarifier facility, Sludge Treatment Building
8	Defoaming transfer piping	100 to 160	HDPE	Disinfection Facility	Oxidation Ditch
9	Waste water transfer piping	225	HDPE	Waste Water Tank	Grit Chamber
10	Deodorization piping	160 to 355	HDPE	Grit Chamber, Distribution Chamber, Scum Pit	Sludge Treatment Building

Note: above table, the Contractor shall obtain approval from the Employer or the Engineer.

**DIVISION 12.**

**FURNISHINGS**

**(Not Used)**

## **Division 12 Furnishings**

### **SECTION 12100**

#### **PS 12.01 General Requirements**

- A. The Contractor shall furnish and install equipment for laboratories and also furnish glassware to be used at the laboratories, and reagents for water quality analysis as specified herein.
- B. For these works, Division 12 of the Standard Specifications shall be applied as applicable.

#### **PS 12.02 Products**

The items, specifications and quantities of the products to be supplied are indicated in Appendix to Division 12 hereof.

**END OF DIVISION 12**

**APPENDIX TO DIVISION 12****ITEMS, SPECIFICATIONS AND QUANTITIES OF  
LABORATORY EQUIPMENT, GLASSWARE AND  
REAGENTS FOR WATER QUALITY ANALYSIS TO BE SUPPLIED**

## 1 Glassware (1/2)

No.	Description		Unit	No. of Glass wares		Total Quantities of Glass wares
	Name	Specifications		E & Q Laboratory <sup>1)</sup>	Kila Kila STP	
1	Conical flask for CODMn	300 mL	Nr	10	4	14
2	Beaker	50 mL	Nr	4	2	6
		100 mL	Nr	4	2	6
		300 mL	Nr	4	2	6
		500 mL	Nr	2	2	4
		1,000 mL	Nr	2	1	3
		10 L, PE	Nr	0	1	1
3	Pipette	Mess 1mL	Nr	4	2	6
		Mess 2mL	Nr	4	2	6
		Mess 5mL	Nr	4	2	6
		Mess 10mL	Nr	4	2	6
		Mess 25mL	Nr	4	2	6
		Hole 50 mL	Nr	4	2	6
		Hole 100 mL	Nr	2	0	2
4	Messzylinder	20 mL with stopper	Nr	2	2	4
		50 mL with stopper	Nr	5	2	7
		100 mL with stopper	Nr	2	2	4
		250 mL with stopper	Nr	2	2	4
		500 mL with stopper	Nr	2	2	4
		1,000 mL	Nr	2	5	7
5	Messflask	20 mL	Nr	2	0	2
		50 mL	Nr	4	0	4
		100 mL	Nr	4	2	6

## 1 Glassware (2/2)

No.	Name	Specifications	Unit	No. of Glass wares		Total Quantities of Glass wares
				E & Q Laboratory <sup>1)</sup>	Kila Kila STP	
5	Messflask	250 mL	Nr	2	0	2
		500 mL	Nr	2	2	4
		1,000 mL	Nr	2	0	2
6	Plastic bottle (wide mouth)	100 mL	Nr	10	10	20
		250 mL	Nr	10	4	14
		500 mL	Nr	6	2	8
		1,000 mL	Nr	2	1	3
7	Wash bottle	250 mL	Nr	2	2	4
		500 mL	Nr	2	2	4
8	Others					
	Measuring/transfer pipette	25 mL	Nr	4	2	6
	Syringe	PE, 5 mL	Nr	2	2	4
	Pipette stand		Nr	2	1	3
	crucible, melting pot	15 mL, high purified alumina for VSS	Nr	4	0	4
	Watch glass	Φ 9 cm	Nr	10	10	20
9	Evaporating dish	100 mL	Nr	10	10	20
	Tongs	21 cm	Nr	2	0	2
	Spatula		Nr	2	2	4
	Nitrate reduction column	Copper-Cadmium	Nr	4	0	4
	Auto burette	White 25 mL, 2,000 mL container	Nr	3	1	4
	Auto burette	Brown 25 mL, 2,000 mL container	Nr	1	0	1
	No.5 A filter	Dia.110 mm	Nr	2	4	6
	Funnel	Dia.60 mm	Nr	2	4	6
	Pincet	Length 125 mm	Nr	2	2	4
	Mortar	Dia.60 mm with pestle	Nr	2	0	2
	Agate Mortar)	50 mm with pestle	Nr	1	0	1
	Separation funnel	500 mL, Pear shaped type , with PTFE cock	Nr	3	0	3
	Separation funnel stand		Nr	3	0	3

1) Environment &amp; Quality Control Section Laboratory



## 2 Analysis/measurement Equipment (1/6)

No.	Name	Specifications	Unit	No. of Equipment		Total Quantities of Equipment
				E & Q Laboratory <sup>1)</sup>	Kila Kila STP	
1	pH/ORP meter	Power source: 4VA Digital indication Glass electrode method pH range: 0.00 - 14.00 ORP range: 0 - ±2,000 mV Data memory: 300 water temperature indication pH standard solutions (7 and 4) ORP standard solution internal liquid	Nr	1	0	1
2	Potable pH/ORP meter	Power source: Dry battery AA Digital indication Glass electrode method pH range: 0 - 14 ORP range: 0 - ±2,000 mV Data memory: 300 water temperature indication cable 10 m with pH standard solutions (7 and 4) ORP standard solution	Nr	0	1	1
3	Potable EC meter	Power source: Dry battery AA Range: 0- 2 S/cm Data memory: 300 Water temperature indication and standard solution	Nr	1	0	1
4	Potable EC meter	Power source: Dry battery AA Range: 1.999S/cm and 19.99S/cm Water temperature indication and standard solution	Nr	0	1	1
5	Transparency meter	Glass made 1,000 mm, with wooden support	Nr	0	1	1
6	MLSS meter	Power source: Dry cell Cable length: 11m MLSS measurement: Near-infrared pulse method Water depth : Semiconductor pressure censer. MLSS range: 0-20,000 mg/L Water depth range: 0-5.00 m, Resolution ability : 10 mg/L (0-10,000 mg/L), 100 mg/L (10,000 -20,000 mg/L) Water depth : 0.01 m	Nr	0	1	1

## 2 Analysis/measurement Equipment (2/6)

No.	Name	Specifications	Unit	No. of Equipment		Total Quantities of Equipment
				E & Q Laboratory <sup>1)</sup>	Kila Kila STP	
7	Simple COD <sub>Mn</sub> analysis set	Power source: 100 W Measurement principal: coulometric titration method Measurement Method: Acid process (standard), Measurement range: 10,20,40,100,200,400,1000mg/L SET:0 ~ 2,000mg/L conical beaker x total 6	Nr	0	1	1
8	BOD analysis set	Controller Power source: : Dry battery AA Memory: 180-360 Bottle Cap Measurement method: pressure-sensitive method Stirrer Power source::AC100~240V Rotating speed: 180-450 rpm,Number of stirrers :12 Incubator Power source::AC115~230V Insulation temperature: 25-50 degrees Celsius	Nr	1	0	1
9	DO meter	Power source: Alkali C-cells Dynamic luminescence quenching lifetime detection DO range: 0 - 50 mg/L, Accuracy 0 to 20 mg/L, 0.1±0.1 mg/L, Data memory: 2,000,cable 15 m, weight for sinking	Nr	0	1	1
10	Soxlet extraction unit for 3 samples	Power source: 0.3 kW 3 sets of heating mantle, 3 sets of soxlet extraction unit hexane (reagent grade) x10, Methylorange solu. 100 mL x 1, Grade hydrochloric acid 500 mL x 1	Nr	1	0	1
11	Nitrogen and phosphorus analysis set	Measuring method: Optical density method Measurement principal T-N: UV absorptiometric method T-P: potassium peroxydisulfate Decomposition method Quantitative range: T-N: 0-25mg/L N, T-P:0-50mg/L P Measurement wavelength: 190-1100mm	Nr	1	0	1
12	Simple nitrogen analysis kit	Colorimetric tube square: plus 4 (total 6) Each reagent: plus 150 samples (Total 200 samples each) Colour comparison table: NH <sub>4</sub> -N, NO <sub>3</sub> -N, NO <sub>2</sub> -N Measurement range: NH <sub>4</sub> -N 0.2-10mg/l, NO <sub>2</sub> -N 0.006-0.3mg/l , NO <sub>3</sub> -N 0.05-4.5 mg/l	Unit	0	1	1

## 2 Analysis/measurement Equipment (3/6)

No.	Name	Specifications	Unit	No. of Equipment		Total Quantities of Equipment
				E & Q Laboratory <sup>1)</sup>	Kila Kila STP	
13	Coliform analysis set	<u>Incubator</u> Power source: 0.6 kW Temperature control by PID, 7-60 °C, Natural convection, Temperature accuracy : $\pm 0.5^{\circ}\text{C}$ at 37°C, Temperature distribution $\pm 1.5^{\circ}\text{C}$ , Stainless	Nr	1	0	1
		<u>Auto crave</u> Power source: 1.4 kW Can body: $\Phi 230 \times 460$ Effective capacity: 20 L Temperature range to be used : 110-127°C Maximum pressure to be used: 0.18 MPa Stainless wire basket, receiver tank from exhaust gas drain cock	Nr	1	0	1
		<u>Dry heat sterilizer</u> Power source: 1.2 kW Inner capacity : approximately 95L Natural convection, 40-270°C PID control, Accuracy $\pm 1^{\circ}\text{C}$ , Stainless, with safety equipment Handy typed colony counter x1, Measuring flask 1L x 1, Petri dish: Glass made $\phi 90 \times 20 \times 20$ units,	Nr	1	0	1
		Bunsen burner For LPG, with cock Hose 1m Test tube 15 x 150, 20 mL x 50 units Measuring pipette 1mL scale at the edge x 5, 10mL scale at the edge x 5, Pipette sterilization 65 x 80 x 400 x1 Test tube stand: SUS 5x10x1 Platinum loop : SUS loop 280mm; Deoxycholate agar culture medium 400 mL x 40, Potassium dihydrogen phosphate : Grade 500g Grade sodium hydroxide : 500g x1	Nr	1	0	1

## 2 Analysis/measurement Equipment (4/6)

No.	Name	Specifications	Unit	No. of Equipment		Total Quantities of Equipment
				E & Q Laboratory <sup>1)</sup>	Kila Kila STP	
14	Potable Residual chlorine meter	Colour comparison method Range: 0.05-2.0 mg/L Measuring cell: Total 4 with caps) Carrying case Reagent: Total for 200 samples	Nr	0	1	1
15	Pure water production equipment	Power source: 1.5 kW Ion-exchange+ distillation + filtration 1.8 L/h, Product storage tank 30 L	Nr	1	0	1
16	Distilled water production equipment	Power source: 2.6 kW 3.5 L/h, Crystal heater Fired anti-air	Nr	0	1	1
17	Auto precise balancer	Power source: 0.01 kW Analytical electronic balance Maximum weight: 220 g Minimum indication : 0.1 mg plate size : $\phi$ 90mm Reproducibility: 0.1mg,	Nr	1	1	2
18	Storage shelf	Reference Dimension: 1,760 (D) x 400 (W) x 880 (H) Stainless	Nr	2	1	3
19	Centrifugal	Power source: 0.5 kW Small tabletop centrifuge: H-19FM or equivalent, Maximum revolution speed: 4,000 rpm, Maximum centrifugal force: 2,600 G, Microcomputer control, Revolution speed: digital indication, with swing rotor, metal basket, centrifuge tubes with scale 50 mL x 4	Nr	1	0	1
20	Shaker	Power source: 2.2 kW Horizontal/vertical direction Maximum number of frame: 1,000 mL Separation funnel holder x 3 Shaking speed: 20-300rpm Timer setting, Setting velocity: dial changing,	Nr	1	0	1

## 2 Analysis/measurement Equipment (5/6)

No.	Name	Specifications	Unit	No. of Equipment		Total Quantities of Equipment
				E & Q Laboratory <sup>1)</sup>	Kila Kila STP	
21	SS analysis set	Power source: 0.1 kW Tabletop SS measuring unit 47 mm, stainless filter holder 1 um glass fibre filter vacuum bottle vacuumed/pressurized pump pressure resistance rubber hose filter inset	Nr	0	1	1
22	Stirrer	Power source: 0.2 kW Mini stirrer: 100-1,500 rpm Mixing: 50 -1,000mL with magnetic rotors: 10 mm x 3, magnetic rotors: 10 mm x 3 for 1 set	Nr	2	1	3
23	Dryer	Power source: 1.5 kW Temperature range: 40-260 °C Temperature distribution accuracy: $\pm 10$ °C (at 260 °C) Maximum temperature reaching time; approximately 75 minutes PID control by microcomputer Capacity: 100 L	Nr	1	1	2
24	Digital microscope	Power source: DC12V, 1.5A Biological Microscopes: More than 3 million pixel USB camera (C mount CMOS), 600 times magnification, more than 2 inch LTPS LCD Display, SD card, USB cable, TV out cable, etc., with 20 slide glass and cover glass	Nr	0	1	1
25	Electro balancer	Power source: Dry cell Electronic balance Maximum: 410 g, Minimum.10 mg,	Nr	1	1	2
26	Dryer shelf	Assembly and mesh shelf top plate : SUS 304m, mesh shelf : Chrome Plating wire Mesh : 100 x 50 mm x 1 150 x 100 mm x2	Nr	2	1	3

## 2 Analysis/measurement Equipment (5/6)

No.	Name	Specifications	Unit	No. of Equipment		Total Quantities of Equipment
				E & Q Laboratory <sup>1)</sup>	Kila Kila STP	
27	Ultrasonic cleaning machine	Power source: 0.16 kW Tabletop ultrasonic cleaner Capacity: 5.8 L Tank: SUS304, Body: Aluminum acryl coating and ABS Frequency number: 38 kHz Self-originating system	Nr	1	0	1
28	Desicator	Plate diameter: 18 cm, total diameter: 27 cm, Height 21.5 cm, with silica gel	Nr	1	1	2
29	Distillation equipment	Power source: 1.2 kW For distillation of NH <sub>4</sub> -N, 3 set	Nr	1	0	1
30	Air pump	Power source: 0.04 kW 5 L/min	Nr	0	1	1
31	Water bath	Power source: 2 kW COD water bath MWE-8 or equivalent. Stainless made, for 8 unit, Temperature control by Robert Shaw, Fired anti-air	Nr	1	0	1
32	Muffle furnace	Power source: 1.4 kW Range:100 -1,150 °C, Setting temperature 0.5 °C, Reaching time approximately 60 minutes to 1,150 °C, 120 x 90 x 220 mm muffle inside, PID control	Nr	1	0	1
33	Hot plate	Power source: 0.55 kW Max 350 degree, body: aluminum (chemical finish baking), the top plate: white glass-ceramic, Heater control system: thermocouple ON / OFF control		1	1	2

- ① Required Power total: Environment and Quality Control Laboratory: 15.72 kW, Kila Kila STP: 5.10 kW, with allowance Environment and Quality Control Laboratory: 22 kW, Kila Kila STP: 7.5 kW
- ② Both laboratories shall have 100 Voltage line. One for wiring, 230 Voltage line for BOD analysis set
- ③ Contractor shall consider and prepare the necessary spare parts, consumables (Reagents) for 2 months' commissioning period at least.
- ④ Water, kitchen, electricity, gas supply facilities and tables for installation of analysis/measurement equipment during D/D stage.
- ⑤ Necessary room space will be approximately 50 and 30 m<sup>2</sup> for Environment and Quality Control Laboratory and site laboratory, respectively.
- ⑥ Space for Environment and Quality Control Laboratory may be reduced by using existing space.
- ⑦ Fans shall be installed. Three (4) (Above the place where dryer and muffle furnace, Water bath and Soxlet extraction equipment is to be located for Environment and Quality Control Laboratory, respectively) and two (2) (Above the place where dryer and simple CODMn analysis set is to be located) for site laboratory.
- ⑧ Tables and floor shall be finished with chemical resistance painting.
- ⑨ Manuals of all the analysis/measurement equipment shall be in English.

## 3 List of Reagents, etc. to be used for Water Quality Analysis (1/2)

Parameter	Reagents, etc.	No. of Lot	Remarks
pH	pH standard 7, 500ml	1	
	pH standard 4, 500ml	1	
SS	Glass filter for SS measurement, 47 mm, 100 sheets	1	
VSS	Ammonium nitrate, 500g	1	
M-alkalinity	Grade Hydrochloric acid, 500mL	1	
	Methyl red, 25g	1	
	Bromocresol green, 25g	1	
	95 % grade ethanol, 500mL	1	
	0.1 mol/L hydrochloric acid standard, 5,000mL	1	
COD <sub>Mn</sub> - Official	Grade sulfuric acid, 500mL	1	
	Grade silver nitrate, 500 g	3	
	Sodium oxalate(volumetric analysis), 50 g	1	
	Potassium permanganate, 500 g	1	
	5 mmol/L potassium permanganate standard solution, 5,000 mL	1	
	0.05mol/l(N/10)-Sodium oxalate solution, 20,000m	1	
COD <sub>Mn</sub> - simple	N/40 KMnO <sub>4</sub> solution, 100mL	1	
	FeNH <sub>4</sub> (SO <sub>4</sub> ) <sub>2</sub> + H <sub>2</sub> SO <sub>4</sub> + H <sub>3</sub> PO <sub>4</sub> + catalyst, 500mL	1	
BOD <sub>5</sub>	Hydrochloric acid, 500 mL	1	
	Sodium hydroxide, 500g	1	
	Dipotassium hydrogenphosphate, 500g	1	
	Potassium dihydrogenphosphate, 500g	1	
	Disodium hydrogen phosphate, 500g	1	
	Ammonia chloride, 500g	1	
	Magnesium sulfate heptahydrate, 500g	1	
	Calcium chloride, 500g	1	
	Iron (III) chloride hexahydrate, 500g	1	
	D (+) –glucose, 500g	1	
	L--glutamic acid, 1,000g	1	
Hexane Extract	Grade Hydrochloric acid, 500mL	1	
	Methyl orange, 25 g	1	
	Acetone, 500mL	1	
	Sodium sulfate Anhydrous, 500g	1	
	Hexane, 3000 L	1	
NH <sub>4</sub> -N (EDA)	Sulfuric acid, 500mL	1	
	Sodium hydroxide, 500g	1	
	Magnesium oxide, 25g	1	
	Phenol, 500 g	1	
	Sodium hydrochloride (effective chlorine more than 5 %),500 mL	1	
	Ammonium ion NH <sub>4</sub> 1,000 standard solution, 500mL	1	
	Reagents for Indophenol blue absorptiometry, 100 samples	1	

## 3 List of Reagents, etc. to be used for Water Quality Analysis (2/2)

Parameter	Reagents, etc.	No. of Lot	Remarks
NH <sub>4</sub> -N (Site)	Reagents for Indophenol blue absorptiometry, 100 samples	1	
NO <sub>2</sub> -N (EDA)	4-aminobenzenesulfonamide, 100g	1	
	N-1-naphthylenediammonium dichloride, 25g	1	
	Nitrite ion standard solution 1000, 1 ampoule	1	
NO <sub>3</sub> -N (EDA)	Ammonium chloride, 500g	1	
	Aqueous ammonia, 500mL	1	
	Nitrate ion standard solution 1000, 500mL	1	
	Disodium hydrogen ethylene-dimine tetra acetate dehydrate, 500g	1	
	Copper ( II ) sulfate pentahydrate, 25g	1	
	Nitric acid, 500g	1	
	Copper-cadmium packing, 4L	1	
	Glass wool	1	
Coliforms	Deoxycholate agar culture medium, 500g	1	
	BGLB culture medium, 300g	1	
	Durham fermentation tube, φ18 x 210	10	
	Durham fermentation tube cap, φ21.5 x40	10	



## 4 List of Reagents, etc. for Water Quality Analysis to be used during Commissioning Period

Parameter	Reagents, etc.	No. of Lot	Remarks
pH	pH standard 7, 500ml	2	
	pH standard 4, 500ml	2	
SS	Glass filter for SS measurement, 47 mm, 100 sheets	5	
M-alkalinity	Grade Hydrochloric acid, 500mL	1	
	0.1 mol/L hydrochloric acid standard, 5,000mL	1	
COD <sub>Mn</sub> - Offial	Grade sulfuric acid, 500mL	1	
	Grade silver nitrate, 500 g	1	
	5 mmol/L potassium permanganate standard solution, 5,000 mL	1	
COD <sub>Mn</sub> - simple	N/40 KMnO <sub>4</sub> solution, 100mL	3	
	FeNH <sub>4</sub> (SO <sub>4</sub> ) <sub>2</sub> + H <sub>2</sub> SO <sub>4</sub> + H <sub>3</sub> PO <sub>4</sub> + catalyst, 500mL	9	
BOD <sub>5</sub>	Hydrochloric acid, 500mL	1	
Hexane Extract	Grade Hydrochloric acid, 500mL	1	
	Sodium sulfate Anhydrous, 500g	1	
	Hexane, 3000 L	1	
NH <sub>4</sub> -N (EDA)	Sulfuric acid, 500mL	1	
	Sodium hydroxide, 500g	1	
	Magnesium oxide, 25g	1	
	Sodium hydrochloride (effective chlorine more than 5 %),500mL	1	
	Reagents for Indophenol blue absorptiometry, 100 samples	1	
NH <sub>4</sub> -N (Site)	Reagents for Indophenol blue absorptiometry, 100 samples	3	
NO <sub>3</sub> -N (EDA)	Ammonium chloride, 500g	1	
	Copper ( II ) sulfate pentahydrate, 25g	1	
	Nitric acid, 500g	1	
T-N (EDA)	Reagent set 25 samples	1	
T-P (EDA)	Reagent set 25 samples	1	
Coliforms	Deoxycholate agar culture medium, 500g	2	

**END OF APPENDIX TO DIVISION 12**

**DIVISION 13.**

**SPECIAL CONSTRUCTIONS**

## Division 13 Special Constructions

### Section 13410

#### PS13.01 General Requirements

- A. The Contractor shall furnish and complete the installation of all ICM systems and equipment, including system engineering as necessary, in accordance with the specifications and requirements specified herein and other parts of ICM Sections of Division 13 of the Particular Specifications and also fully complying with the requirements stated in Section 13410 and other sections of Division 13 of the Standard Specifications except any requirements contradicting those in this section of the Particular Specifications which shall take precedence.
- B. The Contractor shall arrange witness by the representatives of the Employer and Engineer, one person each during the shop test and inspection to be conducted in accordance with 1.03 E. of Section 13410 of the Standard Specifications, for which the Contractor shall allow for bearing and paying the travelling expenses (i.e., round air fares from the home place to the destination, inland transport expenses, and accommodation charges during the travel) for the Employer's and Engineer's persons attending to the respective shop test and inspection in his tender price .

Equipment requiring witness by the Employer's and Engineer's representatives in shop tests and inspections are listed below:

- Electromagnetic flow meter with diameter over than 100mm
- SCADA System major equipment
  - Operator Stations: 2 pcs
  - Servers: 2 pcs
  - Emergency Station: 1 pc
  - LCD Large Screen: 1 pc
  - Printers: 2 pcs
  - Managed Ethernet Switch: 1 pc
  - PLC Panel: 1 pc
  - RIO Panels: 4 pcs
- Telemetry Panels: 18 pcs (0-1-01 to 17 TMP01, 01-12 TMP02)
- GPRS Modem/Gateway to be installed at the STP

The shop tests shall be carried out on the SCADA system which shall be integrated by interconnecting over Ethernet data LAN and GPRS wireless so that data uploading/downloading within the system can be confirmed. If the GPRS wireless network is not available at the shop, any simulator or alternative shall be applied.

### Section 13415

#### PS 13.02 Functional Design Specification

The Functional Design Specification is given in Appendix I to this Division 13.

### Section 13420

**PS 13.03 Monitoring Devices**

- A The Contractor shall furnish and install the monitoring devices as specified in B to J hereunder. The equipment shall meet the operational and dimensional requirements as given therein.

**B Electromagnetic flow meter**

Name of Loop	Delivery flow	Delivery flow	Delivery flow
Tag No.	01-05FE01	01-07FE01	01-08FE01
Quantity	1	1	1
Size	400mm dia.	100mm dia.	100mm dia.
Measurement fluid	Raw sewage	Raw sewage	Raw sewage
Measurement range	0~10 m <sup>3</sup> /min.	0~3 m <sup>3</sup> /min.	0~1 m <sup>3</sup> /min
Located at	PS5: Konedobu PS	PS7: Stanley Esplanade PS	PS8: Sea Park PS

Name of Loop	Delivery flow	Delivery flow	Delivery flow
Equipment No.	01-10FE01	01-12FE01	01-15FE01
Quantity	1	1	1
Size	350mm dia.	250mm dia.	100mm dia.
Measurement fluid	Raw sewage	Raw sewage	Raw sewage
Measurement range	0~15 m <sup>3</sup> /min.	0~10 m <sup>3</sup> /min.	0~3 m <sup>3</sup> /min
Located at	PS10: Lawes Road PS	Flow meter chamber at the receiving well 1 The transmitter to be mounted inside the telemetry panel separately from the sensor	PS15: Gabutu PS
Remark	-		-

Name of Loop	Delivery flow	Delivery flow	Return sludge flow
Equipment No.	01-16FE01	01-17FE01	05FE11/21/31
Quantity	1	1	3
Size meter/pipe line	100mm dia.	400mm dia.	200 mm dia.
Measurement fluid	Raw sewage	Raw sewage	Return sludge
Measurement range	0~3 m <sup>3</sup> /min.	0~30 m <sup>3</sup> /min.	0~10 m <sup>3</sup> /min
Located at	PS16: Horsecamp PS	PS17: kugere PS	STP sludge pump room

Name of Loop	Waste sludge feed flow	Polymer feed flow
Equipment No.	07FE01	07FE12/22
Quantity	1	2
Size meter/pipe line	100 mm dia.	100 mm dia.
Measurement fluid	Waste sludge	Polymer
Measurement range	0~3m <sup>3</sup> /min.	0~2m <sup>3</sup> /hr
Located at	STP sludge treatment building	STP sludge treatment building

**C Ultrasonic type flow meter**

Name of Loop	Blower flow
Equipment No.	05FE11/21/31
Quantity	3
Measurement object	Air
Size meter/pipe line	400mm dia.
Measurement range	0~70 m <sup>3</sup> /min.
Located at	STP blower houses

- D Weir with ultrasonic level-flow converting type flow meter

Name of Loop	Inlet flow	Effluent flow
Equipment No.	02FE01	06FE01
Quantity	1	1
Measurement object	Raw sewage	Treated effluent
Measurement range	0~30 m <sup>3</sup> /min.	0~30 m <sup>3</sup> /min.
Level detection type	Ultrasonic type	Ultrasonic type
Located at	Outlet end of STP grit chamber	Outlet end of STP disinfection tank

## E Ultrasonic type level meter

Name of Loop	Pumping station pump wet well levels	Per-screen channel level	Post-screen channel level
Equipment No.	01-05/10/12//17/LE01,	02LE11/21	02LE12/22
Quantity	4	2	2
Measurement liquid	Raw sewage	Raw sewage	Raw sewage
Measurement range	0~10 m	0~1 m	0~1 m
Located at	PS5 Konedobu PS10: Lawes Road PS PS12: Badili PS PS17: Kaugere PS	Upstream of fine screen at STP grit chamber	Downstream of fine screen at STP grit chamber

## F Differential pressure type level meter

Name of Loop	Chlorine solution tank level	Polymer tank level
Equipment No.	06LE11	07LE11/21
Quantity	1	2
Measurement liquid	Chlorine solution	Polymer
Measurement range	0~5 m	0~5 m
Located at	STP UV disinfection room	STP sludge treatment building
Diaphragm material	Hastelloy-C or Tantalum	Hastelloy-C or Tantalum

## G Conductivity (Electrode)/Float micro-switch type level switches

Name of Loop	Pumping station pump wet well level	STP grit chamber oil discharge pump pit level	STP grit chamber sump level
Equipment No.	01-01/02/03/04/05/06/07/08/09/10/11/12/13/14/15/16/17LS11	02LS01	02LS02
Quantity	17	1	1
Measurement liquid	Raw sewage	Oil and grease	Leakage water
Located at	Each pumping station wet well	STP grit chamber oil discharge pump pit	STP grit chamber base (underground) floor

Name of Loop	STP sludge pump room sump level	STP treated effluent tank level	STP treated effluent tank level for water supply unit
Equipment No.	05LS11/21/	06LS01/	06LS02/
Quantity	2	1	1
Measurement liquid	Leakage water	Treated effluent	Treated effluent
Located at	STP sludge pump room sump	STP treated effluent tank	STP treated effluent tank

Name of Loop	STP waste water tank level	STP sludge treatment building sump level	Utility potable water tank level
Equipment No.	07LS01	07LS02	07LS03
Quantity	1	1	1
Measurement liquid	Waste/filtrate water	Leakage water	Potable water
Located at	STP sludge treatment building waste water tank	STP sludge treatment building waste water tank	STP sludge treatment building utility potable water tank

#### H Strain gauge type load cell weighing meter

Name of Loop	STP cake hopper weight
Equipment No.	07WE01
Quantity	1
Measurement object	Sludge cake
Measurement range	0~5 m
Located at	STP sludge treatment building

#### I Water analyser

Name of Loop	STP oxidation ditch dissolved oxygen meter	STP waste sludge densitometer
Equipment No.	04AE11/21/31	07AE01
Type	Luminescent DO type	Ultrasonic double pass attenuation type
Quantity	3	1
Measurement fluid	Activated sludge	Waste sludge
Measurement range	0~5 mg/l	0~20,000 ppm
Located at	STP oxidation ditches	STP sludge treatment building waste sludge feed pipe

#### J Pressure switch

Name of Loop	STP compressed air pressure
Equipment No.	07PS01
Quantity	17
Measurement liquid	Compressed air
Located at	STP sludge treatment building compressed air pipe

(Note) PS: Pumping Station  
STP: Sewage Treatment Plant

K Proper surge protection devices shall be provided on monitoring and associated equipment to ensure immunity to surge voltages, current or combined effect due to induced voltages, current and switching of equipment in the close vicinity. This shall include, PPL incoming power supply, power feeder to the UPS, both ends of the outgoing power feeder starting from UPS to the field instruments, analogue and pulse signals to the instruments at the telemetry/RIO panels. In case where the instrument is located more than 50m away from the telemetry/RIO panels, additional surge panel shall be provided at the signal transmitter / converter of the instrument to clamp surge voltages induced in the signal and power lines.

Earthing for the instruments shall be provided as per the instrument manufacturer's guide lines for field installation.

**Section 13430****PS 13.04 Panel Mounted and Miscellaneous Instruments**

- A Remote monitoring system for the pumping stations and the flow meter chamber at the receiving well 1 shall be introduced as parts of the SCADA system for the project. The telemetry panels shall be installed at each remote station to collect the field data, such as pump statuses and faults, the generator status and faults, delivery flow, wet well level etc., and transmit them to the STP playing a role of the central monitoring station. The telemeter panels shall consist of a micro PLC, an UPS with 1 kVA and a GPRS modem/gateway to control the standby generator set during PPL power failure and the sewage pumps based on the wet well level in addition to the data collection/transmission. There are 18 places to monitor, from which data shall be transferred to the central monitoring station via remote mobile communication with General Packet Radio Service (GPRS).
- B The telemeter panels shall meet the operational and dimensional requirement as follows:  
Tag No.

<b>Description</b>	<b>Tag Number</b>
PS1: Kaudi PS	01-01 TMP01
PS2: Idubada PS	01-02 TMP01
PS3: Hagara PS	01-03 TMP01
PS4: Hanuabada PS	01-04 TMP01
PS5: Konedobu PS	01-05 TMP01
PS6: Old Yacht Club PS	01-06 TMP01
PS7: Stanley Esplanade PS	01-07TMP01
PS8: Sea Park PS	01-08 TMP01
PS9: Davara PS	01-09 TMP01
PS10: Lawes Road	01-10 TMP01
PS11: Koki PS	01-11 TMP01
PS12: Badili PS	01-12 TMP01
Flow meter chamber at the receiving well 1	01-12 TMP02
PS13: Kila Police PS	01-13TMP01
PS14: Konebada PS	01-14TMP01
PS15: Gabutu PS	01-15TMP01
PS16: Horsecamp PS	01-16TMP01
PS17: Kaugere PS	01-17 TMP01

Purpose:	to control the standby generators and the sewage pumps, to collect/transmit the field data,
Type:	outdoor for 01-12TMP01/02, indoor for the rest, free-standing, metal enclosed
Number:	1 each
IP code :	IP55 for the outdoor type, while IP54 for the indoor type
Dimension for reference:	refer to the drawings
Structure:	same as the LV switchboards
Nameplate:	plastic plate, with engraved black letter on white back-ground
Rated voltage:	AC 600 V
Control voltage:	
Control circuit	AC 240 V
Pilot lamp and protective device	AC 240 V

Inboard lighting and socket outlet AC 240 V

Accessories:

Door key	1 set each
Inboard lighting	1 set each
Lighting door switch	1 set each

- C There are two PLCs with dual redundant configuration and four RIO (Remote Input Output) module stations to be installed in the following local electrical rooms and the administration building central monitoring room respectively at the STP. Auto-mode operation circuits, or linked operation circuits, for plant loads shall be provided in the PLCs, while manual-mode operation circuits shall be provided in each MCC.

Blower house electrical room -1:	04 RIO 01
Blower house electrical room -2:	04 RIO 02
Sludge treatment building electrical room:	07 RIO 01
Electrical substation LV switchgear room:	09 RIO 01
Administration building - monitoring room:	08 PLC 01/02

LCD touch screens shall be mounted on the RIO panels of 02 RIO 01, 04 RIO 01/02 and 09RIO 01 to display the plant status, alarms, the process values, etc., as HMI. The specifications for the LCD touch screen shall be as follows;

type	: colour TFT
colour	: 256 colours
dimension	: 15 inches or more
interface with PLC	: RS 232C or RS 485
definition	: 1280 x 960 pixels (SVGA)
character fonts	: ASCII

The PLCs and RIO modules shall meet the operational and rating requirement as follows:

Tag No.: 02RIO 01, 04 RIO 01/02, 09 RIO 01, 08 PLC 01/02

The 08PLC01 and the 08PLC02 shall be configured in redundant hot-standby system so that the primary PLC shall be taken over to the standby PLC in case of primary PLC failure without interruption to the plant operation.

Purpose: to provide auto-mode and linked operation circuits for plant loads; to input plant loads contacts such as limit switches, faults and status; to utilize them as plant operational conditions; to receive process values of analogue signal and send them to the host supervisory system

Program language: Ladder chart, SFC (Sequential Flow Chart)

The Contractor / the system integrator shall be responsible to provide all the software licences relevant to the above PLCs for the Employer to add / amend the installed program in the PLCs when necessary.

Communication function:

to support a manufacture's own protocol, Ethernet of open system protocol and Microsoft OPC protocol,

08PLC01/02 to be equipped with a PLC link communication port, an Ethernet port and a modem port,

the remaining Remote IO modules shall be equipped with a PLC link communication port

Communication medium

Multi-mode, eight (8) core fibre optic cable for in-plant local area network,

Input /Output capacity

The Input /Output capacity shall be sufficient enough to complete the plant control and monitoring system based on the approved shop-drawings for the detailed process design. The minimum requirements of the I/O numbers are shown below just for guidance only, but not limited to;



	Digital I	Digital O	Analogue I	Analogue O	Pulse I
01-01PLC01	54 or over	6 or over	12 or over	-	2 or over
01-02PLC01	54 or over	6 or over	12 or over	-	2 or over
01-03PLC01	54 or over	6 or over	12 or over	-	2 or over
01-04PLC01	54 or over	6 or over	12 or over	-	2 or over
01-05PLC01	95 or over	14 or over	14 or over	-	2 or over
01-06PLC01	54 or over	6 or over	12 or over	-	2 or over
01-07PLC01	54 or over	6 or over	13 or over	-	2 or over
01-08PLC01	54 or over	6 or over	13 or over	-	2 or over
01-09PLC01	65 or over	8 or over	12 or over	-	2 or over
01-10PLC01	95 or over	14 or over	14 or over	-	2 or over
01-11LC01	54 or over	6 or over	12 or over	-	2 or over
01-12PLC01	95 or over	14 or over	14 or over	-	2 or over
01-12PLC02	3 or over	-	1 or over	-	-
01-13LC01	54 or over	6 or over	12 or over	-	2 or over
01-14LC01	54 or over	6 or over	12 or over	-	2 or over
01-15LC01	54 or over	6 or over	13 or over	-	2 or over
01-16LC01	54 or over	6 or over	13 or over	-	2 or over
01-17PLC01	95 or over	14 or over	14 or over	-	2 or over
04PRIO01	217 or over	56 or over	4 or over	-	-
04RIO02	217 or over	56 or over	4 or over	-	-
07RIO01	238 or over	51 or over	11 or over	6 or over	-
09RIO01	185 or over	42 or over	19 or over	-	2 or over

System loading in the above PLCs and RIOs shall be sized as per the following criteria.

80% - I/O capacity

30% - Processor, including user memory

60% - Communication network (for deterministic protocol)

15% - Communication network (for non-deterministic protocol)

The above percentages shall be based on the capacity available in the approved shop drawings.

#### Spare Parts and Special Tool:

In addition to the items mentioned above, the Contractor shall provide the spare parts and the special tool pertaining to the PLC and RIO modules in protective package as follows;

- 1) Micro PLC complete : 1 set complete
- 2) CPU for PLC, : 1 pc
- 3) power supply unit for PLC, : 1 pc
- 4) power supply unit for RIO, : 1 pc
- 5) communication module for PLC, : 1 pc
- 6) communication module for RIO, : 1 pc
- 7) LCD touch screen : 1 pc
- 8) digital input modules, : 3 pcs
- 9) digital output modules, : 2 pcs
- 10) analogue input modules, : 5 pcs
- 11) analogue output module, : 1 pc
- 12) pulse input module, : 1 pc
- 13) Ethernet switches, : 2 pcs
- 14) surge arresters, : 100 %
- 15) fuses used in the PLC and RIO modules, if any, : 300 %
- 16) multi-mode, eight-core FOC, : 500 m
- 17) FOC splicing machine with accessories required for FOC splicing, : 1 set
- 18) lap top computers with necessary serial communication cables for PLC software maintenance, : 2 sets

The lap top computer shall work on the MS Windows 7 or latest version of MS Window and be loaded with the necessary software for maintenance of the PLC software, which control and monitor the plant.

- 19) erasing/writing device with necessary accessories for program storage memory, such as Flash memory, Flash NAND or EEPROM,: 1 set
- 20) other spare parts/special tools recommended by the manufacture/supplier.

The PLC/RIO panels shall be protected to IP65.

The auto-mode operation and linked operation shall be provided in each PLC as follows:

09 RIO 01:

Two sump drainage pumps (02 DP 01 and 02) shall be controlled automatically on the level switch 02 LS 02.

Two fine screens shall be controlled automatically on pre-set difference levels detected by level elements 02LE11/12 and 02LE12/22, which continuously monitor the levels in the two screen channels.

Two grit collectors shall be controlled automatically on 24-hour-run base.

Two grit pumps shall be controlled automatically on pre-set time schedule (cycle time /duration time). On manually pre-set falling levels the pumps are stopped from 01 PLC 02.

One grit washer /separator shall be controlled in linkage with the grit pumps.

Two oil discharge pumps shall be controlled on level switch 02LS01.

One scum screen shall be controlled in linkage with the grit pumps or four scum pumps to be located at the scum pit of the return sludge pump room.

04 RIO 01/02:

The remote IO module 04 RIO01 shall manage the No.1 and No.2 oxidation ditches and final sedimentation tanks, while the remote IO module 04 RIO02 shall manage the No.3 oxidation ditch and final sedimentation tank.

Four sump drain pumps shall be controlled automatically on a level monitor 04 LS 11/21.

Five blowers shall be controlled automatically on pre-set time schedule (cycle time and duration time), which shall be set according to desired aeration period for each oxidation ditch. The aeration period for each oxidation ditch shall be independent each other. Accordingly, there may three blowers work at a same time. They are separated into two groups, three blowers for NO.1/2 oxidation ditches and the others for No.3 oxidation ditch.

Two air supply valves for No.1 and No.2 oxidation ditches shall be controlled automatically on pre-set time schedule (cycle time), which shall be set on aeration period required for each OD.

Six waste sludge pumps shall be controlled automatically on pre-set time schedule (cycle time/duration time) and a start/stop command from dewatering unit mounted local control unit. The dewatering unit shall start by pressing a start button on completion of the dewatering unit selected and peripheral equipment ready to work. Only one waste sludge pump is selected automatically and cyclically as the duty on the pre-set time schedule in certain period for feeding waste sludge to the duty dewatering unit.

Four mixers each for each oxidation ditch shall be controlled automatically on 24-hour-run basis.

One clarifier each for each final sedimentation tank shall be controlled automatically on 24-hour-run basis.

Two return sludge pump each for each final sedimentation tank shall be controlled automatically on 24-hour-run basis.

## 07 RIO 01:

Two sump drain pumps shall be controlled automatically on level switch 07 LS 02.

Two defoaming pumps shall be controlled automatically on level switch 06 LS 01.

One chlorine tank mixer shall be controlled automatically on 24-hour-run basis.

Two polymer tank mixers, two polymer feeders and ancillary solenoid valves shall be controlled automatically for initiating polymer solution process by pressing a start button on the polymer tank mixer local control panel (07LCP01) under semi-auto mode set by the selector switch "LOCAL-REMOTE-SEMI AUTO". On pressing the start button, the water supply solenoid valve of the duty/selected tank shall open without time lag. A pre-set tank level detected by a level element (07LE11 or 21) activates the tank and the polymer feeder to fill the polymer to mix it into water followed by opening of the air supply valve with some time lag. On a pre-set duration time elapsed, the feeder stops and the air supply valves closes. On detection of a pre-set high level for the tank, the water supply solenoid valve closes followed by stopping of the mixer.

The duty/selected dewatering unit in association with the peripheral equipment, such as the waste sludge pumps the polymer feed pumps and the utility potable water supply unit and the sludge cake conveyer, set in dewatering process by pressing a start button on the dewatering unit local control unit.

Two waste water pumps shall be controlled automatically on level switch 07 LS 01.

PLC shall comprise of necessary processors, Simplex input/output (I/O) modules of the same series of the PLC CPU, communication interface modules and Human-Machine Interface (HMI) to perform the desired functions.

PLC shall have the following attributes as a Hot-Standby Controller.

- carry out sequential logic implementation for operations of plant;
- carry out computation and interfacing for data acquisition, data storage and retrieval;
- it shall accept downloaded program from a programmer;
- it shall have different functional modules to perform the desired functions;
- it shall scan the inputs in time cycles and update the status of its outputs.

The PLC system shall be expandable, OPC Compliant and shall be modular in construction, so as to be capable of future expansion without hardware modifications. PLC's shall be microprocessor based. PLCs shall use standard known protocols and structures for communication outside the system.

No external OPC server shall be considered.

In case of system failure or power supply failure the outputs shall attain a predetermined fail safe condition (this shall normally be 'off'). The PLC used shall have a proven record in the type of application concerned and in the prevailing environmental conditions. PLC System (Panel) should be housed in a dust free environment.

Spare parts;

The spare parts shall be provided in protective package as follows, but not limited to.

- |                         |         |
|-------------------------|---------|
| 1) power distributors,  | : 10 %  |
| 2) signal distributors  | : 10 %  |
| 3) surge arresters,     | : 50 %  |
| 4) LED indicator lamps, | : 100 % |

- 5) circuit fuses if any, : 300 %
- 6) PVC/PVC sealed, 1.5mm<sup>2</sup>, 2-core control cable : 100 m
- 7) PVC/PVC, 1.5mm<sup>2</sup>, 5-core control cable : 100 m
- 8) PVC/PVC, 1.5mm<sup>2</sup>, 10-core control cable : 100 m
- 9) PVC/PVC, 1.5mm<sup>2</sup>, 15-core control cable : 100 m
- 10) PVC/PVC, 1.5mm<sup>2</sup>, 20-core control cable : 100 m
- 11) other spare parts recommended by the suppliers

## Section 13450

### PS 13.05 Supervisory Control and Data Acquisition System

- A There shall be two Operator Stations (OS01/02), two servers, one Engineering Station, one LCD large screen and two PLCs installed in the Administration Building monitoring room to comprise the SCADA system as the major components. The GPRS modem/gateway, the managed Ethernet switch, fibre optic cable patch panels, power cables, twisted pair cables, coaxial cables and multi-mode fibre optic cables shall be furnished to make the SCADA system complete. The SCADA architecture is shown on the drawing Kila Kila STP SCADA System Diagram STP-E-008.
- B The data collected at the pumping stations and the flow meter chamber shall be transferred to the operator work stations and servers through GPRS wireless network, to which the GPRS modems/gateways at the remote pumping stations, the remote flow meter chamber and the STP can access.
- C The two Operator Stations (08OS01/02) shall play the role of human-machine interface to monitor the plant loads status, failure and process values through a graphical interface at the central monitoring room level. One (08OS01) of the two operator station is used mainly for monitoring the pumping stations and the flow meter chamber located along the coastal line, while the other one (08OS02) is used mainly for monitoring/controlling the STP. Furthermore, the interface on 08OS02) shall allow operators to change the set points and time schedule listed below;
- 1) time schedule for the fine screens,
  - 2) level difference for the fine screens
  - 3) time schedule for the grit chamber
  - 4) time schedule for the blowers
  - 5) DO set points for the blowers
  - 6) Time schedule for the waste sludge pumps
  - 7) numbers in service for the return sludge
  - 8) low level point for the chlorine solution tank to stop
  - 9) time schedule for the polymer solution system for the dewatering units
  - 10) mixer start levels of the polymer tanks for the mixer to start
  - 11) water supply stop level points for the water supply valve of the polymer tank to close
  - 12) speed set points for the dewatering unit screw VFD
- D The PLCs at the STP shall be the interface between the Operator Stations, the servers and the Remote I/O stations installed in the local electrical rooms to collect the data from local control level, such as plant loads status, failure and process values, and to transmit the information to the upper level Servers. The two PLCs shall be configured as dual redundant system, one primary and the other hot-standby, so that the standby PLC can take over the primary PLC in case of the primary PLC failure without interruption to the plant operation. Each PLC shall comprise a CPU, a power supply unit and a communication port to establish the dual redundant system. The two PLCs and the four remote input/output stations shall be connected to the multi-mode fibre

optic cable and shall communicate with each other by Ethernet protocol, OPC and or other open protocol standard.

- E The servers shall play a data processing role so that it can generate the required reports, such as daily, monthly and yearly reports, historical trend graphs, historical process running and historical alarms.
- F The Engineering station shall enable to set up, modify and maintain the SCADA system in order to operate the pumping stations and the pumping stations and the STP properly.
- G The LCD large screen shall be installed at the administration monitoring, the monitoring room to show the plant outline, plant statuses, process values, historical trends etc., for operators and visitors. The LCD screen shall meet the operational and rating requirements as follows;

size:	70 inches
aspect ratio:	16:9
native resolution:	1920 x 1080
display resolution:	1920 x 1080p (full HD)
dynamic contrast ratio (internal):	15,00:1
on-screen contrast ratio:	1,500:1
viewing angle (Right/Left):	170°or over (85° or over/ 85° or over)
viewing angle (Up/Down):	170°or over (85° or over/ 85° or over)
inputs and outputs	
analogue audio inputs:	6
analogue audio input for HDMI	
audio out:	1
component video(Y/Pb/Pr) input:	1
composite video input:	1
digital audio output:	1
digital meda port:	1
Ethernet connection:	1
HDMI™ connection:	1
PC in (D-sub) + Audio in (stereo mini):	1
RS-232C:	1
USB2.0:	1

- H One monochrome laser printers and one colour laser printer together with a printer desk shall be installed at the administration building, the monitoring room to print alarm events of the plant processes, the operation status of the plant processes and to print the reports such as hourly, daily, monthly and yearly. The printers shall be complied with the following requirement;

print speed	: 30 pages per minute at full colour graphics.
colours	: to be compatible with VDU image.
paper feed	: A3/A4 with auto sheet feeder mechanism and minimum 50 sheets per tray.
paper width	: A4/A3.
resolution	: 600 DPI.
character set	: Full ASCII.

- I Data Storage

A historical data storage system with removable media for archive and backup shall be provided.

The data storage system shall store alarms and events, with the time of occurrence for one month and selected analogue signals connected to the system. All alarms and events shall be archived in a first in first out buffer, for a period of 40 days.

A high speed back up device with removable media, such as streaming tape cartridge or optical disk, shall be provided for each , suitable for backing up the whole system on a weekly basis. Data selected for archive shall be written to removable media which shall be sized to support at least 40-day worth of archive data.

At least one double DVD write/rewrite/read with +R and -R capacity in addition to the historical data storage device in the Operator Stations should be provided.

- J Ergonomic operator console desk/furniture shall be provided for housing the SCADA components neatly with necessary furniture at the administration building monitoring room. As a minimum, the furniture shall include desk(s), two chairs, one cabinet for the storage of the as-built drawings, the O&M manuals, daily/monthly/yearly reports, alarm lists etc., and other necessary furniture, if any. The shop drawings for arranging the master station equipment shall be submitted for the Engineer's approval.

K Software Functions

**General:**

The Contractor shall be responsible for supplying complete software packages including licenses to enable the equipment to control the plant adequately as stated in this specification. Provision must be made for the adding of further software tasks as and when required.

All software functions shall be user friendly, with instruction and messages to aid the operator. The Contractor shall make available all standard software functions, even if not specifically detailed in the specification.

The computers shall utilise a real time multi-tasking and networked operating system with a proven track record in real time control applications.

The Operating System shall be Windows 7 or latest MS version, loaded with MS-Office latest licensed version suitable for interconnection with external networks in a Wide Area Network (WAN) configuration, where specified.

The Application Software shall provide communication with other industrial standard open networks. The Software shall support Object Linked Embedding for Process Control (OPC). External interfaces are not allowed for OPC.

The System shall support a fully distributed 64-bit Client/Server architecture.

The System shall include Visual Basic for Applications (VBA) as a built-in programming language. Facility shall be available for building custom objects using VBA

Object oriented graphics and tools to easily build reusable control strategies.

The SCADA software & Hardware shall support OPC standards as both a client and a server for fast and reliable communications with a wide variety of hardware devices.

Provide Active-X controls with selection of third-party Active-X controls for ready-made solutions without VBA programming.

The SCADA software shall use SQL server as the integral database.

A standard software package, such as Crystal Report shall be provided to facilitate generation of free format, intuitive and presentation quality reports.

The Engineering Workstation shall be provided with simulation tools to support off-line testing of the control logics.

The Server shall provide the master clock for the SCADA time synchronization.

The system software shall be from the SCADA equipment manufacturer. Third party software is not acceptable.

It is a requirement that the system be supported by on line configuration and editing of all VDU mimic displays and database and to create new displays and additional database.

Operational mimics and other graphics shall be presented in an industry standard graphical user interface (GUI) format. A minimum of three active windows shall be displayable concurrently. Both text and graphics shall resize automatically to accommodate changes made to the size of a window. The system shall be designed to minimise the operator use of the keyboard. All major functions shall be accessible on-screen through use of the mouse or track ball.

Operator system entry, for each area will be password coded with different levels of entry depending on the level of authority of the operator. Development and systems level entry passwords will be provided for engineering workstations. Each action taken by any operator at any level of entry, or at any operator terminal, shall be log file recorded and time and date stamped. Log in and out time and dates will be printed on the control room event logging printer.

VDU mimics will display dynamic colour details of flow rates, plant load statuses, wet well levels, tank levels, alarms, electrical power supplies and other general equipment status conditions. All requests and commands shall be via icons, whether menu linked or linked to equipment control actions. A permanent dynamic alarm banner shall be displayed at the bottom or top of each operator screen. Each control action will be routed through a series of confirmation routines.

The reports shall be available for printing in graph or tabular format. Dynamic trend displays shall also be available for all analogue flow and level values. Custom, as well as preconfigured reports and trends shall be available to a higher level of entry. A colour, A4/A3 size, screen dump printer shall be provided for graph and trend prints.

An operator help utility shall be provided, offering help linked to the particular action being carried out by the operator at that time. At least one help screen per screen page shall be available. This facility shall be preconfigured with an option for updating by operators, via a password entry.

The Application Server software shall be configurable to provide for the monitoring and control of all points, loops, and systems through graphic display screens and hard copy reports. These shall include:

Parameter Displays for signal control

Control Loop Status Displays

Real Time and Historical Data Trend Displays

Event Displays and Log Reports

Alarm Displays and Log Reports

Equipment Diagnostic Displays and Reports.

The system shall provide on-line diagnostics that display the current status and operation of the local area network and its nodes. The diagnostic display shall include the LAN adapter status for the machine showing the display, as well as the current number of messages, errors and retries.

The system shall conform to and take advantage of industry standards. These shall include, but not be limited to:

**ODBC**

**OLE**

**ActiveX**

**COM/DCOM**

**DDE and Advance DDE**

**C programming language**

**Visual Basic**

**Microsoft Windows 7 or the most current Operating System**

**TCP/IP**

**OPC**

**XML**

It must be possible to integrate standard Windows applications such as Microsoft® Excel, Microsoft® Word and Microsoft® Access by means of the standard mechanisms OLE/ActiveX, ODBC/SQL. Any user programs (e.g. individual data management, analysis, process optimization) must work together with the control system via the integrated C programming interface and then utilize both the control system data and the control system functions.

The control system must be OPC-compatible in order to allow cross-vendor communication. The different OPC standards (DA, HDA and A&E) must be taken into consideration here. Current process data regarding this should be made available to other computers and applications. In this way, any computer that is connected to the network should be able to access all of the control system's data. The use of a standard database (Microsoft® SQL Server 2000) is required to store (write-protected) all of the list-oriented configuration data such as lists of variables and message texts as well as current process data such as messages, measured values and user data sets in order to be able to access the database via the opened programming interfaces C-API or OLE-DB. Work steps in the engineering phase should be automated and the configuration environment should be individually expandable through the integration of the standard tool Visual Basic for Applications (this simplifies the generation of mass data).

It is critical that the control system should offer the capability of homogeneously integrating other applications and application blocks into the user interface for process operation. Both the application windows and the OLE Custom Controls (32 bit OCX objects) or ActiveX Controls can be integrated into the control system application as if they were the control system's own objects. It should be possible to use the ANSI-C script language and Visual Basic Scripting for dynamizing graphical objects.

#### Spare Parts and others

It is responsible for the Contractor to provide the following spare parts and other items but not limited to.

1. 25% rounded up spare units of each supplied category and include 03 Nos. of fuses per each device.
2. two set of GPRS modem and wireless gateway.
3. ten pieces of each indication lamp.
4. ten pieces of each type control switch
5. ten pieces of each type fuse



6. ten sets of each type tonner cartridge
7. A4/A3 papers for the printer for 2 year operation.
8. one piece for each diameter of short pipe used for the electromagnetic flow meter maintenance purposes.

#### **PS 13.06 Testing and Commissioning**

It is necessary to conduct all testing and commissioning without disturbing or interrupting the existing system. According to the subcontractor in places where the plant or section of the plant need to be stopped, justification for such stoppage and the time required and time plan to test and commission must be documented with the tender proposal.

#### **PS 13.07 Service Contract**

##### **A General**

ICM sub-contractor may enter into a new contract agreement and should supply his services to maintain the system in the working condition and proper order for a period of two years after defect liability period. All maintenance requirements are listed in this section shall not be covered by the service contract as specified in each subsection, but not limited to propose such services by the ICM sub-contractor where responsibilities overlap.

- B Fault finding and Replacement of hardware Instrumentation Devices  
This shall not be covered by the service contract and is expected to be conducted by the internal staff of EDA RANU.
- C Fault finding and Replacement of Network Switches and Optical Modems  
This shall not be covered by the service contract and is expected to be conducted by the internal staff of NWSDB.
- D Fault finding and Replacement of Electrical Accessories in ICM cabinets and panels  
This shall not be covered by the service contract and is expected to be conducted by the internal staff of EDA RANU.
- E Fault finding and Replacement of PLC input/output modules  
This shall not be covered by the service contract and is expected to be conducted by the internal staff of EDA RANU.
- F Fault finding and Replacement of touch operator panels  
This need not be covered by the service contract but not limited to propose by the ICM contractor if this overlaps with subsection 4.10.
- G Fault finding and Replacement of cables and wires  
This shall not be covered by the service contract and is expected to be conducted by the internal staff of EDA RANU.
- H Fault finding and Replacement of PLC CPU units  
This need not be covered by the service contract but not limited to propose by the ICM contractor if this overlaps with subsection 4.10.
- I Fault finding and Replacement of computer servers, stations at administrative building  
This shall be covered by the service contract where SCADA system has to be reinstalled in the replacement

- J Installation of software required in case of updates or failure of a computer server, PLC CPU or touch operator panel.  
This shall be covered by the service contract
- K Software Modification of ICM system  
This shall be covered with a condition to pay for the extra work. The amount of work shall be considered on the basis of man hour or man days of a competent ICM engineer that should be clearly documented at the submission of the service agreement.

### **PS 13.08 Training program**

The SCADA System integrator shall impart a training program to EDA RANU engineers & management personnel.

The Contractor/ system integrator shall conduct training courses for personnel selected by EDA RANU.

Training shall be conducted by personnel employed by the Contractor/ system integrator familiar with the system supplied and who have experience and training in developing and implementing instructional courses.

The Contractor/ system integrator shall make a workbook on each course available to every person taking the courses listed herein. The workbook will be of sufficient detail so that, at a later date, a trainee could review in detail the major topics of the course.

Training program shall be held in a phased manner. Typical program would be as follows:

- Training to EDA RANU engineers before Factory acceptance test.
- Training to EDA RANU engineers after Site acceptance test.

Training program shall be developed for personnel who have computers & electronics experience, but shall not assume any familiarity with the specific hardware furnished. The training need not be limited to the identified modules, but the modules should be considered as minimum guidelines. In any case, the training program shall be submitted to the Engineer for approval.

As a minimum, the following subjects shall be covered:

- System Architecture and Layout
- Hardware Components, maintenance and troubleshooting.
- Module Switch Settings (Configuration Switches)
- Fieldbus device management
- System Engineering, software updating, future modifications and distribution control
- Administration, operations and installation
- IOP programming and Diagnostic techniques
- Assembly and Testing of components
- PC and workstation familiarization and maintenance:
- Disassembly
- Component Replacement
- Re-assembly.

**END OF DIVISION 13**

Appendix I -FDS**Division 13 – Appendix I Functional Design Specification**

## Abbreviations Used

API	Application Program Interface
COM/DCOM	Computer Object Model/ Distributed Computer Object Model
CPU	Central Processor Unit
DDE	Dynamic Data Exchange
DLP	Data Loss Prevention
DO	Dissolved Oxygen
FOC	Fibre Optic Cable
GPRS	General Packet Radio Service
GSM	Global System for Mobile
HMI	Human Machine Interface
IEC	International Electrotechnical Commission
I/O	Input / Output
ISO	International Standards Organization
IT	Information Technology
LAN	Local Area Network
MUX	Multiplexer
OPC	OLE for Process Control
OSI	Open Systems Interconnect
PLC	Programmable Logic Controller
RIO	Remote Input/Output
RTU	Remote Terminal Unit
SCADA	Supervisory Control and Data Acquisition
STP	Sewage Treatment Plant
TCP/IP	Transmission Control Protocol/Internet Protocol
TE	Treated Effluent
Windows™	Microsoft Windows
XML	Extensible Markup Language

## **1. General Control Philosophy**

This Appendix I describes the general control philosophy that is applicable for all PS(s), pumping mains and STP. These requirements are specified for design concept only and the information provided is not intended for construction.

Incoming raw sewage shall be screened by a detachable cage located upstream of each PS (Pumping Station) and shall be pumped to the PS or the STP located downstream of the PS concerned by sewage pumps designated as PS Pumps. There is one receiving well, RW1, proposed to receive the pumped and/or gravity sewage from the Lawes Road PS, the Badili PS and the Gabutu PS.

The pumped sewage from the Kaugere PS shall enter the coarse/medium screen common inlet channel and shall flow by gravity through the coarse screens, the medium screens and the grit chambers for screening and de-gritting of the sewage.

The de-gritted sewage shall flow by gravity to the distribution chamber and then shall be distributed to the oxidation ditches for biological treatment. The mixed liquor from the oxidation ditches shall overflow by gravity to effluent pits of the oxidation ditch and shall then be flown to final sedimentation tanks (clarifiers). Waste sludge pumps shall be installed in the oxidation ditches to remove a portion of the sludge from the biological treatment system as waste sludge and route it to dewatering units. Most of the sludge from the bottom of the clarifiers shall be returned to the upstream end to the effluent pit in the oxidation ditches by the return sludge pumps.

The treated effluent from the clarifiers shall overflow by gravity to the treated water tanks. Effluent shall be disinfected in the treated water tanks by ultraviolet disinfection units before being discharged by gravity to ocean via an outfall pipe. A portion of the disinfected effluent in the treated water tank shall be pumped to a water TE supply unit via auto strainers for general in-plant use such as landscape irrigation, cleaning, washing, and miscellaneous maintenance. A portion of the treated water without disinfection shall be pumped to the oxidation ditches for de-foaming in the ditches.

The waste sludge shall be dewatered by the dewatering units for reduction of the sludge volume. The dewatered sludge shall be conveyed to a sludge cake hopper for storage before disposing to the sludge disposal lot proposed at the Morata STP. The stored sludge in the sludge cake hopper shall be dumped to a sludge tanker for conveying to the Morata STP.

The STP control system shall include a dual hot standby central main plant PLC. Signals from instrument groups belonging to common unit processes, control loops, or package systems, shall typically be transmitted to RIO (Remote Input/Output) panels or local control panels dedicated to the

respective unit processes, control loops, or package systems. The following specific systems may be provided with their own dedicated PLC, and all signals from these systems shall be transmitted to the plant main PLC via the related RIOs.

- Dewatering units
- Ultra violet disinfection units
- Biological odor control unit

The control logic for the above systems shall be programmed by the system supplier into the system PLC, if provided. However, all signals received or generated by the system PLC, including alarms, shall also be transmitted to the STP SCADA HMI for monitoring, and operator shall have option to provide all required operator input (including but not limited to set points, start/stop control, open/close control, speed control, etc.) either at the system PLC or at the STP SCADA HMI.

All signals between the RIO panels and the main plant PLC shall be transmitted using FOC (Fibre Optic Cable). A central monitoring/control room shall be provided in the administration building at the STP. The followings shall be provided in the central monitoring/control room at a minimum:

- Dual redundant SCADA system (two Operator Stations and Dual redundant Servers)
- Historian system
- Engineering station
- Network printers and managed Ethernet switches
- Wireless communication equipment (GPRS)

The tag numbering system will be developed in a logical, meaningful, modular, and expandable way for all control elements, including but not limited to equipment, instruments, actuators, and control loops. The numbering system shall be such that components of the tag number provide immediate indication of the type of element (e.g. pump, blower, gate, valve, mixer, flow meter, etc.), its location and/or unit process, and the number of similar modular units proposed. The system shall allow for easy modifications such as future addition of units for expansion. The Contractor shall submit the tag numbering system for Engineer's review and approval prior to implementation.

I/O list will be developed in each hierarchy level such as field level, local control panel, local electrical/MCC room level, STP central control room level. The I/O list will be categorized into discrete input/output signals, analog input/output signals, signals through field bus, and signals through LAN communication at each level. The list shall also contain process/equipment status and alarm/fault signals, commands to process, and log items for historical records. All alarms shall be visually and prominently indicated at the local control panel, the STP SCADA HMI. Critical alarms

Appendix I - FDS

shall also be annunciated with flashing/strobe lights and audio sirens at selected locations throughout the PS/STP sites.

## **2. Pumping Station (PS)**

Each PS comprises at minimum a pump wet well, a detachable cage screen, submersible pumps, pump control panel(s), a standby generator set an RTU (Remote Terminal Unit) and GPRS wireless gateway. Flow meters are also proposed for monitoring collected sewage flow properly within the proposed catchment area on discharge header of the PSs as follows;

- PS-5, Konedobu
- PS-7, Stanley Esplanade
- PS-8, Sea Park
- PS-10, Lawes Road
- PS-12, Badili (at the receiving manhole, MH1)
- PS-15, Gabutu
- PS-16, Horsecamp
- PS-17, Kaugere

For pump control and warning of high-high level of a wet well, level transmitters and or level switches will be installed at each PS. The level transmitters and the level switches (conductivity/electrode type or float type) will be installed in the wet wells at the large size pumping stations, such as PS5 Konedobu, PS10 Lawes Road, PS12 Badili and PS17 Kaugere, while the rest small size pumping stations will be equipped with only level switches.

The data collected at the RTU from the field of the pump stations are transmitted to the SCADA system at the STP for monitoring and data processing. In addition to the sewage flows and the wet well levels, the wet well high-high levels, pump statuses, pump alarms, electricity power consumption, electrical alarms and generator set statuses and generator set alarms are transmitted to the SCADA system for monitoring and instructions of troubleshooting. The above data can be seen at both the RTU at the PS and the SCADA HMI at the STP through GPRS network.

### **(1) Detachable Cage Screens**

Pumped or gravity sewage flow shall enter the pump well of the pump stations. The detachable cage screen is provided upstream of the pump well at each PS for screening the sewage. The screenings screened in the cage screen shall be disposed at certain interval in a fully manual way by operators.

## **(2) Sewage Pumps**

The raw sewage enters the wet well after passing through the detachable cage screen.

The pumps shall be constant speed. Ultrasonic level elements as well as low, low-low, high, and high-high level switches shall be installed in the wet wells of the high priority PSs above mentioned. .

The pumps shall be operable manually at a pump control panel located adjacent to the equipment or in generator house. In auto mode, sequencing shall be controlled based on wet well level. The operator shall be able to specify start and stop levels for each working pump. As wet well level rises, pump 1 shall be started first as the level reaches its start level. As the level continues to rise from start level for pump 1 to start level of pump 2 in the PSs with two duty pumps equipped, pump 2 shall be started. For the PSs with one duty pump equipped, one working pump shall be started or stopped as per levels for the pump to start or stop.

The above sequencing shall be reversed for decreasing wet well level. A lead pump, a second pump and a third pump for the PSs with two duty pumps equipped are selectable by a change-over switch “1/2/3 – 2/3/1 – 3/1/2” on the pump control panels. For the PSs with one duty pump, a duty pump shall be selected by a change- over switch “NO.1 – Alternate – No.2”.

An electromagnetic type flow meter installed on the raw sewage pump discharge header of the above mentioned PSs shall measure and transmit the raw sewage flow to the STP SCADA HMI.

## **3. Grit Chamber at STP**

### **(1) Screens**

The pumped sewage from the Horsecamp PS and the Kaugere PS will enter the screen inlet channel. Gates with manual hand-wheel operators and stop logs shall be installed upstream and downstream of the coarse screens and the medium screens respectively so that each screen channel can be isolated for maintenance.

The medium screens (M02-02-01/02) shall be operable manually from the local control panel (02LCP01) located adjacent to the equipment. In auto mode, operation of the screen rake mechanism shall be controlled by level differential with a timer override. Level elements (02LE11/21 for upstream and 02LE12/22 for downstream) shall be installed both upstream and downstream of the screens. When the upstream minus downstream level differential reaches an operator specified maximum, a screen cleaning cycle shall be initiated. Alternatively, the operator may also specify a maximum interval between cleaning cycles. If this interval elapses without cleaning, a cleaning cycle shall be initiated regardless of level differential. The upstream and downstream levels shall be

continuously monitored by ultrasonic type level sensors/transmitters. The flushing valve shall open/close in the auto mode in linkage with the associated screen running condition. The screens can be operated manually by the operator at a local control panel located adjacent to the equipment during trouble shooting or maintenance. The flushing valve will also be operated manually by the operator at the above local control panel.

Removed screenings/debris will be washed prior to being disposed into the skip through a belt conveyer.

### **(2) Screenings Conveyer**

The conveyer (M02-10) shall operate in an auto mode in association with the medium screens. The conveyer will also be operated manually by the operator at the local control panel (02PLC01) above mentioned during trouble shooting or maintenance.

### **(3) Grit Collectors**

The grit collectors (M02-03-01/02) will be installed in the grit basins to collect settled grit into the central pits of the basins.

The collectors shall run continuously when the grit chamber is in service. The grit collector will also be operated manually by the operator at the local control panel (02LCP02) located adjacent to the equipment during trouble shooting or maintenance.

### **(4) Grit Pumps and Flow Measuring Weir**

The grit pumps (M02-04-01/02) will be installed at dry area out of the grit basins to extract settled grit into the grit washer/separator located above the grit pump room of the basins.

In auto mode, the grit pumps shall run according to pre-set time schedule, which is accessible at the RIO panel HMI or at the SCADA HMI by the operator. There shall be two kind of timers provided, namely cycle time and duration time. The grit pumps will also be operated manually by the operator at the local control panel (02LCP03) located adjacent to the equipment during trouble shooting or maintenance.

The de-gritted sewage overflows to a flow measuring weir and then to the distribution chamber. The sewage flow shall be measured continuously at the weir with the ultrasonic type level transmitter and the level-flow converter (02FE01).



### **(5) Grit Washers/Separator**

The grit washer/separator (M02-06) shall be manually operable at the local control panel (02LCP04) located adjacent to the equipment during troubleshooting or maintenance. The flushing valves shall be manually operable at the local control panel (02LCP04) above mentioned during troubleshooting or maintenance.

In auto mode, the grit washer/separator shall be controlled in linkage with the grit pumps. The flushing valve shall open/close automatically in the auto mode in linkage with the grit washer/separator

### **(6) Oil Skimmer**

The oil skimmer (M02-07) will be installed at downstream end of grit chamber effluent channel to skim off fat and oil from the screened and de-gritted sewage.

### **(7) Oil Discharge/Transfer Pumps**

The oil discharge/transfer pumps (M02-08-01/02) will be installed in an oil pit to transfer the oil/fat skimmed off by the oil skimmer at downstream end of the grit chamber effluent channel.

The oil discharge/transfer pumps shall be manually operable at the local control panel (02LCP05) located adjacent to the equipment during troubleshooting or maintenance.

In auto mode, the oil discharge/transfer pumps will be started and stopped according to the oil pit levels detected by level switches (02LS01).

The pumped oil/fat will enter the scum screen for further treatment.

### **(8) Scum Screen**

The scum screen (M02-09) will be installed on grit chamber top slab between the screenings conveyer and the grit collectors to screen out the oil/fat from the pumped fluid by the oil discharge pumps and the scum pumps located at the sludge pump room.

In auto mode, the scum screen shall run in association with the grit pumps (M02-04-01/02) or the scum pumps (M05-06-01/02/03/04). The flushing valve shall open/close automatically in the auto mode in linkage with the scum screen.

The scum pumps will also be operated manually by the operator at the local control panel (02LCP06) located adjacent to the equipment during trouble shooting or maintenance. The flushing valves shall also be manually operable at the local control panel (02LCP06) above mentioned during troubleshooting or maintenance.

The de-oiled sewage flows to the upstream end of the grit chamber by gravity.

## **(9) Sump Drain Pumps**

The sump drain pumps (M02-05-01/02) shall be manually operable at a local control panel (02LCP07) located adjacent to the equipment during troubleshooting or maintenance.

In auto mode, the sump drain pumps will be started and stopped according to a high level switch and a low level switch provided in the sump. A high-high level switch and a low-low level switch will also be installed in the sump to generate alarms on activation of them. The pumped fluid flows to the upstream end of the grit chamber.

## **4. Biological Treatment Process at STP**

Three numbers of oxidation ditches will be constructed at the first stage for achieving biological treatment process on the screened and de-gritted sewage delivered by gravity from the distribution chamber. Each ditch is equipped with two groups of air diffusers and two groups (two sets for each) of mixers for supplying and mixing air into the sewage. The two groups of air diffusers in each ditch are connected to common header, which is arranged to discharge header of three blowers for two oxidation ditches (No.1 and No.2). Positive displacement type blowers are arranged to the discharge header in a formation of two duty and one standby for the Oxidation ditches No.1 and No.2. For the Oxidation ditch No.3, one duty and one standby blower are arranged to discharge header. One motorized valve will be installed on a header of each oxidation ditch diffusers. One DO meter will be installed at appropriate point, normally farthest end to the effluent pit along sewage flow in the ditch, in each ditch for monitoring and controlling the blowers.

### **(1) Aeration Blowers**

The three blowers (M04-05-01/02/03) and the two blowers (M04-05-04/05) shall be connected to different common headers which supply air to the oxidation ditches No.1 and No.2, and the oxidation ditch No.3 respectively.

The aeration blowers shall be operable manually at a local control panel (04LCP07/08) located adjacent to the equipment.

In remote auto mode, AUTO – DO or AUTO – TIMED mode is selectable by the operators and DO set value and cycle/duration time schedule shall be set up the RIO panel HMI (04RIO01/02) or at the SCADA HMI (04OS02) by the operators. The late sets for the time schedule or the DO set value shall override the existing set values regardless of the HMIs. Under AUTO – DO mode, the blower will start and stop according to DO measured values. Two blowers out of the three blowers for the oxidation No.1 and No.2 will start when both the measured DO values for No.1 and No.2 ditches are less than DO set value. One blower of the two running blowers will stop with some time lag when one

of the measured DO values is above the set value. DO values in the oxidation ditches are continuously measured for monitoring and controlling the blowers by DO meter (04AE01).

Under AUTO – TIMED mode, the blowers will start and stop according to pre-set cycle/duration time schedule, which are set to each oxidation ditch independently at the RIO panel HMI or at the STP SCADA HMI by the operators. Since the blowers are not arranged exclusively use to each oxidation ditch, the motorized valves connected to the No.1 and No.2 oxidation ditches will be opened and closed corresponding On-duration and Off-duration respectively according to the pre-set cycle/duration time schedule to the oxidation ditches. An operator-programmable timed sequence shall be the primary control mechanism for the duration of the total overall cycle time as well as of each individual phase of the cycle. The operator shall be able to implement fully flexible cycle times by programming a timed sequence of open/close, start/stop, or activate/deactivate events.

Air flows are measured by ultrasonic type flow meters (04FE11/21/31) located on the root of each air supply pipe for monitoring.

## **(2) Air Supply Valves**

The air supply valves (M04-07/01/02) with motorized will be installed on air supply root pipe of the air diffusers.

The air supply valves shall be operable manually at an actuator interface control panel for troubleshooting or maintenance. In auto mode, the air supply valves will be opened and closed in accordance with the time schedule mentioned above.

## **(3) Mixers**

Under normal operation, the mixers (M04-02-01/02/03/04/05/06/07/08/09/10/11/12) shall run continuously in remote auto mode when the oxidation ditches set in service.

All mixers shall be operable manually in the field at the local control panels (04LCP01/02/03/04/06/06) for trouble-shooting and maintenance.

## **(4) Waste Sludge Pumps**

There will be two sets of the waste sludge pumps for each oxidation ditch and six sets of that in total installed with one duty and one standby formation for each oxidation ditch.

Under normal operation, the waste sludge pump (M04-08-01/02/03/04/05/06) shall be controlled in remote auto mode. In remote auto mode, the waste sludge pumps shall be controlled according to pre-set time schedules and dewatering unit running condition.

In the time schedule, one set pump only out of three duties is scheduled to run for certain period and in cyclic formation so that the waste sludge from the three oxidation ditches shall be removed from

each oxidation ditch evenly. The removed waste sludge shall be fed to the dewatering units for sludge volume reduction.

The waste sludge pumps shall be manually operable at the local operation panels (04LCP09/10/11) located adjacent to the equipment.

Waste sludge flows are continuously measured by electro-magnetic type flow meter (07FE01) located on the waste sludge feed pipe to the dewatering units for monitoring.

#### **(5) Clarifier**

The clarifiers (M05-01-01/02/03) shall be manually operable in the field at the local control panels (05LCP01/02/03). Alarms shall be generated on operator-selectable values for high torque and high-high torque. High-High torque shall also shut down the drive motor via a hardwire interlock. The clarifier motor and drive shall be capable of reversing direction using a pushbutton switch that is normally off and that the operator can push and hold for the duration of the desired reverse rotation.

#### **(6) Return Sludge Pumps**

Under normal operation, the return sludge pumps (M05-02-01/02/03/04/05/06) shall run continuously in remote auto mode.

The return sludge pumps shall be manually operable at the local control panels (05LCP04/05/06) located adjacent to the equipment.

Return sludge flows are continuously measured by electro-magnetic type flow meters (05FE11/21/31) located on the return sludge pipes for monitoring.

#### **(7) Scum Pumps (for the Final Sedimentation Tanks)**

Under normal operation, the scum pumps (M05-05-01/02/03/04) shall be controlled in remote auto mode. In this mode, the designated working pump shall start when wet well level reaches the high level switch and shall stop when the level reaches the low level switch. Alarms shall be activated on activation of low-low and high-high level switches. In addition, the pumps shall be shut down on low-low level via a hardwire interlock.

The scum pumps shall be manually operable at the local control panels (05LCP07/08) located adjacent to the equipment.

#### **(8) Sump Drain Pumps**

The sump drain pumps (M05-04-01/02/03/04) shall be manually operable at the local control panel (05LCP09/10) located adjacent to the equipment during troubleshooting or maintenance.

In auto mode, the sump drain pumps will be started and stopped according to a high level switch and a low level switch provided in a sump. A high-high level switch and a low-low level switch are also installed in the sump to generate alarms on activation of them.

### **(9) Chlorine Disinfection**

The chlorine disinfection system consists of one chlorine-solution tank, one chlorine solution storage tank and two chlorine solution dosing chargers. Chlorine solution will be dosed to the effluent end point of the treated/disinfection tank through the chlorine solution dosing charger by gravity.

Under normal operation, the chlorine solution tank mixer shall be controlled in remote auto mode. In remote auto mode, the mixer (M06-01) shall run continuously on 24-hour-a-day basis. On activation of low level of the tank, the mixer shall be tripped off for preventing it from dry running..

The mixer shall be manually operable at the local control panel (06LCP01) located adjacent to the equipment.

The differential pressure type level meter (06LE011) will be installed on the side of the tanks for monitoring and management of purchasing chlorine.

### **(10) Utility TE (Treated Effluent) Water Supply Unit Pumps**

Under normal operation, the utility water supply unit (M06-04) pumps shall operate in local auto mode set on the unit control panel supplied by the water supply unit manufacturer/vendor. In the auto mode, the operator-specified working pump shall start on low pressure level in the pressurized tank, and shall stop on high pressure level in the tank. High-high and low-low level pressure switches shall be provided in the tank and shall both activate alarms. The high-high pressure switch shall also automatically shut down the water supply unit pumps via a hardwire interlock.

The utility TE water pumps shall be manually operable at the unit control panel mounted on the water supply unit for troubleshooting and maintenance.

### **(11) De-foaming Pumps**

The de-foaming pumps (M06-06-01/02) will be installed in the effluent point of the disinfection tank to feed water to the oxidation ditches for dissipating foam on the oxidation tanks. Under normal operation, the de-foaming pumps shall operate in remote mode set on the local control panel (06LCP02). In the auto mode, the pump shall run continuously on 24-hour-a-day basis. The low-low level switch (06LS01) shall also automatically shut down the de-foaming pumps via a hardwire interlock.

The de-foaming shall be manually operable at the local control panel (06LCP02) for troubleshooting and maintenance.

## **(12) Ultraviolet Disinfection Unit**

The UV (ultraviolet) disinfection units (M06-07-01/02) will be installed in the disinfection channels of the disinfection tank to disinfect treated water by ultraviolet light emission prior to discharging the treated water to ocean. Under normal operation, the UV disinfection units (M06-07-01/02) shall operate in local auto mode set on the unit control panel supplied by the UV disinfection unit manufacturer/vendor. In the auto mode, the UV disinfection units shall run continuously on 24-hour a-day basis.

The UV disinfection units shall be manually operable at the unit control panels above mentioned for troubleshooting and maintenance.

## **5. Sludge Treatment Process at STP**

The sludge treatment process consists of two dewatering units, two sets of polymer feeding facilities, one sludge cake conveyer, one sludge cake hopper, one waste water tank equipped with a mixer and pumps. The extracted waste sludge from the oxidation ditches will be pumped to the dewatering units for dewatering the waste sludge. The polymer will be dosed to the dewatering unit for conditioning and coagulating the waste sludge. Generated filtrate at the dewatering units will flow to the waste water tank by gravity and then be pumped to the upstream end of the grit chamber. The dewatered sludge cake will be conveyed to the sludge cake hopper for temporary storage and then be transferred to the Morata STP for disposal.

### **(1) Dewatering Units**

Under normal operation, the dewatering units (M07-01-01/02) shall operate in local auto mode set on the unit control panel supplied by the equipment manufacturer/vendor. In the auto mode, the operator specified dewatering unit shall set in service from 9am on Monday through 5pm on Friday by pressing a start button on the local control unit in the conditions of it and peripheral equipment ready. The operators will be required to confirm whether the dewatering unit and the peripheral equipment are ready to set in dewatering process.

The sludge dewatering units (M07-01-01/02) shall be manually operable in the field at the unit control panels supplied by the equipment manufacture/vendor for trouble shooting and maintenance. The local control units shall interface with the plant main PLC (08PLC01/02) via the remote IO panel (07RIO01) to read/write data each other for smooth dewatering operation. The signals/data required for each other (between the plant main PLC and the local control units) are listed on Appendix I Monitoring and Control Item Schedule, but not limited to.

## **(2) Polymer Tanks and Polymer Feeders**

The polymer dosing facility shall consist of two polymer tanks (M07-04-01/02) with mixers, two polymer feeders (M05-05-01/02), and two polymer feeding pumps (M07-06-01/02) for conditioning and coagulating the waste sludge to be fed to the dewatering units.

Under normal operation, the polymer tanks (M07-04-01/02) and the polymer feeders (M07-05-01/02) shall operate in local semi-auto mode set on the local control panel (07LCP01). In the semi-auto mode, the operator specified the polymer tank and the polymer feeder shall set in service for polymer solution process by pressing a start button on the local control panel (07LCP01) in the conditions of the two equipment ready. On pressing the start button on 07LCP01, the water supply solenoid valve of the duty/selected tank shall open without time lag. A pre-set tank level detected by a level element (07LE11 or 21) activates the tank and the polymer feeder to fill the polymer and to mix it into water followed by opening of the air supply valve with some time lag. On a pre-set duration time elapsed, the feeder stops and the air supply valves closes. On detection of a pre-set high level for the tank, the water supply solenoid valve closes followed by stopping of the mixer.

In the dewatering process, both the polymer tanks levels shall make the ready signal of the peripheral equipment off to the dewatering unit running.

The polymer tank mixers and the polymer feeders with the water supply valves and the air supply valves shall be manually operable at the local control panels (07LCP01/02) located adjacent to the equipment during troubleshooting or maintenance.

Polymer feed flows will be continuously measured by the electro-magnetic type flow meters (07FE12/22) for monitoring and controlling the polymer feed pumps.

## **(3) Polymer Feed Pumps**

Under normal operation, the polymer feed pumps (M07-06-01/02) shall operate in remote auto mode set on the local control panel (07LCP03). In the auto mode, the operator specified polymer feed pump shall be controlled by the main plant PLC via the remote RIO module (07RIO01). One of the standby pumps will automatically operate on failure of a duty pump. The duty pump operates when the associated dewatering unit provides a permissive for feed of waste sludge to the dewatering unit.

Polymer solution flow will be continuously monitored through an electromagnetic flow meters (07FE12/22) installed on the polymer dosage lines.

The polymer dosage flow will be controlled automatically in the auto mode as per the set value available by multiplying the waste sludge feed flow and the dosing ratio to it in the PLC. The

polymer dosing ratio to the waste sludge feed flow will be set by the operator at the STP SCADA HMI or the dewatering unit local control units. The polymer dosage flow will be obtained by multiplying the waste sludge flow to the dewatering units and the dosing ratio as a set value in the PLC. Polymer feed rate signals will be transmitted as a manipulate value to the eddy current coupling control unit in of the duty pump in 4 to 20 mA DC.

The polymer feed pumps shall be manually operable by the operator at the local control panel (07LCP03) located adjacent to the equipment during trouble shooting and maintenance.

#### **(4) Sludge Cake Conveyer**

The sludge cake conveyer (M07-02) will be installed just beneath the spillway of the dewatering units to convey the sludge cake to the sludge cake hopper for temporary storage in the plant.

The sludge cake conveyer (M07-02) shall be manually operable at the local control panel (07LCP04) located adjacent to the equipment during troubleshooting or maintenance.

In auto mode, the sludge cake conveyer shall be started and stopped in association with the dewatering unit running condition.

#### **(5) Sludge Cake Hopper**

The sludge cake hopper (M07-03) will be installed beneath the dumping-off point of the sludge cake conveyer to receive and stock the sludge cake.

The sludge cake hopper (M07-03) shall be manually operable at the local control panel (07LCP05) located adjacent to the equipment as normal operation and during troubleshooting or maintenance.

The weight meter will be mounted on the sludge cake hopper for monitoring and managing the schedule of tank lorry for disposing the sludge cake to the Morata STP.

#### **(6) Air Compressors**

The air compressor (M07-07-01/02) will provide compressed air to polymer feeding point between the polymer feeders and the polymer dissolving tanks to prevent polymer from hardening by wet.

Under normal operation, the air compressor shall operate in local auto mode set on the unit control panel supplied by air compressor manufacturer/vendor. In the auto mode, the operator-specified working air compressor shall start on low pressure level in the pressurized tank, and shall stop on high pressure level in the tank. High-high and low-low level pressure switches shall be provided in the tank and shall both activate alarms. The high-high pressure switch shall also automatically shut down the air compressor via a hardwire interlock.

The air compressors shall be manually operable at the unit control panel for troubleshooting and maintenance.



### **(7) Air Dryers**

The air dryers (M07-08-01/02) will dry the compressed air to prevent polymer from hardening by wet in association with the air compressors..

Under normal operation, the air compressor shall operate in remote auto mode set on the local control panel (07LCP06). In the auto mode, the operator-specified working air dryer shall start and stop in linkage with the polymer feeders.

The air dryer shall be manually operable at the local control panel (07LCP06) for troubleshooting and maintenance.

### **(8) Utility Potable Water Supply Unit Pumps**

Under normal operation, the utility potable water supply unit (M07-16) pumps shall operate in local auto mode set on the unit control panel supplied by the water supply unit manufacturer/vendor. In the auto mode, the operator-specified working pump shall start on low pressure level in the pressurized tank, and shall stop on high pressure level in the tank. High-high and low-low level pressure switches shall be provided in the tank and shall both activate alarms. The high-high pressure switch shall also automatically shut down the water supply unit pumps via a hardwire interlock.

The utility potable water pumps shall be manually operable at the unit control panel mounted on the water supply unit for troubleshooting and maintenance.

### **(9) Sump Drain Pumps**

The sump drain pumps (M07-11-01/02) shall be manually operable at the local control panel (07LCP07) located adjacent to the equipment during troubleshooting or maintenance.

In auto mode, the sump drain pumps will be started and stopped according to the high level switch and the low level switch (07LS02) provided in the sump. A high-high level switch and a low-low level switch are also installed in the sump to generate alarms on activation of them.

### **(10) Waste Water Pumps**

Under normal operation, the waste water pumps (M07-13-01/02) shall operate in remote auto mode. In auto mode, the working pump shall start and stop when tank level reaches high level activated by a high level switch and low levels (07LS01), respectively. High-high and low-low level switches shall generate alarms, and the low-low switch shall automatically shut down the pumps via a hardwire interlock.

The waste water pumps shall be manually operable at the local control panel (07LCP08) during troubleshooting or maintenance.

### **(11) Mixers**

The mixer (M07-12) will be equipped for the waste water tank for avoiding anaerobic conditions in the tank.

Under normal operation, the mixer (M07-12) will continuously run when the tanks are in service. . High-high and low-low level switches shall generate alarms, and the low-low level switch shall automatically shut down the mixers via a hardwire interlock.

The mixer shall be manually operable at the local control panel (07LCP08) during troubleshooting or maintenance.

### **(12) Deodorization Fans**

The deodorization fans (M07-15-01/02) will be installed adjacent to the biological odor control unit to introduce odorized air generated in the grit chamber, the distribution chamber, the scum pits and the solid process to the biological odor control unit.

Under normal operation, the mixer (M07-15-01/02) will continuously run when the biological odor control unit sets in service..

The deodorization fans shall be manually operable at the local control panel (07LCP09) during troubleshooting or maintenance.

### **(13) Biological Odor Control Unit**

The biological odor control unit (M07-14) will be installed at the sludge treatment building to control odor generated from the grit chamber, the distribution chamber, the scum pits and the solid process facilities.

Under normal operation, the biological odor control unit shall operate in local auto mode set on the unit control panel supplied by the biological odor control unit manufacturer/vendor. In the auto mode, the biological odor control unit shall continuously run when the STP sets in service.

The biological odor control unit shall be manually operable at the unit control panel for troubleshooting and maintenance.

## **6. Electrical Works**

### **(1) Incoming Panels (Incoming from PPL and standby generator sets)**

Incoming panels (01-01/02/03/04/05/06/07/08/09/10/11/12/13/14/15/16/17IFP01 and 09LV01) shall be provided at each PS and the STP. The incoming panels shall include two incoming circuit breakers, one from mains (PNG Power Limited,.) and one from the standby power, with both electrical and

mechanical interlock system between the mains and the standby power. The incoming panels will be installed in a generator house at the PSs and in an electrical substation at the STP respectively.

The main breakers (receiving the main power from PNG Power Limited.,) will be off under an auto mode in case of main failure detected by an under-voltage relay mounted in the incoming panel. Consequently, the standby generator run in the auto mode upon the under-voltage relay activated. After reaching the generator set to a rated speed and a rated voltage, the generator circuit breakers will be turned on to feed generated power to the incoming panels. Eventually, the standby incoming circuit breaker is turned ON to receive /feed the standby power. On restored main supply, the reverse sequence of the above will be followed for the main to feed power to the loads as a normal condition. The two breakers in the panels can be operated manually at each incoming panels during trouble shooting or maintenance.

## **(2) Standby Generator Sets**

There are eighteen (18) diesel generator sets proposed at the PSs and the STP as standby power source to back up critical loads during main failure.

The standby generator sets comprises one diesel engine, one alternator mounted on a common base, one radiator cooling unit, engine exhaust silencer, one daily service tank, one bulk storage tank (only for the STP generator set) one generator control panel and ancillaries. The standby generator sets will be installed in the generator house at the pumping stations and in the electrical substation for the STP respectively.

The standby generator sets will start to run in an auto mode upon the under-voltage relay activated. After reaching the generator sets to the rated speed and the rated voltage, the generator power will be synchronized through the synchronizing devices, and generator circuit breakers will be turned on to feed power to the incoming panels. On restored main supply, the reverse sequence of the above will be followed for the main to feed power to the loads as a normal condition.

The standby generator sets shall be operable manually by the operators at the associated generator control panel during trouble shooting or maintenance.

An ultrasonic type level meter will be installed in the daily service fuel tank and the bulk storage tank for monitoring and a management of fuel purchasing order.

END OF PS DIVISION 13 APPENDIX - I

**Appendix - II**

**Control & Monitoring Item Schedule (CMIS)**

[ Legend ]

Abbreviation	Meaning
STP	Sewage Treatment Plant
OS	Operator Workstation
LCD	Liquid Crystal Display
MCC	Motor Control Center
PCP	Pump Control Panel
Act	Actuator
LCP	Local Control Panel
CMR	Central Monitoring Room
CS	Control Switch
COS	Change-over Switch
St	Status
Co	Control
Al	Alarm
In	Indication
PLC	Programmable Logic Controller
D	Digital
L	Through LAN Communication
A	Analogue
P	Pulse
Log.	Logging

PLC	Pumping Station								Kila Kila STP					Log
	PLC								Central Monitoring Room					
	Input				Output				Operator Station					
	D	L	A	P	D	A	P	In	St	Co	Al	In		
PS1 Kaudi, 01-01 PLC 01	54	0	12	2	6	0	0	13	14	2	36	14	50	
PS2 Idubada, 01-02 PLC 01	54	0	12	2	6	0	0	13	14	2	36	14	50	
PS3 Hagara, 01-03 PLC 01	54	0	12	2	6	0	0	13	14	2	36	14	50	
PS4 Hanuabada, 01-04 PLC 01	54	0	12	2	6	0	0	13	14	2	36	14	50	
PS5 Konedobu, 01-05 PLC 01	95	0	14	2	14	0	0	18	36	2	54	16	70	
PS6 Old Yacht Club, 01-06 PLC 01	54	0	12	2	6	0	0	13	14	2	36	14	50	
PS7 Stanley Esplanade, 01-07 PLC 01	54	0	13	2	6	0	0	14	14	2	36	15	51	
PS8 Sea Park, 01-08 PLC 01	54	0	13	2	6	0	0	14	14	2	36	15	51	
PS9 Davara, 01-09 PLC 01	65	0	12	2	8	0	0	16	18	2	42	14	56	
PS10 Lawes Road, 01-10 PLC 01	95	0	14	2	14	0	0	18	36	2	54	16	70	
PS11 Koki, 01-11 PLC 01	54	0	12	2	6	0	0	13	14	2	36	14	50	
PS12 Badili, 01-12 PLC 01	95	0	14	2	14	0	0	18	36	2	54	16	70	
Receiving Well 1, 01-12 PLC 02	3	0	1	0	0	0	0	4	0	0	3	1	4	
PS13 Kila Police, 01-13 PLC 01	54	0	12	2	6	0	0	13	14	2	36	14	50	
PS14, Konebada, 01-14 PLC 01	54	0	12	2	6	0	0	13	14	2	36	14	50	
PS15 Gabutu, 01-15 PLC 01	54	0	13	2	6	0	0	14	14	2	36	15	51	
PS16 Horsecamp, 01-16 PLC 01	54	0	13	2	6	0	0	14	14	2	36	15	51	
PS17 Kaugere, 01-17 PLC 01	95	0	14	2	14	0	0	18	36	2	54	16	70	
<b>Grand Total</b>	<b>1096</b>	<b>0</b>	<b>217</b>	<b>34</b>	<b>136</b>	<b>0</b>	<b>0</b>	<b>252</b>	<b>330</b>	<b>34</b>	<b>693</b>	<b>251</b>	<b>944</b>	
PLC	Kila Kila STP													Log
	PLC								Central Monitoring Room					
	Input				Output				Operator Station					
	D	L	A	P	D	A	P	In	St	Co	Al	In		
STP Electrical Substation, 09RIO01	185	0	19	2	42	0	0	58	65	0	115	21	132	
STP Blower House -1, 04RIO01	225	0	4	0	56	0	0	97	108	6	89	4	93	
STP Blower House -2, 04RIO02	225	0	4	0	56	0	0	97	108	6	89	4	93	
STP Sludge Treatment Building, 07RIO01	238	5	11	0	51	6	0	99	102	5	103	12	112	
STP Administration Building, 08PLC01/02	0	5	0	0	0	0	0	5	0	0	22	0	22	
<b>Grand Total</b>	<b>873</b>	<b>10</b>	<b>38</b>	<b>2</b>	<b>205</b>	<b>6</b>	<b>0</b>	<b>356</b>	<b>383</b>	<b>17</b>	<b>418</b>	<b>41</b>	<b>452</b>	

Pumping Stations - Control and Monitoring Item Schedule																					
LOAD	ITEMS	NUMBERS	Pumping Stations															Kila Kila STP			
			Field			Generator House			PLC									Central Monitoring Room			
			Actuator			MCC/PCP			Input				Output					Operator Station			Log.
			St	Co	Al	St	Co	Al	In	D	L/S	A	P	D	A	P	In	St	Co	Al	
<b>1-1 PSI Kanudi</b>			01-01 PLC 01																		
<b>1) Sewage Pumps</b>		2																			
	(M01-01-01/02)																				
	STOP																				
	START																				
	Controlled at PCP, Local (Manu)																				
	Controlled at PCP, Remote (Auto)																				
	CS: START																				
	CS: STOP																				
	COS: Off-Remote-Manual at PCP																				
	COS: No.1-Alternate-No.2 at PCP																				
	Earth Fault																		2	2	
	Over Load																		2	2	
	Water Intrusion																		2	2	
	Wet Well Level High-High																		1	1	
	Wet Well Level High																		1	1	
	Wet Well Level Low																		1	1	
	Wet Well Level Low-Low																		1	1	
	Emergency Stop																		1	1	
<b>2) Pump Control Panel (01-01PCP01)</b>		1																			
	PPL Incoming MCCB On																			1	
	DG Set Incoming MCCB On																			1	
	PPL Watt-hour (kWh)																			1	
	PPL Watt (kW)																			1	
	PPL Voltage (V)																			1	
	PPL Ampere (A)																			1	
	PPL Power Factor																			1	
	DG Set Voltage (V)																			1	
	DG Set Ampere (A)																			1	
	PPL Under voltage																			1	
	PPL Overcurrent																			3	
	Grounding Over Currents for Feeders																			5	
<b>3) Standby Generator Set (01-01GEN01)</b>		1																			
	STOP																			1	
	START																			1	
	Controlled at GEN SET LCP, Manu																			1	
	Controlled at GEN SET LCP, Remote																			1	
	CS: STOP																			1	
	CS: START																			1	
	COS: Off-Local-Remote at LCP																			2	
	Ammeter																			1	
	Voltmeter																			1	
	Power Factor Meter																			1	
	Watt Meter																			1	
	Watt-hour Meter																			1	
	Frequency Meter																			1	
	Over-speed																			1	
	Lubricant Pressure Low																			1	
	Starting Time Over																			1	
	Alternator Bearing Temperature Rise																			1	
	Alternator Stator Winding Temperature Rise																			1	
	Earth Fault																			1	
	Over Current																			1	
	Under Voltage																			1	
	Over Voltage																			1	
	Emergency Stop																			1	
	Lubricant Temperature Rise																			1	
	Day Tank Level Meter																			1	
	Day Tank Level L																			1	
	DC Power Source Failure																			1	
	Lubricant priming pump Failure																			1	
	Radiator Failure																			1	
<b>4) Telemetry Panel (01-01 TMP01)</b>		1																			
	UPS Failure																			1	
	Micro PLC Failure																			1	
	GPRS MODEM/Gateway Failure																			1	
	Sub-total for 01-01 PLC01																			54	
																				0	
																				12	
																				2	
																				6	
																				0	
																				0	
																				13	
																				14	
																				2	
																				36	
																				14	
																				50	



Pumping Stations - Control and Monitoring Item Schedule																						
LOAD	ITEMS	NUMBERS	Pumping Stations														Kila Kila STP					
			Field			Generator House			PLC								Central Monitoring Room					
			Actuator			MCC/PCP			Input				Output				Operator Station					
			St	Co	Al	St	Co	Al	In	D	L/S	A	P	D	A	P	In	St	Co	Al	In	Log
<b>1-3 PS3 Hagara</b>			01-03 PLC 01																			
<b>1) Sewage Pumps</b>		2																				
	(M01-03-01/02)																					
	STOP																					
	START																					
	Controlled at PCP, Local (Manu)																					
	Controlled at PCP, Remote (Auto)																					
	CS: START																					
	CS: STOP																					
	COS: Off-Remote-Manual at PCP																					
	COS: No.1-Alternate-No.2 at PCP																					
	Earth Fault																					
	Over Load																					
	Water Intrusion																					
	Wet Well Level High-High																					
	Wet Well Level High																					
	Wet Well Level Low																					
	Wet Well Level Low-Low																					
	Emergency Stop																					
<b>2) Incoming /Feeder Panel (01-03 IFP01)</b>		1																				
	PPL Incoming MCCB On																					
	DG Set Incoming MCCB On																					
	PPL Watt-hour (kWh)																					
	PPL Watt (kW)																					
	PPL Voltage (V)																					
	PPL Ampere (A)																					
	PPL Power Factor																					
	DG Set Voltage (V)																					
	DG Set Ampere (A)																					
	PPL Under voltage																					
	PPL Overcurrent																					
	Grounding Over Currents for Feeders																					
<b>3) Standby Generator Set (01-03GEN01)</b>		1																				
	STOP																					
	START																					
	Controlled at GEN SET LCP, Manu																					
	Controlled at GEN SET LCP, Remote																					
	CS: STOP																					
	CS: START																					
	COS: Off-Local-Remote at LCP																					
	Ammeter																					
	Voltmeter																					
	Power Factor Meter																					
	Watt Meter																					
	Watt-hour Meter																					
	Frequency Meter																					
	Over-speed																					
	Lubricant Pressure Low																					
	Starting Time Over																					
	Alternator Bearing Temperature Rise																					
	Alternator Stator Winding Temperature Rise																					
	Earth Fault																					
	Over Current																					
	Under Voltage																					
	Over Voltage																					
	Emergency Stop																					
	Lubricant Temperature Rise																					
	Day Tank Level Meter																					
	Day Tank Level L																					
	DC Power Source Failure																					
	Lubricant priming pump Failure																					
	Radiator Failure																					
<b>4) Telemetry Panel (01-03 TMP01)</b>		1																				
	UPS Failure																					
	Micro PLC Failure																					
	GPRS MODEM/Gateway Failure																					
	Sub-total for 01-03 PLC01																					
										54	0	12	2	6	0	0	13	14	2	36	14	50



Pumping Stations - Control and Monitoring Item Schedule																					
LOAD	ITEMS	NUMBERS	Pumping Stations													Kila Kila STP					
			Field			Generator House			PLC							Central Monitoring Room					
			Actuator			MCC/PCP			Input				Output			Operator Station					
			St	Co	Al	St	Co	Al	In	D	L/S	A	P	D	A	P	In	St	Co	Al	In
<b>1-4 PS4 Hanuabada</b>																					
<b>1) Sewage Pumps</b>																					
	(M01-04-01/02)	2																			
	STOP				2			2									2				
	START				2			2									2				
	Controlled at PCP, Local (Manu)				2												2				
	Controlled at PCP, Remote (Auto)				2												2				
	CS: START				2								2								
	CS: STOP				2								2								
	COS: Off-Remote-Manual at PCP				4			4													
	COS: No.1-Alternate-No.2 at PCP				2			2													
	Earth Fault				2			2					2				2		2		
	Over Load				2			2					2				2		2		
	Water Intrusion				2			2					2				2		2		
	Wet Well Level High-High				1			1					1				1		1		
	Wet Well Level High							1													
	Wet Well Level Low							1													
	Wet Well Level Low-Low				1			1					1				1		1		
	Emergency Stop				1			1					1				1		1		
<b>2) Incoming /Feeder Panel (01-04 IFP01)</b>																					
	PPL Incoming MCCB On				1			1									1				
	DG Set Incoming MCCB On				1			1									1				
	PPL Watt-hour (kWh)											1							1	1	
	PPL Watt (kW)											1							1	1	
	PPL Voltage (V)											1							1	1	
	PPL Ampere (A)											1							1	1	
	PPL Power Factor											1							1	1	
	DG Set Voltage (V)											1							1	1	
	DG Set Ampere (A)											1							1	1	
	PPL Under voltage				1			1											1	1	
	PPL Overcurrent				3			3											3	3	
	Grounding Over Currents for Feeders							5				5							5	5	
<b>3) Standby Generator Set (01-04GEN01)</b>																					
	STOP				1			1									1				
	START				1			1									1				
	Controlled at GEN SET LCP, Manu				1			1									1				
	Controlled at GEN SET LCP, Remote				1			1									1				
	CS: STOP				1								1						1		
	CS: START				1								1						1		
	COS: Off-Local-Remote at LCP				2																
	Ammeter							1					1							1	
	Voltmeter							1					1							1	
	Power Factor Meter							1					1							1	
	Watt Meter							1					1							1	
	Watt-hour Meter							1					1							1	
	Frequency Meter							1					1							1	
	Over-speed				1			1											1	1	
	Lubricant Pressure Low				1			1											1	1	
	Starting Time Over				1			1											1	1	
	Alternator Bearing Temperature Rise				1			1											1	1	
	Alternator Stator Winding Temperature Rise				1			1											1	1	
	Earth Fault				1			1											1	1	
	Over Current				1			1											1	1	
	Under Voltage				1			1											1	1	
	Over Voltage				1			1											1	1	
	Emergency Stop				1			1											1	1	
	Lubricant Temperature Rise				1			1											1	1	
	Day Tank Level Meter							1					1						1	1	
	Day Tank Level L				1			1											1	1	
	DC Power Source Failure				1			1											1	1	
	Lubricant priming pump Failure				1			1											1	1	
	Radiator Failure				1			1											1	1	
<b>4) Telemetry Panel (01-04 TMP01)</b>																					
	UPS Failure												1						1	1	
	Micro PLC Failure												1						1	1	
	GPRS MODEM/Gateway Failure												1						1	1	
	Sub-total for 01-04 PLC01												54	0	12	2	6	0	0	13	14
																			2	36	14
																				50	

Pumping Stations - Control and Monitoring Item Schedule																						
LOAD	ITEMS	NUMBERS	Pumping Stations													Kila Kila STP						
			Field			Generator House			PLC							Central Monitoring Room						
			Actuator			MCC/PCP			Input				Output			Operator Station						
			St	Co	Al	St	Co	Al	In	D	L/S	A	P	D	A	P	In	St	Co	Al	In	Log.
<b>1-5 PS5 Konedobu</b>																						
<b>1) Sewage Pumps</b>																						
01-05 PLC 01																						
	(M01-05-01/02/03)	3																				
	STOP					3												3				
	START					3												3				
	Controlled at PCP, Local (Manu)					3												3				
	Controlled at PCP, Remote (Auto)					3												3				
	CS: START					3												3				
	CS: STOP					3												3				
	COS: Off-Remote-Manual at PCP					6																
	COS: No.1/2/3-1-3/1/2					3																
	Earth Fault					3			3									3	3			
	Over Load					3			3									3	3			
	Water Intrusion					3			3									3	3			
	Wet Well Level (01-05 LE01)									1								1	1			
	Wet Well Level High-High							1		1								1	1			
	Wet Well Level High									1												
	Wet Well Level Low									1												
	Wet Well Level Low-Low							1		1								1	1			
	Emergency Stop							1		1								1	1			
	Delivery Flow (01-05 FE01)							1		1								1	1			
<b>2) Delivery Valves (M01-05-04/05/06)</b>																						
	Open	3																3				
	CLOSE	3																3				
	Controlled at Act, Manu (Local)	3																3				
	Controlled at Act, Auto (Remote)	3																3				
	CS: CLOSE	3																3				
	CS: OPEN	3																3				
	COS: Off-Local-Remote	6																				
	Over Load	3																3	3			
	Over Torqque	6																6	6			
	Earth Fault	3																3	3			
	Fully CLOSE	3																3				
	Fully OPEN	3																3				
<b>3) Incoming /Feeder Panel (01-05 IFP01)</b>																						
	PPL Incoming MCCB On							1										1				
	DG Set Incoming MCCB On							1										1				
	PPL Watt-hour (kWh)														1				1			
	PPL Watt (kW)														1				1			
	PPL Voltage (V)														1				1			
	PPL Ampere (A)														1				1			
	PPL Power Factor														1				1			
	DG Set Voltage (V)														1				1			
	DG Set Ampere (A)														1				1			
	PPL Under voltage							1		1								1	1			
	PPL Overcurrent							3		3								3	3			
	Grounding Over Currents for Feeders							8		8								8	8			
<b>4) Standby Generator Set (01-05GEN01)</b>																						
	STOP							1										1				
	START							1										1				
	Controlled at GEN SET LCP, Manu							1										1				
	Controlled at GEN SET LCP, Remote							1										1				
	CS: STOP							1										1				
	CS: START							1										1				
	COS: Off-Local-Remote at LCP							2														
	Ammeter									1									1			
	Vollmeter									1									1			
	Power Factor Meter									1									1			
	Watt Meter									1									1			
	Watt-hour Meter									1				1					1			
	Frequency Meter									1				1					1			
	Over-speed							1		1								1	1			
	Lubricant Pressure Low							1		1								1	1			
	Starting Time Over							1		1								1	1			
	Alternator Bearing Temperature Rise							1		1								1	1			
	Alternator Stator Winding Temperature Rise							1		1								1	1			
	Earth Fault							1		1								1	1			
	Over Current							1		1								1	1			
	Under Voltage							1		1								1	1			
	Over Voltage							1		1								1	1			
	Emergency Stop							1		1								1	1			
	Lubricant Temperature Rise							1		1								1	1			
	Day Tank Level Meter									1								1	1			
	Day Tank Level L							1		1								1	1			
	DC Power Source Failure							1		1								1	1			
	Lubricant priming pump Failure							1		1								1	1			
	Radiator Failure							1		1								1	1			
<b>5) Telemetry Panel (01-05 TMP01)</b>																						
	UPS Failure																	1	1			
	Micro PLC Failure																	1	1			
	GPRS MODEM/Gateway Failure																	1	1			
	Sub-total for 01-05 PLC01									95	0	14	2	14	0	0	18	36	2	54	16	70



Pumping Stations - Control and Monitoring Item Schedule																								
LOAD	ITEMS	NUMBERS	Pumping Stations													Kila Kila STP								
			Field			Generator House			PLC							Central Monitoring Room								
			Actuator			MCC/PCP			Input				Output			Operator Station								
			St	Co	Al	St	Co	Al	In	D	L/S	A	P	D	A	P	In	St	Co	Al	In	Log		
01-07 PLC 01																								
<b>1-7 PS7 Stanley Esplanade</b>																								
<b>1) Sewage Pumps</b>		2																						
	(M01-07-01/02)																							
	STOP					2				2								2						
	START					2				2								2						
	Controlled at PCP, Local (Manu)					2												2						
	Controlled at PCP, Remote (Auto)					2												2						
	CS: START					2											2							
	CS: STOP					2											2							
	COS: Off-Remote-Manual at PCP					4				4														
	COS: No.1-Alternate-No.2 at PCP					2				2														
	Earth Fault						2		2								2		2	2				
	Over Load						2		2								2		2	2				
	Water Intrusion						2		2								2		2	2				
	Wet Well Level High-High						1		1								1		1	1				
	Wet Well Level High									1														
	Wet Well Level Low									1														
	Wet Well Level Low-Low						1		1								1		1	1				
	Emergency Stop						1		1								1		1	1				
	Delivery Flow (01-07 FE01)						1					1					1			1	1			
<b>2) Incoming /Feeder Panel (01-07 IFP01)</b>		1																						
	PPL Incoming MCCB On						1				1							1						
	DG Set Incoming MCCB On						1				1							1						
	PPL Watt-hour (kWh)												1							1	1			
	PPL Watt (kW)												1							1	1			
	PPL Voltage (V)												1							1	1			
	PPL Ampere (A)												1							1	1			
	PPL Power Factor												1							1	1			
	DG Set Voltage (V)												1							1	1			
	DG Set Ampere (A)												1							1	1			
	PPL Under voltage							1		1										1	1			
	PPL Overcurrent							3		3										3	3			
	Grounding Over Currents for Feeders							5		5										5	5			
<b>3) Standby Generator Set (01-07GEN01)</b>		1																						
	STOP						1				1								1					
	START						1				1								1					
	Controlled at GEN SET LCP, Manu						1				1								1					
	Controlled at GEN SET LCP, Remote						1				1								1					
	CS: STOP						1										1							
	CS: START						1										1							
	COS: Off-Local-Remote at LCP						2																	
	Ammeter								1				1							1	1			
	Voltmeter								1				1							1	1			
	Power Factor Meter								1				1							1	1			
	Watt Meter								1				1							1	1			
	Watt-hour Meter								1				1							1	1			
	Frequency Meter								1				1							1	1			
	Over-speed							1		1										1	1			
	Lubricant Pressure Low							1		1										1	1			
	Starting Time Over							1		1										1	1			
	Alternator Bearing Temperature Rise							1		1										1	1			
	Alternator Stator Winding Temperature Rise							1		1										1	1			
	Earth Fault							1		1										1	1			
	Over Current							1		1										1	1			
	Under Voltage							1		1										1	1			
	Over Voltage							1		1										1	1			
	Emergency Stop							1		1										1	1			
	Lubricant Temperature Rise							1		1										1	1			
	Day Tank Level Meter								1				1							1	1			
	Day Tank Level L							1		1										1	1			
	DC Power Source Failure							1		1										1	1			
	Lubricant priming pump Failure							1		1										1	1			
	Radiator Failure							1		1										1	1			
<b>4) Telemetry Panel (01-07 TMP01)</b>		1																						
	UPS Failure																		1		1	1		
	Micro PLC Failure																		1		1	1		
	GPRS MODEM/Gateway Failure																		1		1	1		
	Sub-total for 01-07 PLC01											54	0	13	2	6	0	0	14	14	2	36	15	51

Pumping Stations - Control and Monitoring Item Schedule																				
LOAD	ITEMS	NUMBERS	Pumping Stations														Kila Kila STP			
			Field			Generator House				PLC							Central Monitoring Room			
			Actuator			MCC/PCP				Input			Output				Operator Station			
			St	Co	Al	St	Co	Al	In	D	L/S	A	P	D	A	P	In	St	Co	Al
1-8 PS8 Sea Park																				
1) Sewage Pumps																				
	(M01-08-01/02)	2	01-08 PLC 01																	
	STOP																			
	START																			
	Controlled at PCP, Local (Manu)																			
	Controlled at PCP, Remote (Auto)																			
	CS: START																			
	CS: STOP																			
	COS: Off-Remote-Manual at PCP																			
	COS: No.1-Alternate-No.2 at PCP																			
	Earth Fault																			
	Over Load																			
	Water Intrusion																			
	Wet Well Level High-High																			
	Wet Well Level High																			
	Wet Well Level Low																			
	Wet Well Level Low-Low																			
	Emergency Stop																			
	Delivery Flow (01-08 FE01)																			
2) Pump Control Panel (01-08 PCP01)																				
	PPL Incoiming MCCB On																			
	DG Set Incoming MCCB On																			
	PPL Watt-hour (kWh)																			
	PPL Watt (kW)																			
	PPL Voltage (V)																			
	PPL Ampere (A)																			
	PPL Power Factor																			
	DG Set Voltage (V)																			
	DG Set Ampere (A)																			
	PPL Under voltage																			
	PPL Overcurrent																			
	Grounding Over Currents for Feeders																			
3) Standby Generator Set (01-08GEN01)																				
	STOP																			
	START																			
	Controlled at GEN SET LCP, Manu																			
	Controlled at GEN SET LCP, Remote																			
	CS: STOP																			
	CS: START																			
	COS: Off-Local-Remote at LCP																			
	Ammeter																			
	Voltmeter																			
	Power Factor Meter																			
	Watt Meter																			
	Watt-hour Meter																			
	Frequency Meter																			
	Over-speed																			
	Lubricant Pressure Low																			
	Starting Time Over																			
	Alternator Bearing Temperature Rise																			
	Alternator Stator Winding Temperature Rise																			
	Earth Fault																			
	Over Current																			
	Under Voltage																			
	Over Voltage																			
	Emergency Stop																			
	Lubricant Temperature Rise																			
	Day Tank Level Meter																			
	Day Tank Level L																			
	DC Power Source Failure																			
	Lubricant priming pump Failure																			
	Radiator Failure																			
4) Telemetry Panel (01-08 TMP01)																				
	UPS Failure																			
	Micro PLC Failure																			
	GPRS MODEM/Gateway Failure																			
	Sub-total for 01-08 PLC01																			

Pumping Stations - Control and Monitoring Item Schedule																						
LOAD	ITEMS	NUMBERS	Pumping Stations															Kila Kila STP				
			Field			Generator House			PLC									Central Monitoring Room				
			Actuator			MCC/PCP			Input					Output				Operator Station				
			St	Co	Al	St	Co	Al	In	D	L/S	A	P	D	A	P	In	St	Co	Al	In	Log
01-09 PLC 01																						
<b>1-5 PS9 Davara</b>																						
<b>1) Sewage Pumps</b>																						
	(M01-09-01/02/03)	3																				
	STOP					3					3							3				
	START					3					3							3				
	Controlled at PCP, Local (Manu)					3												3				
	Controlled at PCP, Remote (Auto)					3												3				
	CS: START					3											3					
	CS: STOP					3											3					
	COS: Off-Remote-Manual at PCP					6					6											
	COS: No.1/23-2/3/1-3/1/2					3					3											
	Earth Fault					3					3						3		3	3		
	Over Load					3					3						3		3	3		
	Water Intrusion					3					3						3		3	3		
	Wet Well Level High-High					1					1						1		1	1		
	Wet Well Level High					1					1											
	Wet Well Level Low					1					1											
	Wet Well Level Low-Low					1					1						1		1	1		
	Emergency Stop					1					1						1		1	1		
<b>2) Incoming /Feeder Panel (01-09 IFP01)</b>																						
	PPL Incoming MCCB On					1					1							1				
	DG Set Incoming MCCB On					1					1							1				
	PPL Watt-hour (kWh)										1								1	1		
	PPL Watt (kW)										1								1	1		
	PPL Voltage (V)										1								1	1		
	PPL Ampere (A)										1								1	1		
	PPL Power Factor										1								1	1		
	DG Set Voltage (V)										1								1	1		
	DG Set Ampere (A)										1								1	1		
	PPL Under voltage					1					1								1	1		
	PPL Overcurrent					3					3								3	3		
	Grounding Over Currents for Feeders					8					8								8	8		
<b>3) Standby Generator Set (01-09GEN01)</b>																						
	STOP					1					1							1				
	START					1					1							1				
	Controlled at GEN SET LCP, Manu					1					1							1				
	Controlled at GEN SET LCP, Remote					1					1							1				
	CS: STOP					1												1				
	CS: START					1												1				
	COS: Off-Local-Remote at LCP					2																
	Ammeter										1								1	1		
	Voltmeter										1								1	1		
	Power Factor Meter										1								1	1		
	Watt Meter										1								1	1		
	Watt-hour Meter										1								1	1		
	Frequency Meter										1								1	1		
	Over-speed					1					1								1	1		
	Lubricant Pressure Low					1					1								1	1		
	Starting Time Over					1					1								1	1		
	Alternator Bearing Temperature Rise					1					1								1	1		
	Alternator Stator Winding Temperature Rise					1					1								1	1		
	Earth Fault					1					1								1	1		
	Over Current					1					1								1	1		
	Under Voltage					1					1								1	1		
	Over Voltage					1					1								1	1		
	Emergency Stop					1					1								1	1		
	Lubricant Temperature Rise					1					1								1	1		
	Day Tank Level Meter										1								1	1		
	Day Tank Level L					1					1								1	1		
	DC Power Source Failure					1					1								1	1		
	Lubricant priming pump Failure					1					1								1	1		
	Radiator Failure					1					1								1	1		
<b>4) Telemetry Panel (01-09 TMP01)</b>																						
	UPS Failure										1								1	1		
	Micro PLC Failure										1								1	1		
	GPRS MODEM/Gateway Failure										1								1	1		
	Sub-total for 01-09 PLC01									65	0	12	2	8	0	0	16	18	2	42	14	56

Pumping Stations - Control and Monitoring Item Schedule																									
LOAD	ITEMS	NUMBERS	Pumping Stations																Kila Kila STP						
			Field			Generator House			PLC										Central Monitoring Room						
			Actuator			MCC/PCP			Input					Output					Operator Station				Log		
			St	Co	Al	St	Co	Al	In	D	L/S	A	P	D	A	P	In	St	Co	Al	In				
1-10 Lawes Road																									
1) Sewage Pumps																									
	(M01-10-01/02/03)	3	01-10 PLC 01																						
	STOP																								
	START																								
	Controlled at PCP, Local (Manu)																								
	Controlled at PCP, Remote (Auto)																								
	CS: START																								
	CS: STOP																								
	COS: Off-Remote-Manual at PCP																								
	COS: No.1/23-2/3/1-3/1/2																								
	Earth Fault																								
	Over Load																								
	Water Intrusion																								
	Wet Well Level (01-10 LE01)																								
	Wet Well Level High-High																								
	Wet Well Level High																								
	Wet Well Level Low																								
	Wet Well Level Low-Low																								
	Emergency Stop																								
	Delivery Flow (01-10 FE01)																								
2) Delivery Valves (M01-10-04/05/06)																									
	Open																								
	CLOSE																								
	Controlled at Act, Manu (Local)																								
	Controlled at Act, Auto (Remote)																								
	CS: CLOSE																								
	CS: OPEN																								
	COS: Off-Local-Remote																								
	Over Load																								
	Over Torqque																								
	Earth Fault																								
	Fully CLOSE																								
	Fully OPEN																								
3) Incoming /Feeder Panel (01-10 IFP01)																									
	PPL Incoming MCCB On																								
	DG Set Incoming MCCB On																								
	PPL Watt-hour (kWh)																								
	PPL Watt (kW)																								
	PPL Voltage (V)																								
	PPL Ampere (A)																								
	PPL Power Factor																								
	DG Set Voltage (V)																								
	DG Set Ampere (A)																								
	PPL Under voltage																								
	PPL Overcurrent																								
	Grounding Over Currents for Feeders																								
4) Standby Generator Set (01-10GEN01)																									
	STOP																								
	START																								
	Controlled at GEN SET LCP, Manu																								
	Controlled at GEN SET LCP, Remote																								
	CS: STOP																								
	CS: START																								
	COS: Off-Local-Remote at LCP																								
	Ammeter																								
	Vollmeter																								
	Power Factor Meter																								
	Watt Meter																								
	Watt-hour Meter																								
	Frequency Meter																								
	Over-speed																								
	Lubricant Pressure Low																								
	Starting Time Over																								
	Alternator Bearing Temperature Rise																								
	Alternator Stator Winding Temperature Rise																								
	Earth Fault																								
	Over Current																								
	Under Voltage																								
	Over Voltage																								
	Emergency Stop																								
	Lubricant Temperature Rise																								
	Day Tank Level Meter																								
	Day Tank Level L																								
	DC Power Source Failure																								
	Lubricant priming pump Failure																								
	Radiator Failure																								
5) Telemetry Panel (01-10 TMP01)																									
	UPS Failure																								
	Micro PLC Failure																								
	GPRS MODEM/Gateway Failure																								
	Sub-total for 01-10 PLC01																								





Pumping Stations - Control and Monitoring Item Schedule																				
LOAD	ITEMS	NUMBERS	Pumping Stations														Kila Kila STP			
			Field			Generator House			PLC								Central Monitoring Room			
			Actuator			MCC/PCP			Input				Output				Operator Station			Log.
			St	Co	Al	St	Co	Al	In	D	L/S	A	P	D	A	P	In	St	Co	
<b>1-12 Badili</b>																				
<b>1-12-1 Badili Pumping Station</b>																				
01-12 PLC 01																				
<b>1) Sewage Pumps</b>																				
3																				
(M01-12-01/02/03)																				
STOP																				
3																				
START																				
3																				
Controlled at PCP, Local (Manu)																				
3																				
Controlled at PCP, Remote (Auto)																				
3																				
CS: START																				
3																				
CS: STOP																				
3																				
COS: Off-Remote-Manual at PCP																				
6																				
COS: No.1/23-2/3/1-3/1/2																				
3																				
Earth Fault																				
3																				
Over Load																				
3																				
Water Intrusion																				
3																				
Wet Well Level (01-10 LE01)																				
1																				
Wet Well Level High-High																				
1																				
Wet Well Level High																				
1																				
Wet Well Level Low																				
1																				
Wet Well Level Low-Low																				
1																				
Emergency Stop																				
1																				
Delivery Flow (01-12 FE01)																				
1																				
<b>2) Delivery Valves (M01-12-04/05/06 )</b>																				
3																				
Open																				
3																				
CLOSE																				
3																				
Controlled at Act, Manu (Local)																				
3																				
Controlled at Act, Auto (Remote)																				
3																				
CS: CLOSE																				
3																				
CS: OPEN																				
3																				
COS: Off-Local-Remote																				
6																				
Over Load																				
3																				
Over Torque																				
6																				
Earth Fault																				
3																				
Fully CLOSE																				
3																				
Fully OPEN																				
3																				
<b>3) Incoming /Feeder Panel (01-10 IFP01)</b>																				
1																				
PPL Incomig MCCB On																				
1																				
DG Set Incoming MCCB On																				
1																				
PPL Watt-hour (kWh)																				
1																				
PPL Watt (kW)																				
1																				
PPL Voltage (V)																				
1																				
PPL Ampere (A)																				
1																				
PPL Power Factor																				
1																				
DG Set Voltage (V)																				
1																				
DG Set Ampere (A)																				
1																				
PPL Under voltage																				
1																				
PPL Overcurrent																				
3																				
Grounding Over Currents for Feeders																				
8																				
<b>4) Standby Generator Set (01-12GEN01)</b>																				
1																				
STOP																				
1																				
START																				
1																				
Controlled at GEN SET LCP, Manu																				
1																				
Controlled at GEN SET LCP, Remote																				
1																				
CS: STOP																				
1																				
CS: START																				
1																				
COS: Off-Local-Remote at LCP																				
2																				
Ammeter																				
1																				
Voltmeter																				
1																				
Power Factor Meter																				
1																				
Watt Meter																				
1																				
Watt-hour Meter																				
1																				
Frequency Meter																				
1																				
Over-speed																				
1																				
Lubricant Pressure Low																				
1																				
Starting Time Over																				
1																				
Alternator Bearing Temperature Rise																				
1																				
Alternator Stator Winding Temperature Rise																				
1																				
Earth Fault																				
1																				
Over Current																				
1																				
Under Voltage																				
1																				
Over Voltage																				
1																				
Emergency Stop																				
1																				
Lubricant Temperature Rise																				
1																				
Day Tank Level Meter																				
1																				
Day Tank Level L																				
1																				
DC Power Source Failure																				
1																				
Lubricant priming pump Failure																				
1																				
Radiator Failure																				
1																				
<b>5) Telemetry Panel (01-12 TMP01)</b>																				
1																				
UPS Failure																				
1																				
Micro PLC Failure																				
1																				
GPRS MODEM/Gateway Failure																				
1																				
Sub-total for 01-12 PLC01																				
95 0 14 2 14 0 0 18 36 2 54 16 70																				

Pumping Stations - Control and Monitoring Item Schedule																								
LOAD	ITEMS	NUMBERS	Pumping Stations															Kila Kila STP						
			Field			Generator House			PLC									Central Monitoring Room						
			Actuator			MCC/PCP			Input				Output					Operator Station				Log		
			St	Co	Al	St	Co	Al	In	D	L/S	A	P	D	A	P	In	St	Co	Al	In			
<b>1-12-2 Receiving Well 1</b>																								
	<b>1) Telemetry Panel (01-12 TMP01)</b>	1	01-12 PLC 02																					
	UPS Failure										1							1		1				
	Micro PLC Failure										1							1		1				
	GPRS MODEM/Gateway Failure										1							1		1				
	Delivery Flow (01-12FE01)											1						1		1				
	Sub-total for 01-12 PLC02										3	0	1	0	0	0	0	4	0	0	3	1	4	
<b>1-13 PS13 Kila Police</b>																								
	<b>1) Sewage Pumps</b>	2	01-13 PLC 01																					
	(M01-13-01/02)																							
	STOP					2						2							2					
	START					2						2							2					
	Controlled at PCP, Local (Manu)					2													2					
	Controlled at PCP, Remote (Auto)					2													2					
	CS: START					2												2						
	CS: STOP					2												2						
	COS: Off-Remote-Manual at PCP					4						4												
	COS: No.1-Alternate-No.2 at PCP					2						2												
	Earth Fault					2						2							2		2	2		
	Over Load					2						2							2		2	2		
	Water Intrusion					2						2							2		2	2		
	Wet Well Level High-High					1						1							1		1	1		
	Wet Well Level High											1												
	Wet Well Level Low											1												
	Wet Well Level Low-Low										1								1		1	1		
	Emergency Stop					1						1							1		1	1		
	<b>2) Pump Control Panel (01-13PCP01)</b>	1																						
	PPL Incoming MCCB On					1						1							1					
	DG Set Incoming MCCB On					1						1							1					
	PPL Watt-hour (kWh)															1					1	1		
	PPL Watt (kW)															1					1	1		
	PPL Voltage (V)															1					1	1		
	PPL Ampere (A)															1					1	1		
	PPL Power Factor															1					1	1		
	DG Set Voltage (V)															1					1	1		
	DG Set Ampere (A)															1					1	1		
	PPL Under voltage					1						1								1		1		
	PPL Overcurrent					3						3								3		3		
	Grounding Over Currents for Feeders					5						5								5		5		
	<b>3) Standby Generator Set (01-13GEN01)</b>	1																						
	STOP					1						1								1				
	START					1						1								1				
	Controlled at GEN SET LCP, Manu					1						1								1				
	Controlled at GEN SET LCP, Remote					1						1								1				
	CS: STOP					1													1					
	CS: START					1													1					
	COS: Off-Local-Remote at LCP					2																		
	Ammeter											1									1	1		
	Voltmeter											1									1	1		
	Power Factor Meter											1									1	1		
	Watt Meter											1									1	1		
	Watt-hour Meter											1									1	1		
	Frequency Meter											1									1	1		
	Over-speed											1									1	1		
	Lubricant Pressure Low											1									1	1		
	Starting Time Over											1									1	1		
	Alternator Bearing Temperature Rise											1									1	1		
	Alternator Stator Winding Temperature Rise											1									1	1		
	Earth Fault											1									1	1		
	Over Current											1									1	1		
	Under Voltage											1									1	1		
	Over Voltage											1									1	1		
	Emergency Stop											1									1	1		
	Lubricant Temperature Rise											1									1	1		
	Day Tank Level Meter											1									1	1		
	Day Tank Level L											1									1	1		
	DC Power Source Failure											1									1	1		
	Lubricant priming pump Failure											1									1	1		
	Radiator Failure											1									1	1		
	<b>4) Telemetry Panel (01-13 TMP01)</b>	1																						
	UPS Failure											1									1	1		
	Micro PLC Failure											1									1	1		
	GPRS MODEM/Gateway Failure											1									1	1		
	Sub-total for 01-13 PLC01											54	0	12	2	6	0	0	13	14	2	36	14	50

Pumping Stations - Control and Monitoring Item Schedule																										
LOAD	ITEMS	NUMBERS	Pumping Stations													Kila Kila STP										
			Field			Generator House			PLC							Central Monitoring Room										
			Actuator			MCC/PCP			Input				Output			Operator Station										
			St	Co	Al	St	Co	Al	In	D	L/S	A	P	D	A	P	In	St	Co	Al	In	Log				
1-14 PS14 Konebada																										
1) Sewage Pumps																										
2																										
01-14 PLC 01																										
	(M01-14-01/02)																									
	STOP																									
	START																									
	Controlled at PCP, Local (Manu)																									
	Controlled at PCP, Remote (Auto)																									
	CS: START																									
	CS: STOP																									
	COS: Off-Remote-Manual at PCP																									
	COS: No.1-Alternate-No.2 at PCP																									
	Earth Fault																									
	Over Load																									
	Water Intrusion																									
	Wet Well Level High-High																									
	Wet Well Level High																									
	Wet Well Level Low																									
	Wet Well Level Low-Low																									
	Emergency Stop																									
2) Pump Control Panel (01-14PCP01)																										
	PPL Incoming MCCB On																									
	DG Set Incoming MCCB On																									
	PPL Watt-hour (kWh)																									
	PPL Watt (kW)																									
	PPL Voltage (V)																									
	PPL Ampere (A)																									
	PPL Power Factor																									
	DG Set Voltage (V)																									
	DG Set Ampere (A)																									
	PPL Under voltage																									
	PPL Overcurrent																									
	Grounding Over Currents for Feeders																									
3) Standby Generator Set (01-14GEN01)																										
	STOP																									
	START																									
	Controlled at GEN SET LCP, Manu																									
	Controlled at GEN SET LCP, Remote																									
	CS: STOP																									
	CS: START																									
	COS: Off-Local-Remote at LCP																									
	Ammeter																									
	Voltmeter																									
	Power Factor Meter																									
	Watt Meter																									
	Watt-hour Meter																									
	Frequency Meter																									
	Over-speed																									
	Lubricant Pressure Low																									
	Starting Time Over																									
	Alternator Bearing Temperature Rise																									
	Alternator Stator Winding Temperature Rise																									
	Earth Fault																									
	Over Current																									
	Under Voltage																									
	Over Voltage																									
	Emergency Stop																									
	Lubricant Temperature Rise																									
	Day Tank Level Meter																									
	Day Tank Level L																									
	DC Power Source Failure																									
	Lubricant priming pump Failure																									
	Radiator Failure																									
4) Telemetry Panel (01-14 TMP01)																										
	UPS Failure																									
	Micro PLC Failure																									
	GPRS MODEM/Gateway Failure																									
	Sub-total for 01-14 PLC01																									
													54	0	12	2	6	0	0	13	14	2	36	14	50	

Pumping Stations - Control and Monitoring Item Schedule																					
LOAD	ITEMS	NUMBERS	Pumping Stations															Kila Kila STP			
			Field			Generator House				PLC								Central Monitoring Room			
			Actuator			MCC/PCP				Input				Output				Operator Station			Log.
			St	Co	Al	St	Co	Al	In	D	L/S	A	P	D	A	P	In	St	Co	Al	
<b>1-15 PS15 Gabutu</b>			<b>01-15 PLC 01</b>																		
<b>1) Sewage Pumps</b>		2																			
	(M01-15-01/02)																				
	STOP																				
	START																				
	Controlled at PCP, Local (Manu)																				
	Controlled at PCP, Remote (Auto)																				
	CS: START																				
	CS: STOP																				
	COS: Off-Remote-Manual at PCP																				
	COS: No.1-Alternate-No.2 at PCP																				
	Earth Fault																				
	Over Load																				
	Water Intrusion																				
	Wet Well Level High-High																				
	Wet Well Level High																				
	Wet Well Level Low																				
	Wet Well Level Low-Low																				
	Emergency Stop																				
	Delivery Flow (01-15 FE01)																				
<b>2) Incoming /Feeder Panel (01-15 IFP01)</b>		1																			
	PPL Incoiming MCCB On																				
	DG Set Incoming MCCB On																				
	PPL Watt-hour (kWh)																				
	PPL Watt (kW)																				
	PPL Voltage (V)																				
	PPL Ampere (A)																				
	PPL Power Factor																				
	DG Set Voltage (V)																				
	DG Set Ampere (A)																				
	PPL Under voltage																				
	PPL Overcurrent																				
	Grounding Over Currents for Feeders																				
<b>3) Standby Generator Set (01-15GEN01)</b>		1																			
	STOP																				
	START																				
	Controlled at GEN SET LCP, Manu																				
	Controlled at GEN SET LCP, Remote																				
	CS: STOP																				
	CS: START																				
	COS: Off-Local-Remote at LCP																				
	Ammeter																				
	Voltmeter																				
	Power Factor Meter																				
	Watt Meter																				
	Watt-hour Meter																				
	Frequency Meter																				
	Over-speed																				
	Lubricant Pressure Low																				
	Starting Time Over																				
	Alternator Bearing Temperature Rise																				
	Alternator Stator Winding Temperature Rise																				
	Earth Fault																				
	Over Current																				
	Under Voltage																				
	Over Voltage																				
	Emergency Stop																				
	Lubricant Temperature Rise																				
	Day Tank Level Meter																				
	Day Tank Level L																				
	DC Power Source Failure																				
	Lubricant priming pump Failure																				
	Radiator Failure																				
<b>4) Telemetry Panel (01-15 TMP01)</b>		1																			
	UPS Failure																				
	Micro PLC Failure																				
	GPRS MODEM/Gateway Failure																				
	Sub-total for 01-15 PLC01																				
									54	0	13	2	6	0	0	14	14	2	36	15	51

Pumping Stations - Control and Monitoring Item Schedule																												
LOAD	ITEMS	NUMBERS	Pumping Stations														Kila Kila STP											
			Field			Generator House			PLC								Central Monitoring Room				Log							
			Actuator			MCC/PCP			Input				Output				Operator Station											
			St	Co	Al	St	Co	Al	In	D	L/S	A	P	D	A	P	In	St	Co	Al		In						
01-16 PLC 01																												
<b>1-16 PS16 Konebada</b>																												
<b>1) Sewage Pumps</b>																												
	(M01-16-01/02)	2																										
	STOP				2			2											2									
	START				2			2											2									
	Controlled at PCP, Local (Manu)				2														2									
	Controlled at PCP, Remote (Auto)				2														2									
	CS: START				2													2										
	CS: STOP				2													2										
	COS: Off-Remote-Manual at PCP				4			4																				
	COS: No.1-Alternate-No.2 at PCP				2			2																				
	Earth Fault				2			2										2			2				2			
	Over Load				2			2										2			2				2			
	Water Intrusion				2			2										2			2				2			
	Wet Well Level High-High				1			1										1			1				1			
	Wet Well Level High				1			1																				
	Wet Well Level Low				1			1																				
	Wet Well Level Low-Low				1			1										1			1				1			
	Emergency Stop				1			1										1			1				1			
	Delivery Flow (01-16 FE01)				1			1					1					1						1	1			
<b>2) Pump Control Panel (01-16PCP01)</b>																												
	PPL Incoiming MCCB On				1			1										1										
	DG Set Incoming MCCB On				1			1										1										
	PPL Watt-hour (kWh)												1											1	1			
	PPL Watt (kW)												1											1	1			
	PPL Voltage (V)												1											1	1			
	PPL Ampere (A)												1											1	1			
	PPL Power Factor												1											1	1			
	DG Set Voltage (V)												1											1	1			
	DG Set Ampere (A)												1											1	1			
	PPL Under voltage				1			1																1	1			
	PPL Overcurrent				3			3																3	3			
	Grounding Over Currents for Feeders				5			5																5	5			
<b>3) Standby Generator Set (01-16GEN01)</b>																												
	STOP				1			1																1				
	START				1			1																1				
	Controlled at GEN SET LCP, Manu				1			1																1				
	Controlled at GEN SET LCP, Remote				1			1																1				
	CS: STOP				1								1											1				
	CS: START				1								1											1				
	COS: Off-Local-Remote at LCP				2																							
	Ammeter							1					1											1	1			
	Voltmeter							1					1											1	1			
	Power Factor Meter							1					1											1	1			
	Watt Meter							1					1											1	1			
	Watt-hour Meter							1					1											1	1			
	Frequency Meter							1					1											1	1			
	Over-speed				1			1																1	1			
	Lubricant Pressure Low				1			1																1	1			
	Starting Time Over				1			1																1	1			
	Alternator Bearing Temperature Rise				1			1																1	1			
	Alternator Stator Winding Temperature Rise				1			1																1	1			
	Earth Fault				1			1																1	1			
	Over Current				1			1																1	1			
	Under Voltage				1			1																1	1			
	Over Voltage				1			1																1	1			
	Emergency Stop				1			1																1	1			
	Lubricant Temperature Rise				1			1																1	1			
	Day Tank Level Meter							1					1											1	1			
	Day Tank Level L				1			1										1						1	1			
	DC Power Source Failure				1			1																1	1			
	Lubricant priming pump Failure				1			1																1	1			
	Radiator Failure				1			1																1	1			
<b>4) Telemetry Panel (01-16 TMP01)</b>																												
	UPS Failure												1											1	1			
	Micro PLC Failure												1											1	1			
	GPRS MODEM/Gateway Failure												1											1	1			
	Sub-total for 01-16 PLC01												54						0						13			2
													6						0						0			0
													14						14						2			36
													15						15						15			51

Pumping Stations - Control and Monitoring Item Schedule																					
LOAD	ITEMS	NUMBERS	Pumping Stations															Kila Kila STP			
			Field			Generator House			PLC									Central Monitoring Room			
			Actuator			MCC/PCP			Input			Output						Operator Station			
			St	Co	Al	St	Co	Al	In	D	L/S	A	P	D	A	P	In	St	Co	Al	In
<b>1-5 PS17 Kaugere</b>			01-17 PLC 01																		
<b>1) Sewage Pumps</b>		3																			
	(M01-17-01/02/03)																				
	STOP					3															3
	START					3															3
	Controlled at PCP, Local (Manu)					3															3
	Controlled at PCP, Remote (Auto)					3															3
	CS: START					3															3
	CS: STOP					3															3
	COS: Off-Remote-Manual at PCP					6															6
	COS: No.1/23-2/3/1-3/1/2					3															3
	Earth Fault					3				3											3
	Over Load					3				3											3
	Water Intrusion					3				3											3
	Wet Well Level (01-17 LE01)												1								1
	Wet Well Level High-High									1											1
	Wet Well Level High									1											1
	Wet Well Level Low									1											1
	Wet Well Level Low-Low									1											1
	Emergency Stop									1											1
	Delivery Flow (01-17 FE01)									1											1
<b>2) Delivery Valves (M01-17-04/05/06)</b>		3																			
	Open					3															3
	CLOSE					3															3
	Controlled at Act, Manu (Local)					3															3
	Controlled at Act, Auto (Remote)					3															3
	CS: CLOSE					3															3
	CS: OPEN					3															3
	COS: Off-Local-Remote					6															6
	Over Load					3															3
	Over Torqque					6															6
	Earth Fault					3															3
	Fully CLOSE					3															3
	Fully OPEN					3															3
<b>3) Incoming /Feeder Panel (01-17 IFP01)</b>		1																			
	PPL Incoming MCCB On					1															1
	DG Set Incoming MCCB On					1															1
	PPL Watt-hour (kWh)																				1
	PPL Watt (kW)																				1
	PPL Voltage (V)																				1
	PPL Ampere (A)																				1
	PPL Power Factor																				1
	DG Set Voltage (V)																				1
	DG Set Ampere (A)																				1
	PPL Under voltage									1											1
	PPL Overcurrent									3											3
	Grounding Over Currents for Feeders									8											8
<b>4) Standby Generator Set (01-17GEN01)</b>		1																			
	STOP					1															1
	START					1															1
	Controlled at GEN SET LCP, Manu					1															1
	Controlled at GEN SET LCP, Remote					1															1
	CS: STOP					1															1
	CS: START					1															1
	COS: Off-Local-Remote at LCP					2															2
	Ammeter																				1
	Vollmeter																				1
	Power Factor Meter																				1
	Watt Meter																				1
	Watt-hour Meter																				1
	Frequency Meter																				1
	Over-speed									1											1
	Lubricant Pressure Low									1											1
	Starting Time Over									1											1
	Alternator Bearing Temperature Rise									1											1
	Alternator Stator Winding Temperature Rise									1											1
	Earth Fault									1											1
	Over Current									1											1
	Under Voltage									1											1
	Over Voltage									1											1
	Emergency Stop									1											1
	Lubricant Temperature Rise									1											1
	Day Tank Level Meter																				1
	Day Tank Level L																				1
	DC Power Source Failure																				1
	Lubricant priming pump Failure																				1
	Radiator Failure																				1
<b>5) Telemetry Panel (01-17 TMP01)</b>		1																			
	UPS Failure																				1
	Micro PLC Failure																				1
	GPRS MODEM/Gateway Failure																				1
	Sub-total for 01-05 PLC01																				95
																					0
																					14
																					2
																					14
																					0
																					18
																					36
																					2
																					54
																					16
																					70

Sewage Treatment Plant - Control and Monitoring Item Schedule																						
LOAD	ITEMS	NUMBERS	Kila Kila Sewage Treatment Plant																			
			Field			Field			Elec. Room			PLC						Central Monitoring Room				
			Actuator / Chlorinator			LCP			MCC/PCP/ Switchgear			Input			Output			Operator Station				Legi.
			St	Co	Al	St	Co	Al	In	St	Co	Al	In	D	L/S	A	P	D	A	P	In	
<b>2 Grit Chamber and Electrical Substation</b>			09 RIO 01																			
<b>1) Fine Screen</b>		2																				
	(M02-02-01/02)																					
	STOP																					
	STRAT (FORWARD)																					
	START (REVERSE)																					
	Controlled at LCP, Local (Manu)																					
	Controlled at LCP, Remote (Auto)																					
	CS: START (FORWARD)																					
	CS: START (REVERSE)																					
	CS: STOP																					
	COS: Off-Remote-Local at LCP																					
	Upstream Levels (02-LE11/21)																					
	Downstream Levels (02-LE21/22)																					
	Earth Fault																					
	Over Load																					
	Over Torque																					
	Emergency Stop																					
	TE Water Supply Valve	2																				
	CS: Open																					
	CS: Close																					
	Opening/Closing Jam																					
<b>2) Grit Collector</b>		2																				
	(M02-03-01/02)																					
	STOP																					
	START																					
	Controlled at LCP, Local (Manu)																					
	Controlled at LCP, Remote (Auto)																					
	CS: START																					
	CS: STOP																					
	COS: Off-Remote-Manual at LCP																					
	Earth Fault																					
	Over Load																					
	Over Torque																					
	Emergency Stop																					
<b>3) Grit Pump</b>		3																				
	(M02-04-01/02)																					
	STOP																					
	START																					
	Controlled at LCP, Local (Manu)																					
	Controlled at LCP, Remote (Auto)																					
	CS: START																					
	CS: STOP																					
	COS: Off-Remote-Manual at LCP																					
	Earth Fault																					
	Over Load																					
<b>4) Sump Drain Pump (M02-05-01/02)</b>		2																				
	STOP																					
	START																					
	Controlled at LCP, Manu																					
	Controlled at LCP, Auto																					
	CS: START																					
	CS: STOP																					
	COS: Remote (Auto)-Local (Manual)																					
	COS: No.1-No.2-Alternate																					
	Sump High Level																					
	Sump Low Level																					
	Earth Fault																					
	Over Current																					
	Water Intrusion																					
	Sump H.H.W.L																					
	Sump L.L.W.L																					
	Emergency Stop																					
<b>5) Grit Separator (M02-06)</b>		1																				
	STOP																					
	START																					
	Controlled at LCP, Local (Manu)																					





Sewage Treatment Plant - Control and Monitoring Item Schedule																											
LOAD	ITEMS	NUMBERS	Kila Kila Sewage Treatment Plant																								
			Field			Field				Elec. Room				PLC						Central Monitoring Room							
			Actuator / Chlorinator			LCP				MCC/PCP/Switchgear				Input			Output			Operator Station				Leg.			
			St	Co	Al	St	Co	Al	In	St	Co	Al	In	D	L/S	A	P	D	A	P	In	St	Co		Al	In	
	PPL Ampere (A)										1														1	1	
	PPL Power Factor										1														1	1	
	DG Set Voltage (V)										1														1	1	
	DG Set Ampere (A)										1														1	1	
	PPL Under voltage										1														1	1	
	PPL Overcurrent										3														3	3	
	Grounding Over Currents for Feeders										28														28	28	
	<b>10) Standby Generator Set (09GEN01)</b>	1																									
	STOP										1														1		
	START										1														1		
	Controlled at GEN SET LCP, Manu										1														1		
	Controlled at GEN SET LCP, Remote										1														1		
	CS: STOP										1																
	CS: START										1																
	COS: Off-Local-Remote at LCP										2																
	Ammeter																									1	1
	Voltmeter																									1	1
	Power Factor Meter																									1	1
	Watt Meter																									1	1
	Watt-hour Meter																									1	1
	Frequency Meter																									1	1
	Over-speed																									1	1
	Lubricant Pressure Low																									1	1
	Starting Time Over																									1	1
	Alternator Bearing Temperature Rise																									1	1
	Alternator Stator Winding Temperature Rise																									1	1
	Earth Fault																									1	1
	Over Current																									1	1
	Under Voltage																									1	1
	Over Voltage																									1	1
	Emergency Stop																									1	1
	Lubricant Temperature Rise																									1	1
	Day Tank Level																									1	1
	Day Tank Level L																									1	1
	DC Power Source Failure																									1	1
	Lubricant priming pump Failure																									1	1
	Radiator Failure																									1	1
	Bulk Storage Tank Level																									1	1
	Day Tank Level L																									1	1
	<b>11) Fuel Transfer Pump</b>	2																									
	(09FP01/02)																										
	STOP																										2
	START																										2
	Controlled at LCP, Local (Manu)																										2
	Controlled at LCP, Remote (Auto)																										2
	CS: START																										2
	CS: STOP																										2
	COS: Manu-Auto																										2
	COS: Remote-Local																										2
	Earth Fault																										2
	Over Current																										2
	Flow Switch L	1																									1
	Pressure Switch L	1																									1
	<b>12) UPS</b>	2																									
	(09UPS01)																										
	Healthy																										1
	Battery Low Voltage																										1
	Charger Failure																										1
	Inverter Failure																										1
	Output Voltage (V)																										1
	Output Current (A)																										1
	Output Frequency (Hz)																										1
	Sub-total for 09RIO01																										185 0 19 2 42 0 0 58 65 0 115 21 132
	<b>3 No.1/2 OD/Clarifier</b>																										
	<b>1) Reactor Tank Mixer</b>	8																									
	(M04-02-01/08)																										
	STOP																										8
	STRAT																										8





Sewage Treatment Plant - Control and Monitoring Item Schedule																								
LOAD	ITEMS	NUMBERS	Kila Kila Sewerage Treatment Plant																					
			Field			Field			Elec. Room			PLC						Central Monitoring Room						
			Actuator / Chlorinator			LCP			MCC/PCP/ Switchgear			Input			Output			Operator Station				Legi.		
			St	Co	Al	St	Co	Al	St	Co	Al	In	D	L/S	A	P	D	A	P	In	St		Co	Al
	CS: STOP					3																		
	COS: Off-Remote-Manual at LCP					6									6									
	Earth Fault							3			3				3								3	3
	Over Load							3			3				3								3	3
	Emergency Stop							1							1								1	1
	Blower Flow (04FE31/41), 04FE41 for Future																2						2	2
	<b>3) Air Supply Valve (M04-07-03/04)</b>	2																						
	Both for Future																							
	Open		2												2								2	
	Stop		2												2								2	
	CLOSE		2												2								2	
	Controlled at Act, Manu		2												2								2	
	CS: CLOSE			2													2						2	
	CS: STOP			2													2						2	
	CS: OPEN			2													2						2	
	COS: Off-Local-Remote at ACT			4											4								4	
	Earth Fault										2				2								2	2
	Over Torque			4											4								4	4
	Over Load										2				2								2	2
	Thermo switch (Motor protection)			2											2								2	2
	Fully CLOSE		2												2					2			2	
	Fully OPEN		2												2					2			2	
	<b>4) Waste Sludge Pump (M04-08-05/08)</b>	4																						
	M04-008-07/08 for Future																							
	STOP				4			4							4								4	
	START				4			4							4								4	
	Controlled at LCP, Local (Manu)				4										4								4	
	Controlled at LCP, Remote (Auto)				4										4								4	
	CS: START					4											4							
	CS: STOP					4											4							
	COS: Off-Remote-Manual at LCP					8									6									
	Earth Fault							4			4						4						4	4
	Over Load							4			4						4						4	4
	Water Intrusion							2									2						2	2
	Emergency Stop							2									2						2	2
	<b>5) Clarifier (M05-01-03/04)</b>	2																						
	M05-001-04 for Future																							
	STOP				2				2														2	
	START				2				2														2	
	Controlled at LCP, Local (Manu)				2																		2	
	Controlled at LCP, Remote (Auto)				2																		2	
	CS: START					2											2							
	CS: STOP					2											2							
	COS: Off-Remote-Manual at LCP					4									4									
	Earth Fault							2			2						2						2	2
	Over Load							2			2						2						2	2
	Emergency Stop							2									2						2	2
	<b>6) Return Sludge Pump (M05-02-05/08)</b>	4																						
	M05-002-07/08 for Future																							
	STOP				4						4												4	
	START				4						4												4	
	Controlled at LCP, Local (Manu)				4																		4	
	Controlled at LCP, Remote (Auto)				4																		4	
	CS: START					4											4							
	CS: STOP					4											4							
	COS: Off-Remote-Manual at LCP					8									6									
	Earth Fault							4			4						4						4	4
	Over Load							4			4						4						4	4
	Emergency Stop							2									2						2	2
	Return Sludge Flow (05FE11/21)	2															2						2	2
	<b>7) Sump Drain Pump (M05-04-03/04)</b>	2																						
	STOP				2						2												2	
	START				2						2												2	
	Controlled at LCP, Local (Manu)				1																		1	

Sewage Treatment Plant - Control and Monitoring Item Schedule																															
LOAD	ITEMS	NUMBERS	Kila Kila Sewage Treatment Plant																												
			Field			Field			Elec. Room			PLC						Central Monitoring Room													
			Actuator / Chlorinator			LCP			MCC/PCP/ Switchgear			Input			Output			Operator Station				Leg.									
			St	Co	Al	St	Co	Al	In	St	Co	Al	In	D	L/S	A	P	D	A	P	In		St	Co	Al	In					
	Controlled at LCP, Remote (Auto)					1																				1					
	CS: START					2													2												
	CS: STOP					2													2												
	COS: Remote (Auto)-Local (Manual)					2													2												
	COS: No.1-No.2-Alternate					2													2												
	Sump High Level																		1												
	Sump Low Level																		1												
	Earth Fault							2			2								2					2			2	2			
	Over Current							2			2								2					2			2	2			
	Water Intrusion							2			2								2					2			2	2			
	Sump H.H.W.L							1			1								1					1			1	1			
	Sump L.L.W.L							1			1								1					1			1	1			
	Emergency Stop							1			1								1					1			1	1			
<b>8)</b>	<b>Scum Pump (M05-05-03/04)</b>	2																													
	STOP					2					2								2					2							
	START					2					2								2					2							
	Controlled at LCP, Local (Manu)					1																		1							
	Controlled at LCP, Remote (Auto)					1																		1							
	CS: START							2																2							
	CS: STOP							2																2							
	COS: Remote (Auto)-Local (Manual)							2											2												
	COS: No.1-No.2-Alternate							2											2												
	Pit High Level																		1												
	Pit Low Level																		1												
	Earth Fault							2			2								2					2			2	2			
	Over Current							2			2								2					2			2	2			
	Water Intrusion							2			2								2					2			2	2			
	Pit H.H.W.L							1			1								1					1			1	1			
	Pit L.L.W.L							1			1								1					1			1	1			
	Emergency Stop							1			1								1					1			1	1			
	Sub-total for 04RIO02																		225	0	4	0	56	0	0	97	108	6	89	4	93
<b>5</b>	<b>Utility Water and Disinfection Facility</b>																														
	<b>1) Chlorine Solution Tank Mixer (M06-0)</b>	1																													
	STOP					1					2								2					2							
	START					1					2								2					2							
	Controlled at LCP, Local (Manu)					1																		1							
	Controlled at LCP, Remote (Auto)					1																		1							
	CS: START							2																2							
	CS: STOP							2																2							
	COS: Remote (Auto)-Local (Manual)							2											2												
	Tank Level (06LE11)																														
	Earth Fault							1			1								1					1			1	1			
	Over Current							1			1								1					1			1	1			
	Emergency Stop							1			1								1					1			1	1			
<b>2)</b>	<b>Utility TE Water Supply Unit (M06-04)</b>	1																													
	STOP					2													2					2							
	START					2													2					2							
	Controlled at LCP, Manu					1																		1							
	Controlled at LCP, Auto					1																		1							
	CS: START							2																2							
	CS: STOP							2																2							
	COS: Off-Local-Remote at LCP							2																2							
	Earth Fault							2			1													1			1	1			
	Over Current							2			1													1			1	1			
	Pressure Switch L.L.							1																							
	Representative Fault																		1					1			1	1			
<b>3)</b>	<b>Auto Strainer (M06-05-01/04)</b>	4																													
	STOP					4													4					4							
	START					4													4					4							
	Controlled at LCP, Manu					4																		4							
	Controlled at LCP, Auto					4																		4							
	CS: START							4																4							
	CS: STOP							4																4							
	COS: Off-Local-Remote at LCP							8																8							

Sewage Treatment Plant - Control and Monitoring Item Schedule																										
LOAD	ITEMS	NUMBERS	Kila Kila Sewage Treatment Plant																							
			Field			Field			Elec. Room			PLC							Central Monitoring Room							
			Actuator / Chlorinator			LCP			MCC/PCP/ Switchgear			Input				Output			Operator Station				Legi.			
			St	Co	Al	St	Co	Al	In	St	Co	Al	In	D	L/S	A	P	D	A	P	In	St		Co	Al	In
	Earth Fault					4				2							2					2				
	Over Current					4				2							2					2				
	Representative Fault																1					1				
	<b>4) Defoaming Pump (M06-06-01/02)</b>	2																								
	STOP					2				2												2				
	START					2				2												2				
	Controlled at LCP, Local (Manu)					1																1				
	Controlled at LCP, Remote (Auto)					1																1				
	CS: START					2																2				
	CS: STOP					2																2				
	COS: Remote (Auto)-Local (Manual)					2											2									
	COS: No.1-No.2-Alternate					2											2									
	Pit High Level																1									
	Pit Low Level																1									
	Earth Fault						2				2										2			2		
	Over Current						2				2										2			2		
	Water Intrusion						2														2			2		
	Pit H.H.W.L						1										1				1			1		
	Pit L.L.W.L						1										1				1			1		
	Emergency Stop						1										1				1			1		
	<b>5) Sludge Dewatering Unit (M07-01-01/02)</b>	2																								
	STOP					2											2					2				
	START					2											2					2				
	Controlled at LCP, Manu					2																				
	Controlled at LCP, Auto					2																				
	CS: START					2																				
	CS: STOP					2																				
	COS: Off-Local-Remote at LCP					4																				
	Dewatering Unit Ready									2												2				
	Peripheral Equipment Ready									2										2		2				
	Earth Fault						2				2										2			2		
	Over Current						2				2										2			2		
	Representative Fault																				2			2		
	Speed Set Point						2								2					2		2				
	Waste Sludge Feed Flow						1								1					1				1		
	Waste Sludge Density						1								1					1				1		
	Ratio Set Point to Dry Solid						2								1	2				2		1		1		
	<b>6) Sludge Cake Conveyer (M07-02)</b>	1																								
	STOP					1					1											1				
	START (FORWARD)					1					1											1				
	START (REVERSE)					1					1											1				
	Controlled at LCP, Single (Manu)					1																1				
	Controlled at LCP, Linkage (Auto)					1																1				
	CS: START (FORWARD)					1																1				
	CS: START (REVERSE)					1																1				
	CS: STOP					1																1				
	COS: Linkage (Auto)-Single (Manual)					2											2									
	Earth Fault						1				1												1			
	Over Current						1				1												1			
	Over Torque						1				1												1			
	Emergency Stop						1										1						1			
	<b>7) Sludge Cake Hopper (M07-03-01/02)</b>	2																								
	STOP					2																2				
	START					2																2				
	Controlled at LCP, Manu					1																1				
	Controlled at LCP, Auto					1																1				
	CS: START					2																2				
	CS: STOP					2																2				
	COS: Off-Local-Remote at LCP					2											2									
	Earth Fault						2				2										2			2		
	Over Current						2				2										2			2		
	Over Torque						4				4										4			4		
	Emergency Stop						1										1						1			
	Hopper Weight (07WE01)	1																			1			1		
	<b>8) Polymer Dissolving Tank Mixer (M07-04-01/02)</b>	2																								

Sewage Treatment Plant - Control and Monitoring Item Schedule																											
LOAD	ITEMS	NUMBERS	Kila Kila Sewage Treatment Plant																								
			Field			Field				Elec. Room				PLC								Central Monitoring Room					
			Actuator / Chlorinator			LCP				MCC/PCP/ Switchgear				Input				Output				Operator Station					Leg.
			St	Co	Al	St	Co	Al	In	St	Co	Al	In	D	L/S	A	P	D	A	P	In	St	Co	Al	In		
	STOP																										
	START																										
	Controlled at LCP, Single (Manu)																										
	Controlled at LCP, Linkage (Auto)																										
	CS: START																										
	CS: STOP																										
	COS: Linkage (Auto)-Single (Manual)																										
	Earth Fault																										
	Over Current																										
	Emergency Stop																										
	Tank H.H.W.L																										
	Tank L.L.W.L																										
	Tank Level (07LE11/21)	2																									
	<b>9) Polymer Feeder</b>	2																									
	(M07-05-01/02)																										
	STOP																										
	START																										
	Controlled at LCP, Single (Manu)																										
	Controlled at LCP, Linkage (Auto)																										
	CS: START																										
	CS: STOP																										
	COS: Linkage (Auto)-Single (Manual)																										
	Earth Fault																										
	Over Current																										
	Emergency Stop																										
	Potable Water Supply Valve	2																									
	CS: Open																										
	CS: Close																										
	Opening/Closing Jam																										
	Compressed Air Supply	2																									
	CS: Open																										
	CS: Close																										
	Opening/Closing Jam																										
	<b>10) Polymer Feed Pump</b>	2																									
	(M07-06-01/02)																										
	STOP																										
	START																										
	Controlled at LCP, Single (Manu)																										
	Controlled at LCP, Linkage (Auto)																										
	CS: START																										
	CS: STOP																										
	COS: Linkage (Auto)-Single (Manual)																										
	Earth Fault																										
	Over Current																										
	Emergency Stop																										
	Speed Set Point																										
	Polymer Feed Flow (07FE12/22)	2																									
	<b>11) Air Compressor</b>	2																									
	(M07-07-01/02)																										
	STOP																										
	START																										
	Controlled at LCP, Manu																										
	Controlled at LCP, Auto																										
	CS: START																										
	CS: STOP																										
	COS: Off-Local-Remote at LCP																										
	Earth Fault																										
	Over Current																										
	Pressure Switch L.L.																										
	Representative Fault																										
	<b>12) Air Dryer</b>	2																									
	(M07-08-01/02)																										
	STOP																										
	START																										
	Controlled at LCP, Manu																										
	Controlled at LCP, Auto																										

Sewage Treatment Plant - Control and Monitoring Item Schedule																								
LOAD	ITEMS	NUMBERS	Kila Kila Sewage Treatment Plant																					
			Field			Field				Elec. Room				PLC						Central Monitoring Room				
			Actuator / Chlorinator			LCP				MCC/PCP/ Switchgear				Input			Output			Operator Station				Leg.
			St	Co	Al	St	Co	Al	In	St	Co	Al	In	D	L/S	A	P	D	A	P	In	St	Co	
	CS: START					2																		
	CS: STOP					2																		
	COS: Off-Local-Remote at LCP					2																		
	Earth Fault							2				1			1							1		1
	Over Current							2				1			1							1		1
	Representative Fault											1			1							1		1
	<b>13) Motorised Hoist Crane For Polymer (M07-10)</b>	1																						
	Earth Fault							1				1			1							1		1
	Over Current							1				1			1							1		1
	<b>14) Sump Drain Pump (M07-11-01/02)</b>	2																						
	STOP					2						2										2		
	START					2						2										2		
	Controlled at LCP, Local (Manu)					1						1										1		
	Controlled at LCP, Remote (Auto)					1						1										1		
	CS: START							2														2		
	CS: STOP							2														2		
	COS: Remote (Auto)-Local (Manual)							2				2												
	COS: No.1-No.2-Alternate							2				2												
	Sump High Level											1												
	Sump Low Level											1												
	Earth Fault					2						2										2		2
	Over Current					2						2										2		2
	Water Intrusion					2						2										2		2
	Sump H.H.W.L					1						1										1		1
	Sump L.L.W.L					1						1										1		1
	Emergency Stop					1						1										1		1
	<b>15) Waste Water Mixer (M07-12)</b>	1																						
	STOP					1						1										1		
	START					1						1										1		
	Controlled at LCP, Local (Manu)					1						1										1		
	Controlled at LCP, Remote (Auto)					1						1										1		





Sewage Treatment Plant - Control and Monitoring Item Schedule																																										
LOAD	ITEMS	NUMBERS	Kila Kila Sewage Treatment Plant																																							
			Field			Field				Elec. Room				PLC								Central Monitoring Room																				
			Actuator / Chlorinator			LCP				MCC/PCP/ Switchgear				Input				Output				Operator Station				Leg.																
			St	Co	Al	St	Co	Al	In	St	Co	Al	In	D	L/S	A	P	D	A	P	In	St	Co	Al	In																	
	Total for 08PLC01																													0	5	0	0	0	0	0	5	0	0	22	0	22

**DIVISION 14.**

**CONVEYING SYSTEMS**

**(Not Used)**

**DIVISION 15.**

**MECHANICAL WORKS FOR BUILDING  
SERVICES**

## **SECTION 15000 : Mechanical Works – Building Services**

### **PS.15.01 Air Conditioning and Mechanical Ventilation**

#### **A Ventilation and Exhaust Fans**

##### **1 General**

Fans shall be capable of giving the specified performance when tested in accordance with B.S.848. Although estimated values of the resistance to air-flow of items of equipment may be indicated this does not relieve the Contractor of the responsibility for providing fans capable of delivering the required air volume through the system.

Each fan shall be capable of continuous operation, having the capacity as indicated in the Equipment Schedules and/or in the drawings when operated at the specified speed against the friction in the system.

##### **2 Propeller Fans**

Propeller fans shall have blades manufactured from P.V.C. coated galvanised steel.

The fans shall be wall mounted to suit the particular installations. Wall mounted fans shall be supplied with wall boxes and wall plates suitable for removal for cleaning or built in the wall where shown on the Drawings. The fan shall be completed with weatherproof, flush fitting grilles, draught preventing iris or similar shutters, wire guards, etc. as specified.

Fan motors shall have IP 55 enclosures.

##### **3 Axial Fans**

The fans shall be the tube axial, direct driven with aerofoil blades and manufactured from heavy gauge metal or other approved materials. Fan motors shall be non-overloading over the characteristic curve at the required rpm to deliver the specified airflows. Fans shall be the bifurcated type where so specified.

The impellers shall be of steel or other equally approved materials and shall be accurately balanced after assembly. The blades shall be fastened to the hub or the blades and hubs shall each be formed in one piece.

The casings shall be longer than the length of the fan and motor. The casings shall be of steel, shall have flanged ends and shall incorporate an inspection door. The fans shall be complete with resilient mountings, mounting feet or plates, connection spigots, wire guards and dampers. Silencers shall be included if required to comply with restrictions on noise levels.

Fans shall be suitable for their particular service, position of fitting and chosen with respect to corrosion, inflammability or other hazardous applications and shall not exceed any specified noise levels.

Fan speeds shall not exceed 1450 rpm unless specified otherwise. The fans shall be directly coupled to totally enclosed squirrel-cage induction motors suitable for either single-phase or three-phase, 50-Hz supply.

##### **4 Roof Exhaust Fans**

Roof ventilator shall have aerofoil blades with weatherproof housing of aluminium, steel or other approved materials. Fans shall be directly coupled to their respective

motors which shall be self cooled and completely separated from the exhaust air streams. Bird screens shall be provided to prevent birds from entering inside the housings. Accessories shall include installation frames, automatic shutters, bolts and washers and sound attenuating curbs to comply with noise restriction requirements.

## 5 Centrifugal Fans

The fans shall be backward curved or airfoil multi-blade centrifugal type, statically and dynamically balanced and complete with matching housings. Fan shafts shall not pass through their first critical speed as units come up to the rated speed. Bearings shall be the self-aligning ball type amply sized for the loads with factory sealed lubrication and with provision for lubrication. The maximum outlet velocity of each fan shall not exceed 1800 rpm. The housings shall be fabricated from black mild steel sheets.

## B Vibration Isolators for Ventilation and Air-Conditioning System

### 1 Selection of Vibration Isolators

Vibration isolators shall be selected based on the recommendations of Chapter 46 of ASHRAE Handbook 1999 HVAC Applications.

The specification of vibration isolators referred to on the drawings and Schedule of Equipment are detailed in the following sections.

### 2 Type "1" – Isolating Pads

This type of vibration isolators shall be generally used where the vibrating force is transmitted directly to ground or the vibrating force is very small compared to the absorption capacity of the structural slab at higher levels.

- a Type "1 A" – Neoprene Rubber Pads : These shall be cross ribbed in multiple layers or of sandwich type to achieve the required deflection. The adhesive used in fabricating the pads shall be as recommended by the manufacturer.
- b Type "1 B" – Glass Fiber Pads : These shall be of pre-compressed fiberglass construction and suitable to take up to 34 kg/sq.cm load. The pads shall be coated with elastometric neoprene rubber spray to protect the glass fiber and increase the damping effect.
- c Type "1 C" – Cork Pads: These shall be constructed from natural cork granules compressed and steam baked to form slabs and shall have a density of 96 to 106 kg/cu.m (6 to 6.6 lbs/cu.ft). The cork pads shall be treated with hot Bitumen Asphalt coating for protection of cork.

### 3 Type "2" – Molded Neoprene Rubber Mounts

These shall be used where a greater deflection is required than that for pads. The maximum deflection allowable on these rubber mounts shall be 12mm (0.5 inch). The normal shape of mount shall be conical with a captive insert for attaching to equipment base.

### 4 Type "3" – Free Standing Spring Isolators

These shall be constructed with open type stable spring and load plates at top and bottom with an adjustable bolt for leveling. Neoprene rubber acoustical treatment shall be provided to prevent transmission of very high frequency vibration and noise.

The spring shall be so designed that the horizontal stiffness is more than 75% of the vertical stiffness.

The rated loads and deflection for these springs shall allow an additional 50% travel to that of the rated deflection before the springs are compressed solid, to accommodate any errors in actual load distribution.

**5 Type “4” – Restrained Spring Isolators**

These are similar to type “3”, but with additional restraint in vertical direction. These isolators shall have hold down bolts to limit vertical movement. The restraints should have adequate clearance so that they are activated only when a temporary restraint is needed.

**6 Type “5” – Housed Spring Isolators**

These isolators are similar to type “4” except that they consist of two telescoping houses. The contact surfaces of houses shall be separated by resilient inserts such as Neoprene Sponge or equivalent materials.

**7 Type “6” – Rubber Hangers**

These are similar to type “2” except that the conical rubber mold is housed in a steel casing and have a through hole for the hanger rod. The assembly shall allow for 20 to 35 degrees angular movement for the hanging rod without metal to metal contact.

**8 Type “7” – Spring Hangers**

These are similar to type “3” except that the spring is mounted in a steel casing and used for suspension only. The assembly shall allow for 20 to 25 degrees angular movement for the hanging rod without metal to metal contact.

**9 Type “8” – Combination Rubber & Spring Hangers**

This shall be a combination of type “6” and “7” having all the specified characteristics therein.

**10 Type “9” – Thrust Restraints**

These shall be similar to type “7”, but installed in pairs to counteract the thrust caused by air pressure.

**11 Type “10” – Air Springs**

These shall consist of constant dry air supplying equipment and air bellows. These shall be used where 150mm or greater deflection is required and natural frequencies do not exceed 80 Hz.

**C Split System Air Conditioning Units**

**1 Description of Equipment**

**a General**

Split system air-conditioning unit shall be of the air-cooled type, factory assembled and furnished complete with wall-mounted/ceiling exposed/ceiling

concealed indoor unit, remote air-cooled condensing unit, refrigerant piping and all other related controls and accessories.

**b Capacity**

The selection of the split system air-conditioning units shall be required to meet the total cooling load as specified on the drawings. The capacity shall have to be suitably derated to take into account any differences in level between the indoor unit and remote air-cooled condensing unit and also the length of refrigerant piping involved.

**c Compressors**

Compressors shall be of the hermetic rotary type with overload protection. It shall be internally spring mounted for quiet operation. The compressor motor shall be interlocked with the condenser fan motor of each unit such that it may only be run when the condenser fan is operating.

**d Evaporators and Condenser Fans**

Evaporator and condenser fans shall be direct driven. The evaporator fan shall be the centrifugal type and the condenser fan shall be the propeller type with provisions to eliminate condensate dripping.

**e Evaporator and Condenser Coil**

Evaporator and condenser coils shall have copper tubing as the primary surface and aluminium fins for the secondary surface. They shall be factory tested for leaks. A suitable metering device shall be provided for the refrigeration system.

**f Refrigerants**

Refrigerants shall be R407C or approved equal and shall be those refrigerants that are ozone-layer friendly.

**g Filters**

Air filters shall be of the reusable type and be efficient for its purpose. They shall be located so that they can be checked, cleaned and replaced easily.

**2 Refrigerant Pipeworks**

**a General**

The refrigerant pipes shall be routed in an orderly manner along the partition wall, brickwall or soffit of floor slab without obstructing other services. The refrigerant pipes shall be housed in white colour metal trunking of adequate thickness.

**b Material of Pipeworks**

The refrigerant pipes shall be copper tubes complying with BS 2871 Part 2 1972.

The pressure rating of copper tubes shall be

Suction Line	1200 kPa
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Liquid and Hot Gas Line 2000 kPa

**c Jointing of Copper Pipes**

Jointing of copper pipes for air conditioning units of 5.5 Hp and below shall not be permitted.

**d Insulation of Refrigerant Pipes**

The refrigerant pipes shall be insulated with 19mm thick flexible, close cell light weight elastometric material. Liquid and hot gas refrigerant pipe shall not be insulated together.

**e Pipe Supports**

Adequate supports shall be provided for refrigerant pipes not housed in metal trunking. The spacing of supports shall be not be more than 2.0m.

**3 Condensate Drain Pipes**

**a General**

The condensate drain pipes shall be routed in an orderly manner along partition wall, brickwalls and soffit of beam without obstruction to other services.

The configuration and sizes of the pipeworks shall be as shown on the drawings.

The horizontal run of the pipework shall be installed with a gradient of not less than 1/100.

**b Pipe Material and Workmanship**

The material of condensate drain pipes shall be PVC.

Where possible, the condensate drain pipes shall be embedded in the brickwall or apron floor slab.

Thermal insulation is not required for embedded pipes. All exposed condensate drain pipes shall be insulated with 19mm thick flexible, close cell light weight elastometric material.

The spacing of supports for condensate drain pipes shall not be more than 2.0m.

**D Ductwork and Accessories**

**1 General**

This section sets out the requirements of materials and standards of construction with respect to ductings, diffusers, grilles, registers, insulations, attenuators and accessories to be used on this project. All ductworks shall not be fabricated with less than the clear internal dimensions indicated on the Drawings and shall be installed generally as shown.

It is the responsibility of the Contractor to check the actual spaces available on site for ductwork installation, prior to fabrication of the ducts. If any departures from the Drawings are deemed necessary, the Contractor shall submit details of such departures and reasons for approval.

All ductworks shown on the Drawings shall be properly supported and anchored to the building structure in an approved manner using steel hangers, anchors, brackets and supports which shall be fixed by means of inserts on expansion shields of adequate size and number to support the loads imposed thereon.

All ductworks shall be fabricated from galvanized sheet metal and all ductworks and fittings shall be constructed in accordance with the practice as recommended by ASHRAE, SMACNA or other equivalent authority.

The gauges of sheet metal, type of joints and brackings shall be constructed in accordance with the Sheet Metal and Air Conditioning Contractors National Association (SMACNA), of United States of America, "HVAC Duct Construction Standards Metal and Flexible, 2nd Edition (1995)".

## **2 Ductwork Construction**

All ductworks shall be machine bent and be free from buckles and waves. Transitions shall be made with sides pitched not exceeding 20° (or 40° included angle) for diverging air flow, or as indicated in the Drawings. Ducts may be constructed around obstructions at beams, etc., provided duct construction practice conforms to ASHRAE recommendations and overall air flow performance is not affected.

Curved elbows shall have a centreline radius of not less than 1.5 times the width or diameter of the duct. Where right-angled bends are used, double thickness turning vanes shall be incorporated.

Pitot tubes access holes shall be provided at the suction and discharge sides of all fans or in such other locations which permit measurement of fan performance. The holes shall be 30 mm diameter, circular, flanged and with gasketed covers.

## **3 Joints**

Joints shall be made substantially air tight, and no marks from air leaks shall show at duct joints or connections to grilles and diffusers. Longitudinal joints of ductwork shall be made at corners only with Pittsburgh or equally approved seams. Transverse joints either shop-made or field-made shall be flanged on ducts of 625mm and above with matching angles bolted together. Angles shall be of size not less than 25x25x3mm and shall be riveted to ducts. Angles shall be coated with approved non-setting compound before bolting up. No ductwork joints, bends or fittings shall be permitted within the thickness of the walls, floor or ceiling structures. Laps at joints shall be made in the direction of air flow. Button punch or bolt connections in standing seams shall be spaced at fixed centers not greater than 150 mm.

## **4 Ductwork Supports and Openings**

All ductworks shall be supported at intervals not greater than 2.4m and shall be supported rigidly from the building structure in an approved manner using steel hangers, anchors, brackets and by means of inserts on expansion shields of adequate size and number to support the loads imposed thereon. Wooden plugs shall not be acceptable. Steel angle iron hangers shall be of similar size to the bracings of that duct section. Ducts shall be so constructed and installed as to be completely free from vibration under all conditions of operation.

Where ducts pass through floors, walls or partitions, the free space shall be adequately caulked with rockwool and a neat sheet metal angle flange arranged to

cover the free space. Where ducts penetrate the roof construction, flashings shall be provided.

Where ducts with fire dampers pass through fire barriers, 10 SWG mild steel sleeves shall be provided. The gap between each sleeve and fire damper shall be packed with rockwool for an air tight seal.

Suitably sized air-tight access with rubber linings shall be provided at all changes of direction and connections with the cooling coils, suction side of fans, filter and fire dampers in the ductwork for maintenance, cleaning and inspection purposes.

## 5 Flexible Connections

Flexible joints shall be provided on fan inlet and outlet connections and elsewhere on the ductwork where indicated. They shall be of the full cross-sectional area of the mating fan inlet or outlet or duct section. The ends of the ducts or the duct and the fan connection shall be in line.

Flexible joints shall consist of, or be protected by, material having a fire penetration time of at least fifteen minutes when tested in accordance with BS 476 Part 1, Section 3. The material shall be of the glass fibre cloth type or 455 gm canvas. The width of the joints from metal edge to metal edge shall be not less than 80 mm and not more than 200 mm.

All flexible joints other than fan inlet connections shall be between flanged ends. Each flexible material flange shall be backed by an angle or flat iron flange and the flexible joint shall be securely held between the metal flanges. Flat iron bands used with fan inlets shall be not less than 4.5mm thick.

## 6 Flexible Ducts

Flexible ducts shall be constructed of a single aluminium plywall and helically corrugated with triple locking seam.

Galvanised ducts/hose clamps shall be used for connection of the flexible duct to diffusers, VAV terminals and other ductwork.

## 7 Dampers

Dampers shall be provided and installed in the sizes, types and locations as indicated on the Drawings and as may be necessary for proper operation of the air conditioning system. Samples of types of dampers to be installed shall be submitted for approval.

Volume dampers shall be of the opposed blade type and the frames shall be steel, enamelled after fabrication and reinforced where necessary to prevent vibration. The blades shall be streamlined and fabricated of galvanised steel weighing not less than 8 kg/m<sup>2</sup>. Each damper blades shall be tipped with 6mm thick hard felt to ensure silent operation. The shafts shall be of steel and the bearings shall be graphite impregnated bronze bushes or similar bearings.

Manual dampers shall be provided with adjustable locking quadrants of approved manufacture. Automatic dampers shall have suitable connecting rod and base plate for mounting the electric motor as may be necessary. The permanent open and close position shall be marked and labelled, and after installation and complete satisfactory balancing, the normal working position of each damper lever shall be clearly labelled.

Splitter dampers shall have approved quadrant operated locking device fitted with an external indicator to show the damper blade positions. Splitters shall be two gauges heavier than the duct in which they are installed.

Access doors or panels shall be provided for all concealed damper operators and locking set screws. Locking type quadrant operators for dampers, when installed on ducts to be thermally insulated, shall be provided with stand-off mounting brackets, bases or adapters to provide clearance between duct surface and operator of not less than the thickness of the insulation. Stand-off mounting items shall be integral with the operator or standard accessory of the damper manufacturer.

## 8 Grilles

Grilles are to have the free area of not less than 80% or as specified in the Drawings and shall be of the louvred type. The static pressure drop across each grille shall not exceed 2.5 mm WG.

## 9 Insect Screens and Louvres

Insect screens of the corrosion resistant type shall be provided and fixed behind all intakes and discharge louvres, grilles and openings where these occur on the outside of the building. The screens shall be fixed for easy removal for periodic cleaning and shall be of minimum gauge 22.

All external supply and discharge air louvres shall be of the sizes indicated on the Drawings and shall be supplied and fixed by the Contractor. They shall be suitable for removal and be complete with suitable corrosion resistant insect screens and shall be constructed of stainless steel or aluminium.

## E Testing and Commissioning

### 1 Testing Equipment

The following calibrated testing equipment shall be made available for the testing and commissioning of the Air Conditioning and Mechanical Ventilation system:

- a Clip-on Type Voltmeter and Ammeter.
- b Pressure Gauge Assembly for measurement of compressor suction and discharge pressure.
- c Sling Type °C Dry Bulb (DB) / Wet Bulb (WB) Thermometer.
- d Vane anemometer with case.
- e Sound level meter with 8 octaves band measurement.

### 2 Schedule of Tests

The air conditioning units shall be tested and fine tuned before the following data are recorded to verify the performance of each equipment:

- a Pressure gauge reading at suction and discharge side of the compressor.
- b Voltage of incoming power supply and operating current of the equipment.
- c Room Dry Bulb (DB) and Wet Bulb (WB) Temperature.

- d Off Coil Dry Bulb (DB) Air Temperature.
- e Outdoor Air Temperature.

Also to be recorded are the observations made on the air conditioning unit as detailed below:

- a Signs of condensation on indoor unit.
- b Signs of condensation on insulated surface of refrigerant pipe.
- c Abnormal operating conditions at indoor and outdoor unit.
- d Signs of clogging at condensate drain pipe.

Any defects identified during testing and commissioning shall be rectified. Tests on the affected air conditioning units shall be repeated until acceptable results are obtained.

The quantity of air for ventilation systems shall be set within  $\pm 5\%$  of the figures given on the Drawings and final setting of air quantities shall be recorded.

The automatic control operation of air conditioning and ventilation systems (timer control or duty/standby changeover, etc.) shall also be tested.

### **3 Format for Recording Test Data**

Test procedures and data sheets shall be submitted to Engineer for approval two (2) weeks before commencement of tests.

All tests and inspections shall be conducted in the presence of Engineer, who shall endorse all test records.

## **F Service and Maintenance**

### **1 General**

The work covered by this section is for the supply of all materials, labour, appliances and necessary incidentals for the service and maintenance of Contract Works.

### **2 Workmanship and Materials**

The work described in this section shall be performed by workmen skilled in the service, maintenance and repair of air conditioning and ventilations system.

All materials to be supplied in connection with work under this section shall be new and unused, and shall generally be of the best quality as regards to manufacture and performance.

### **3 Supervision**

The foreman in charge of the service, maintenance and repair work to be carried out under this Specification shall be thoroughly competent in supervising the service, maintenance and repair of air conditioning and ventilation system.

#### 4 **Scope of Work**

All machinery and equipment comprising the complete air conditioning and ventilation system under this Contract shall be serviced and maintained strictly in accordance with the servicing and maintenance schedule as set out below.

The Contractor shall advise the Engineer of any defects in any part of the Works observed during the routine inspection and service, and shall repair such defects.

The Contractor shall also provide emergency repair services during normal working hours and also during overtime hours if required to do so by the Engineer.

#### 5 **Service and Maintenance Schedules**

The Contractor shall inspect and service all equipment comprising the Works at least once a month.

At each such monthly inspection and service of the Works, the works detailed below shall be performed by the Contractor:-

- a Checking the suction and discharge pressure of all split systems, and if abnormal situation occurs, tracing the faults and rectifying as necessary.
- b Checking all pipelines for leaks and rectifying as necessary.
- c Checking and topping up refrigerant as necessary.
- d Checking and cleaning all filters.
- e Checking and cleaning evaporator coils and condenser coils.
- f Checking and cleaning fans at indoor units and outdoor units.
- g Lubricating bearings for fans as necessary.
- h Checking and clearing clogs in condensate drain pipes.
- i Checking all motor bearings and lubricating with grease as necessary.
- j Checking carbon brushes and slip rings of all motors and cleaning as necessary. Renewing carbon brushes as necessary.
- k Checking safety devices fitted to all motors and cleaning, adjusting and lubricating as necessary.
- l Inspecting and checking the routine operation of all electrical starters, electrical control gears and ancillary electrical apparatus.
- m Cleaning, adjusting and lubricating all bearings, pivots and other moving parts as necessary.
- n Cleaning or renewing electric contactors as necessary.

## 6 Consumable Materials

The Contractor shall supply the following consumable materials as and when required:

- a All refrigerant required to replace refrigerant losses in the refrigerant systems (if applicable)
- b All oils and greases required for lubrication of compressors, fan bearings, motor bearings, pivots and other moving parts.
- c All consumable filter elements.
- d All carbon brushes required to replace worn brushes in electric motors.
- e All electric contact points required to replace worn electric contact points in switchgears, motor start gears, electrical control gears and electric relays.
- f All electric fuses required to replace blown fuses.
- g All cotton waste, soap detergent and other cleaning materials required for cleaning purposes.

## 7 Service and Maintenance Records

- a Service and Maintenance Record Books

The Contractor shall provide a service and maintenance record book for the Works being serviced and maintained by him. This record book shall be kept by the Employer, and brief details of all service, maintenance and repairs carried out on the Works shall be entered by the Contractor into this book for checking purposes. The address and telephone number of the Contractor's and the Telephone number of Contractor's authorized maintenance personnel shall also be entered into this record book to facilitate emergency service calls.

## G Operation and Maintenance (O&M) Manuals

### 1 General

Four (4) copies of the draft O&M Manuals, complete with As-constructed Drawings shall be submitted to Engineer for approval 8 weeks before Mechanical Completion of the WORK. Upon approval by Engineer, four (4) copies of the hard cover bound O&M Manuals shall be submitted to Employer.

### 2 Contents of O&M Manual

The contents of the O&M Manuals shall include:

- a Information on owner and consultant.
- b Maintenance procedure for each equipment
- c Trouble shooting procedure for each equipment
- d Technical specification of each equipment
- e List of spare parts (if any)

- f List of supplier of major equipment
- g Technical information from equipment manufacturer
- h Technical catalogues
- i Testing and commissioning records
- j As-Constructed Drawings and electrical circuit diagrams

## **PS.15.02 Domestic Cold Water and Sanitary Plumbing System**

### **A General**

The whole of the works covered by this Specification shall be carried out in accordance with the latest Australian or British Standards Specifications, Codes of Practice and the local By-Laws. In addition, works performed under this Contract shall also be to the approval of the relevant Authorities for Sanitary and Water Plumbing Works.

All materials used in connection with the piping installation shall be of the quality specified and where not specified, shall be in accordance with the relevant Australian or British Standards Specification.

Water plumbing and sanitary plumbing shall be executed only by plumbers registered with the appropriate Authorities.

All pipework, which are to be concealed and/or buried underground, shall be inspected by the Engineer or his representative and the relevant Authority before covering up. The Contractor shall make all necessary arrangements to have the pipes inspected and approved.

The Contractor shall apply for and obtain all necessary certificates and approvals for the work done from the relevant authorities and shall lodge the same with the Engineer.

### **B General Requirements For Piping Works**

#### **1 Installation of Pipes**

All pipes shall be fixed clear of each other and shall be arranged so as to provide easy access for maintenance and repair. The pipes shall be easily replaceable for their full length.

All pipeworks, except those chased in walls and floors, shall be installed at least 32 mm clear of the surface of the supporting structure to give free access for painting of the full external surface.

All water pipes, other than those within plantrooms, which are not concealed in ducts or within ceiling space shall be concealed in walls or slabs up to a point as near as possible to the fitting or appliance.

Where it is necessary to avoid sound transmission, a P.V.C. insert shall be provided between the bracket and the pipe.



The number of pipe joints shall be kept to an absolute minimum. Long radius bend shall generally be used on all changes of direction. Elbows shall only be used due to site constraints.

Where manufacturer's instructions differ from the Specification or the requirements shown on drawings, the manufacture's instructions shall be followed.

## 2 Pipe Sleeves

When pipe passes through internal walls, slabs, beams etc, pipe sleeve shall be provided. Galvanised pipe sleeve shall generally be used except that brass or copper pipe sleeve shall be used for the case of copper pipe. The size of pipe sleeve shall be at least one size larger than the size of the pipe subject to a minimum annular space of 15mm between the sleeve and the pipe.

Sleeves through floor slabs shall be extended 25mm above finished floor level while sleeves through walls, beams etc shall have the sleeve ends flushed with the walls, beams etc.

The annular space between pipe and pipe sleeve shall be fully packed with non-combustible material to form an effective fire seal without hindering pipe expansion and contraction.

## 3 Pipe Supports and Fixings

All pipes shall be adequately and properly supported by steel hangers, brackets and anchors. Brackets or support spacing shall be as follows:-

Material of Pipe	Diameter of Pipe (mm)	Maximum Spacing of Hangers/ Brackets	
		Vertical Runs (m)	Horizontal Runs (m)
Cast Iron or Spun Iron	50	1.8	1.8
	75	2.7	2.7
	100	2.7	2.7
	150	3.6	3.6
Galvanised Mild Steel	15 - 25	3.0	2.4
	32	3.0	2.7
	40 - 50	3.6	3.0
	60 - 80	4.5	3.6
	100 - 250	4.5	3.9
Polyethylene	10-25	1.3	0.6
	30-40	1.4	0.7
	50-60	1.5	0.7
	75	1.8	0.9
	100	2.0	1.0
Unplasticized PVC	30-40	1.3	0.4
	50	1.3	0.6
	75-100	1.8	0.9
	150	1.8	1.3

Acrylonitrile	15 - 20	0.7	0.9
Butadiene	25 - 32	0.9	1.0
Styrene (ABS)	40 - 50	1	1.2
	80 - 100	1.4	1.6
	150	1.9	2.1

At least one hanger or support shall be provided for each unit length.

All hangers shall be carefully aligned and spaced. In the case of horizontal drain lines, the hangers shall facilitate the proper adjustment in the level of the pipeline.

Hangers or supports shall be secured to the structure by means of expansion bolts or power driven bolts. Grouting of fixings to the structure shall not be permitted.

All pipes installed shall be flexible enough to allow for expansion and contraction due to temperature changes, by taking advantage of change in direction of pipes.

Terminations for future expansion shall be fitted with a plugged or blanked valve.

#### 4 Casting In of Pipes

Pipes passing through external walls shall have a short section of pipe cast into the wall at the time of pouring of concrete. This section shall have a weld-on or cast-on blank flange at the mid-section to prevent ingress of water. The ends of the pipe shall project at least 150mm from the face of the wall to facilitate jointing. The ends shall be of the proper configuration for the method of jointing to be adopted.

#### 5 Jointing of Pipes

Joints and connections in the plumbing system must be made watertight and care shall be taken to ensure that no jointing material projects inside the bore of the pipe.

Flexible connection shall be used where differential movement may occur between two sections of a system, or where excessive expansion or contraction may take place.

Adequate number of mechanical couplings, flanged joints or union couplings shall be provided, especially in plantrooms, service ducts, and adjacent to equipments, fittings and valves so as to facilitate removal of pipe, fittings, and equipments for inspection and repairs.

Care shall be taken to ensure that the pipes are properly aligned and laid at the required gradient before the joints are permanently affected. Joints not properly made shall be cut and remade.

The methods of jointing for the various pipes shall be as described hereafter in the appropriate sections.

#### 6 Prefabrication

Wherever possible, sections of the pipework shall be prefabricated in the shop and delivered to the site ready for fixing and jointing. The Sub-assemblies shall be of such sizes and weight so as to allow for easy handling and shall be tested at the place of fabrication.

## 7 Inspection and Care of Pipework

All pipes, fittings and sub-assemblies shall be carefully examined on arrival on site, to see whether they bear where appropriate, the proper British Standards and/or the Local Authorities' mark.

Cast iron pipes shall be examined for damage to the protective coating. Minor damage shall be made good by painting over with bitumen, but if major defects in the coating exist, the pipes shall be returned to the workshop for recoating.

All open pipe ends, connection openings and access openings shall be temporarily plugged to prevent the entry of foreign matter including during storage and transport.

Upon completion of each section, the pipework shall be inspected to ensure that all pipe brackets, clips, etc. are correctly spaced and securely fixed, and that the pipework is well jointed and all access covers, caps or plugs are accessible.

## C Cold Water System

### 1 Piping

Piping shall be ABS (Acrylonitrile, Butadiene, Styrene)

#### a ABS Pipe

ABS (Acrylonitrile, Butadiene, Styrene) pressure pipes and fittings shall comply with the requirements of Australian Standard AS 3518 Part 1 & 2 for nominal sizes ranging from 15mm up to 200mm.

ABS pipes and fittings shall be suitable for use with potable water and shall have passed the test of "Effect on The Quality of The Water" under BS 6920 or AS 4020:1994.

ABS pipes and fittings shall be free from heavy metal stabilizers and conforms to AS 3855 - 1994 or equivalent and shall conform to World Health Organization Standard for drinking water.

Pipes and fittings shall be legibly and indelibly marked as stipulated in AS 3518.

The pressure rating of pipes and fittings shall be the higher rating of the following:-

Class 12

The pressure rating of pipes and fittings shall be such that the maximum static working pressure of the pipes and fittings at the temperature which the pipes and fittings are subjected to greater than 1.5 times system working pressure.

#### b Jointing For ABS Pipe System

Solvent cement jointing shall be used with spigot and socket type joints in pipes and fittings.

Adequate number of mechanical couplings, flanged joints or union couplings shall be provided, especially in plantrooms, service ducts and adjacent to equipment and valves so as to facilitate removal of pipe, valves, fittings and equipment for inspection and repair. Such couplings, flanges and accessories

shall be procured from the manufacturer of the pipe or from manufacturer acceptable to the pipe manufacturer

Joining shall comply with the procedure of AS 3690 or the recommendation of the manufacturer.

c Pipe Installation

ABS pipe installation shall comply with AS3690 or the recommendation of the manufacturer.

2 Valves, Gauges and Accessories

a General

All valves shall be supplied, installed, connected up and tested as required for the satisfactory operation of the systems.

All valves, gauges, strainers etc. shall be fitted in accessible positions for operation and repair. All valves shall be suitable for the working and test pressures of the systems in which they are installed and shall be of approved manufacture.

The connection between each valve and the adjacent equipment shall be made with a union or a flange, for ease of dismantling. The size of the valve shall be of the same diameter as the pipe for which they are to be fitted unless otherwise specified.

Before installation, all valves shall be blown out to remove any foreign matter. Valve spindles shall be adequately lubricated with graphite and all glands shall be freshly packed before installation.

b Gate and Globe Valves

Gate and globe valves 65mm and below shall be of the screwed bronze body type, complying with B.S. 5154 : 1991. Pressure rating shall be PN16 or the expected pressure encountered, whichever is higher. Gate Valves shall have solid wedge disc, rising stem and union or screwed-in bonnet. Globe valves shall have union or screwed-in bonnet.

Gate and globe valves 75mm and above shall be flanged cast iron body type complying with B.S. 5150 and B.S. 5152 respectively. Pressure rating shall be PN16 or the expected pressure encountered, whichever is higher. Gate Valves shall have bolted bonnet, wedge disc and rising stem. Globe valves shall have bolted bonnet and rising stem.

c Check Valves

Check valves of nominal bore below 100 mm shall comply with B.S. 5154, PN16 and shall be of bronze with female screwed or flanged cast iron type with bronze discs. Check valves with swinging disc shall be provided except that lift checks shall be used where frequent operation of the valve is expected.

Check valves of nominal bore 100 mm and above shall be the spring loaded, dual plate, flat seat type with independent springs for each plate. The construction shall be of a cast iron body, aluminium bronze plate, Buna-N seal, SS316 spring, hinge pin and stop pin. Pressure rating shall be per ANSI 16.1 Class 125.

d Butterfly Valves

Butterfly valves shall be capable of operating and giving tight closure with up to 1035kPa differential across the disc. Valve body and seat clamp shall be of cast iron. Discs shall be of cast iron or stainless steel. Material of seats and sealing rugs shall be suitable for the operating temperatures. Spindle shall be stainless steel.

e Strainers

Approved Y-type strainers shall be provided upstream of all pumps, motorised and solenoid valves. All strainers of sizes up to and including 50mm diameter shall be of steel or bronze body type and threaded. For sizes of 65mm and above, they shall be of the cast iron flanged type. A removable self-aligning screen of stainless steel or bronze shall be provided in each strainer. Pressure rating shall be ANSI Class 125

Isolating valves shall be arranged to allow cleaning of the strainers without draining the systems. Mesh sizes shall be to the recommendations of valve manufacturer and shall suit the equipment installed.

f Ball Float Valves

All ball float valves shall be supplied and fitted complete with back nuts, ball float and arm. Ball floats shall be of soldered copper, brass or PVC. Float valves shall be of the low pressure type complying with B.S. 1212.

g Pressure Gauges

Pressure gauges shall be of the Bourdon tube type with a minimum dial size of 100 mm diameter. The pressure gauges shall be calibrated in kN/m<sup>2</sup> and m head with a full scale reading of approximately double the average working pressure. All pressure gauges shall be provided with gauge cocks and upper tubing. Accuracy of pressure gauges shall be + 1.5% of full scale reading.

h Drain Valves

Gunmetal drain valves shall be provided as necessary to ensure that all sections of the pipework and plant can be effectively drained. Sizes of drain valves shall be as stated below :-

Pipes up to and including 65mm diameter – 13mm diameter.

Pipes 75mm diameter up to and including 150mm diameter – 20mm diameter.

i Automatic Air Release Valves

Automatic air release valve shall be provided at all high points of the piping system for automatically releasing air which may accumulate in the pipe while the system is in operation and under pressure. Automatic air release valve shall have steel or cast iron body and cover. Float, leverage mechanism and all other internal trim shall be stainless steel. Valve outlets shall be tapped for connection of drain lines.

A shut-off valve shall be provided at the inlet pipe to the automatic air release valve.

Automatic air release valve shall be rated for working pressure of 10 Bar or the expected working pressure, whichever is greater. The orifice size shall be selected based on flowrate in pipe and system pressure.

Automatic air release valve shall be installed at the downstream side of each loop in the pipeworks. The discharge from these valves shall be piped to the nearest floor drain or drain pipe.

j Flexible Connectors

All pipe connections to all pumps shall be by means of wire or fabric-reinforced moulded high pressure convoluted rubber connectors. The fittings shall have integral rubber flanges and be bolted onto the pipelines using flanges for 50mm diameter and larger. For pipelines smaller than 50mm diameter, connections shall be by means of flanges, high pressure hose clips or union coupling. Flexible connectors shall be rated at 10 bar or the expected working pressure, whichever is higher.

3 Hydro-Pneumatic Booster Pump System

a General

Hydro-pneumatic booster pump system shall consist of two units (1 duty, 1 standby) of vertical multi-stage centrifugal pumps, pre-pressurised bladder type hydro-pneumatic tank, control panel, pressure switches, manifolds with isolation and non-return valves.

The pump, motors, control panel and pre-pressurised tank shall be from a single manufacturer with a single packaged warranty. Certificate of Originality from manufacturer shall be submitted.

b Pump Design and Construction

The pump shall be vertical multistage centrifugal design with mechanical shaft seal. The pump head shall be removable for access to the mechanical shaft seal without dismantling of the main pump housing from the suction/discharge pipe works. The pump impeller and shaft shall be balanced to provide quiet and vibration free operation. All rotating parts shall be fully protected with shaft guard.

The main components of the pump including the impeller, pump shaft, intermediate chambers and coupling guard shall be of stainless steel.

The mechanical seal shall be of tungsten carbide sealing surfaces for long maintenance-free life and resistance to wear.

The pump and motor assembly shall be base plate mounted.

The Contractor shall ensure that the NPSH required by the pump shall be less than the NPSH available at the site. Pump selection shall take into consideration of the range of static head available, length of suction pipeline and the corresponding friction losses.

c Electric Motor

The motor shall be of totally enclosed fan-cooled squirrel cage type. The enclosure shall be IP55 and insulation shall be of Class F. The motor shall be suitable for single phase 240V, 50Hz or three phase 415V, 50Hz power supply.

Motor power up to 2.2kw shall be suitable for D.O.L. starting. Above 2.2kw, it shall be suitable for star-delta starting.

The motor shall be of non-overloading design regardless of the actual duty points. Speed of the motor shall be 2900 RPM.

The pump and electric motor shall be from a single manufacturer.

d Pre-Pressurised Tank

The tank shall be equipped with a heavy duty butyl bladder which shall be approved by relevant statutory authority having jurisdiction over site and works and shall be constructed for 10 bar working pressure.

e Control Panel

The control panel shall be made of durable materials, housing various electrical components and switches suitable for automatic sequencing of pump units.

In case of low water level in the suction tank, the system shall automatically cut off to protect itself against 'dry running' and an alarm shall be indicated on the control panel. The system shall resume operation automatically when the water level is raised. The 'dry running' protection shall be by means of level electrodes in each tank. Manual override shall be provided for each electrode control such that the required control shall not be affected if one of the tanks is drained empty for maintenance purpose.

In addition, the following minimum requirements shall be incorporated:-

a RYB on indicator

b Pump run indicator

c Pump trip indicator

d Pump start push button

e Pump stop push button

f Ammeter

g Voltmeter

h Ammeter selector switch

i Voltmeter selector switch

j TPN isolator / MCCB

k Fault Alarm

l Label

4 Fibre Reinforced Plastic (FRP) Water Storage Tanks

FRP tanks shall comply with the relevant PNG, Australia and British Standard and approved by relevant statutory authority having jurisdiction over site and works. Tanks shall be compartmented.

Each compartment shall be fitted with an inlet with manually operated valve and a float-operated valve, valved outlet, a valved drain outlet, warning pipe, overflow

pipe and a level indicator. A 600mm x 600mm square or equivalent manhole and a mosquito-proof vent pipe shall be fitted to the roof of each compartment.

The overflow pipe or warning pipe shall be brought to a position so that the discharge from such warning pipe will be readily visible.

Tanks over 1220mm high (if compartmented, each compartment) shall each be provided with both external and internal access ladders. The external ladders shall be of hot dipped galvanised steel and the internal ladder shall be of aluminum.

FRP panels shall be moulded before delivery to site. Tank shall be erected in accordance with the manufacturer's instructions.

Flat gasket, T-gasket and three way gasket made of foam PVC, ribbon sealer of butyl synthetic rubber and conner block of ethylene propylene shall be used as sealing material.

Stay bolts or ties of stainless steel and stay plate made from galvanised mild steel shall be used to retain tank walls in position. To strengthen the joint between panels, reinforcing angles including cleats of galvanised mild steel coated with epoxy are used (cleats, bolts and all other internal components shall be galvanised mild steel coated with epoxy).

#### 5 Mechanical Level Indicators

Each tank compartment shall be fitted with a float and cable operated mechanical level indicator, located at the front of the tank. The floats, guides, cables and pulleys shall be constructed of durable, corrosion resistant materials. The scales shall be fixed to the front of the tank and shall be of metal construction with a hard and durable paint finish. The cable systems, moving indicators, and counter-weights shall be arranged so that the scale is direct reading, that is, the indicator shall move up as the level rises. The scale shall be positioned so that the water level as indicated by the indicating pointer corresponds as closely as possible to the actual level in the tank.

#### 6 Testing and Commissioning

##### a Cleaning out Pipework

After installation and before hydrostatic tests are carried out, the pipework shall be cleaned out thoroughly.

Temporary connections shall be made from the mains to each section of pipework to be flushed out. The discharge of each section of pipework shall be led to a suitable gully or drain.

Pipework shall be disconnected from tanks, control valves and equipment before being washed out.

##### b Testing

After cleaning the pipework shall be tested for water tightness. Subject the pipes, pipe fittings and connected appliances to a test pressure of at least 1.5 times the maximum working pressure with the pressure applied and maintained for at least 1 hour. When all draw-off taps are closed, the service shall be absolutely watertight. Each tap shall be opened and tested for the rate of flow. Any fault discovered shall be made good.



c Sterilization of Installation

The tanks shall be scrubbed down and flushed out with water containing a solution of chloride of lime.

The tank shall then be filled with water and a sterilizing chemical containing chlorine added gradually while the tank is filling to ensure thorough mixing. Sufficient chemical shall be used to give the water a dose of 50 parts of chlorine to one million parts of water. If ordinary 'bleaching powder' is used, the proportions shall be 1.5 kg. of powder to 10,000 litres of water, the powder shall be mixed with water to a creamy consistency before being added to the water. When the tank is full the supply shall be shut off. All the taps on the distributing pipes shall then be opened successively, working progressively away from the tank. Each tap shall be closed when the water discharged begins to smell of chlorine. The tank shall then be topped up and the whole system shall remain charged for at least three hours, whereupon a test shall be made for residual chlorine; if none is found, the sterilization must be carried out again.

Finally the tanks and pipes shall be thoroughly flushed out before any water is used.

d Booster Pump System

Tests shall be carried out to verify the performance characteristics and features of the pump system.

## D Sanitary Plumbing

### 1 General

The Contractor shall supply, install, test and set into perfect operating condition the whole of the sanitary plumbing system comprising all soil, waste and vent piping. The sanitary plumbing installation shall comply with the requirements of the latest Sewerage and Sanitary By-Laws applicable to the locality.

The specification and the accompanying drawings indicate the extent and general arrangement of the system. If any departures from the Contract Drawings are deemed necessary by the Contractor details of such departures and reasons therefore shall be submitted to the Engineer for approval, prior to installation.

All materials, fittings, fixtures, apparatus and all other items shall be of the best quality of their respective kinds, sound, free from defects and approved for use by the respective Authorities.

This specification is general and covers the various methods and materials which may be required. It is the responsibility of the Contractor to ascertain from the specification the specific requirements of this project.

It is not to be construed that an omission of a specific reference to any part of the works in the specification and/or the drawings means that work is excluded from the contractual requirements.

### 2 Piping Material

Above ground level : U.P.V.C. pipes and fittings to B.S. 4514 (for soil pipes and fittings) and B.S. 5255 (for waste pipes and fittings).

- Underground and encased in column : Heavy grade C.I. to B.S. 416 (for soil pipes and fittings). Medium Grade C.I. to B.S. 416 (for waste pipes and fittings). Medium grade C.I. to B.S. 416 (for vent pipes). Heavy grade galvanized steel to B.S. 1387 (for waste pipe below 50mm).
- 3 Joints and Fittings for UPVC Pipes
- Joints and fittings for the use with UPVC shall be in accordance with B.S. 4346.
- Jointing procedures for UPVC pipes shall generally comply with CP312:Part 2:1973.
- 4 Joints and Fittings Between UPVC and Cast Iron Pipes
- Joints of UPVC pipes to cast iron or other material shall be made in accordance with the latest relevant British Standards Specification and Codes of Practice.
- 5 Joints and Fittings for Cast Iron Pipes
- Cast iron pipes shall generally be jointed by means of the spigot and socket joint.
- The spigot shall be centered in the adjoining socket by tightly caulking in sufficient turns of tarred yarn or lead strip to leave unfilled about 44mm and 50mm for 100mm and 150mm pipe respectively for lead joint. A jointing ring shall then be placed round the barrel and against the face of the socket. Molten pig lead shall then be poured in to fill the remainder of the socket and the lead solidly caulked right round the joint.
- Cement mortar joints shall not be permitted.
- 6 Access Opening
- Sufficient access shall be provided to enable all pipework to be cleared and tested. Access openings of adequate size shall generally be provided on the vertical stack directly opposite a branch line, at the extreme end of a main branch line, at the junction of subsidiary branch to a main branch and at bends.
- 7 Fixture Trap
- Plumbing fixtures, except those having integral traps, shall be provided with a water-seal trap, placed as close to the fixture outlet as possible.
- Trap seals, if not provided with union connections at each end to permit removal for rodding, shall have an accessible trap screw of ample size protected by this water seal.
- 8 Floor Wastes
- The Contractor shall supply and install floor wastes comprising 100mmx75mm gully complete with inlet riser and chromium plated screwed grating, at a level to enable the floor to be graded to same and connect to the drainage system complete with all necessary inspection eye fittings.
- 9 Pipework Installation
- Pipework shall be securely fixed in position with plastic pipe clips, hanger supports, clamps and U-bolts.

Pipe clips shall be correctly aligned and shall provide a flat smooth surface for contact with the pipe. The straps shall not clamp the pipe tightly.

Horizontal lines shall be arranged to have the maximum grade with cleaning eyes and inspection openings in accessible locations.

The pipework in branch connection shall always be arranged to allow free drainage of the system. Connections to main or branch pipes shall be so arranged as to prevent cross flow from one appliance to another. Connections shall be made with an easy sweep in the direction of flow. Bends shall be of long radius where applicable.

The venting pipes shall be extended through the roof to the required height with the open end protected by means of a UPVC vent cowl.

#### 10 Anti-Syphonage Pipes

An anti-syphonage arm shall be installed where necessary. Anti-syphonage pipe shall be connected from each fixture to branch or main vent pipe above the level of such fixtures. Except in special cases and with the approval of Local Authorities, anti-syphonage pipes shall be connected to the waste, soil or combine pipes on the opposite side of the water seal to the fixture to a point not less than 75mm or not more than 300mm from the highest point of the traps. No fixtures shall be connected to the soil, waste or combined pipe at any point of the anti-syphonage pipe.

#### 11 Testing

The completed plumbing system shall be tested for water and gas tightness as well as for hydraulic performance.

- a **Water Test** shall be applied before the appliances are connected and carried out in sections so as to limit the static head to 5m. All openings affected by the test shall be sealed and the system filled with water. Some time shall be allowed for absorption by the pipes and joints to take place, after which the level shall be topped up. The pipes and joints shall be inspected for leakage. If no appreciable fall in water level occurs during a period of 10 minutes the system shall be deemed to have passed the test.
- b **Air Test** may be applied by inserting expanding rubber testing plugs in the lower and upper ends of the main sanitary and vent pipes and sealing the plugs with water.

The testing plug at the upper end of the ventilating pipe shall be fitted with a tee-piece with a cock on each branch, one branch being connected by a flexible tube to a Manometer. Air pressure is then introduced into the system through the other branch of the tee-piece until a pressure of 65mm water gauge is shown on the Manometer scale.

Alternatively, the air pressure may be applied by passing a flexible tube from a tee-piece attached to manometer through the water scale of the trap of the sanitary appliance, the test then being carried out as described above.

The system shall be deemed to have passed the test if the pressure remains constant for a period of three minutes.

- c **Smoke Test** shall be employed to locate faults indicated by the air test. Smoke is pumped into the system with a smoke machine, care being taken to ensure that the system is filled with smoke before sealing with plugs.
- d **Hydraulic Performance** discharge tests shall be made for all appliances, singly and collectively. Obstruction in any of the pipe lines shall be traced and the whole system examined for proper hydraulic performance, including the retention of an adequate water seal in each trap.  
  
Any defects revealed by the tests shall be made good and the tests repeated until a satisfactory result is obtained.

## **E Service and Maintenance**

### **1 General**

The Work covered by this section is for the supply of all materials, labour, appliances and necessary incidentals for the service and maintenance of the contract Works.

### **2 Scope of Work**

The scope of work for Service and Maintenance shall include:-

- a Checking the suction and discharge pressure of all pumps, and if abnormal situation occurs, tracing the faults and rectifying as necessary.
- b Checking all cold water pipeworks as for leaks and rectifying as necessary.
- c Checking all motor bearings and lubricating with grease as necessary.
- d Inspecting and checking the control system and safety devices of the pumping system.

### **3 Consumable Materials**

All consumable materials, including but not limited to lubricants, electric contact points, carbon brushes, electric fuses, cotton waste, soap, detergent and other materials required for cleaning purposes, shall be deemed to be included in the Contract Sum.

### **4 Service and Maintenance Record**

All service and maintenance performed shall be recorded on the maintenance / repair sheet, which shall be countersigned the Employer.

## **F Operation and Maintenance (O&M) Manuals**

### **1 General**

Four (4) copies of the draft O&M Manuals, complete with As-constructed Drawings shall be submitted to Engineer for approval 8 weeks before Mechanical Completion of the Work. Upon approval by Engineer four (4) copies of the hard cover bound O&M Manuals shall be submitted to Employer.

### **2 Contents of O&M Manual**

The contents of the O&M Manual shall include:-

- a Information on owner and consultant

- b Maintenance procedure for each sub-system
- c Trouble shooting procedure for sub-system
- d Technical specification of pump sets
- e List of spare parts (if any)
- f List of supplier of pump sets
- g Technical information from pump set manufacturer
- h Technical catalogues
- I Testing and commissioning records
- J As-constructed Drawings and electrical circuit diagrams.

### **PS.15.03 Fire Fighting Services**

#### **A Fire Alarm And Automatic Detection System**

##### **1 General**

This section covers the supply and installation of the complete automatic analogue addressable fire alarm system (Microprocessor type) in accordance with the specification and as shown on the drawings.

The analogue addressable fire alarm system shall be designed and installed in accordance with the relevant PNG, Australia and British Standards and in full compliance with the rules and regulation of the current Building Act & Regulations (Chapter 301) and By-Laws and all other relevant authorities.

The system shall include all approved proprietary equipments, installation and necessary control wirings. All the components of the system shall be supplied from one proprietary manufacturer.

The system shall be totally solid state, microprocessor based and shall include but not limited to the following sub-system:-

- a Main control panel complete Graphic/Text Terminal keyboard, printers, mimic diagram, batteries, charger etc.
- b Interface units.
- c Trigger units i.e. sensors/detectors etc.
- d Sounding devices i.e. sounders etc.

All the above sub-system shall be supplied from one proprietary manufacturer. The system shall be from a reputable manufacturer and widely installed in Malaysia.

## 2 System Description

The system shall have the following features:-

- Each sensor/detector is individually addressed and shall be given a 32 character alpha-numeric label either as an individual or in group. Dip switch or code addressing is not acceptable.
- Complicated installations shall be simply and flexibly configured on SITE using standard hardware and software. There shall be no address switches to be sets in either sensors or sensor bases.
- The most advanced fire sensors and sophisticated signal processing shall be used leading to the minimum possible rate of unwanted false alarms.
- Sensors, sounders, interface units and fire alarm repeat panels shall all be wired on the same two core circuit.
- It shall be possible to trace all wiring and position of all devices in the system through the main control panel and a record of these can be obtained from the printer.
- Location of where the fire first started and the latest location of the fire shall be shown on the LCD screen on the main control panel and the Text/Graphic the monitor.
- All other locations where the fire has spread to shall be scrolled on the LCD screen. All these locations and events shall be printed with exact date and time of the events.
- Once the system is commissioned, a sensor should not be replaced by another of a different type without an automatic warning to the user. Sensor shall be unplugged without disabling other sensors, sounders etc. on the same circuit.
- The system shall operate on the principal of pattern recognition. Analogue readings from sensor are transmitted digitally to the control panel where they are reconstructed into analogue outputs for each sensor and compared against all possible fire patterns stored in the software of the main control panel.
- Full circuit security in the event of a single open or short circuit cable fault with no loss of outstations, by means of loop circuit isolators

### **B Hose Reel System**

#### 1 General

Each hose reel assembly shall consist of a stop valve, reel, and shut-off nozzle. The assembly shall be of the swing-out type, permanently connected to the water supply and so designed as to facilitate the swift withdrawal of the hose in any direction, with the reel axis horizontal.

## 2 Fire Water Storage Tank

The water storage tanks shall be roofed pressed steel tanks complying with B.S. 1564. The capacity of the tank shall not be less than the figure indicated on the Drawings. The tank shall be divided into compartments as shown on the Drawings.

Each compartment shall be fitted as shown in the Drawings with a valves inlet with a float-operated valve, valved outlets as shown, a valved drain, overflow pipes and a level indicator. A 600mm round manhole and a mosquito-proof vent pipe of size as shown on the Drawings shall be fitted to the roof of each compartment.

The overflow pipes or warning pipe shall be brought to a position so that the discharge from such warning pipe will be readily visible and shall be to the approval of the Engineer.

Tanks over 1m high shall be each be provided with both an external and an internal access ladder. If compartmented, each compartment shall have an internal access ladder. The external mild steel ladder and the internal aluminium ladder shall be of a design approved by the Engineer.

The roof of the tanks shall be constructed of sheet metal not less than 3mm thick.

Pads for connections, tapped bosses, screwed flanges or sockets shall be welded to the inside or outside or bolted to the tank plate. Pads shall be machined full width of face. Single pads shall be provided for connection on one side of the plate and double pads for connection on both sides of the plate. Where possible, connections shall be so positioned so as to avoid the embossment of the plate.

The pressed steel plates shall be shop primed before delivery to site. The tank shall be erected in accordance with the manufacturer's instructions. A sealing compound of approval manufacture shall be incorporated in the joints. After erection, all bolts shall be securely tightened and the internal surface of the tanks and roof given an approved coat of bituminous paint and the exterior with two coats of approved enamel paint.

## 3 Rubber Hoses

Each rubber hose shall be non kinking, braided rubber type, manufactured with an inner rubber tube or lining, a reinforcement of braided textile material and an abrasion resistant rubber cover. The reinforcement shall be by means of a single rayon braid or a double braid of cotton.

The rubber hose shall be 25mm internal diameter and suitable for a working pressure up to and including 1034 kPa (150 psi). The length of the rubber hose on the reel shall be 30.5m and there shall be no joints in its length. The minimum bursting pressure shall be 4137 kPa (600 psi).

## 4 Shut-Off Nozzle

The shut-off nozzle assembly shall comply with the following requirements:-

- a The assembly shall be constructed of a corrosion resistant material of adequate strength.

- b Means shall be provided for the attachment of the assembly to the stop valve in such a manner that it cannot be disengaged until the stop valve has been opened.
- c The assembly shall be permanently marked to indicate the open and shut position of the valve.
- d The internal surface of the nozzle shall be finished to provide a smooth surface.
- e The internal diameter of the outlet shall be  $9.525 + 0.076\text{mm}$ .
- f The nozzle shall be adjustable to vary the throw and the flow rate to shut off the flow.

## 5 Hose Reel Drums

The hose reel drums shall be the swing-out type of adequate strength and rigidity and shall be so designed that each hose drum rotates round a horizontal spigot or shaft such that the hose can be freely withdrawn in any direction.

All threaded parts of aluminum alloy components shall be coated with molydenized listate grease. The hose reel waterways connecting the water supply to the hose, excluding the stop valve and that part between the stop valve and hose reel, shall be constructed of non-ferrous materials or stainless steel.

All burrs and sharp edges shall be removed and all waterways shall have smooth finishes. The exterior of all components shall be rounded to prevent injury during use.

A 25mm stop valve, of a type approved by Eda Ranu shall be provided for the connection of each hose reel to the water supply. An indication of the open and shut position shall be fixed or marked on the wheel of the valve, and the body of the valve, except for gate valves which shall be marked with a valve. The valve shall be threaded 25mm BSP parallel. The water connection through the rubber hose shall permit the full flow of water to the hose without external leakage during any rotation of the hose reel.

The hose reels shall be fixed so that the centre is between 914mm and 1067mm above floor level.

Where the hose reel is mounted in a cabinet, there shall be sufficient clearance between the side of the cabinet and the hose reel to enable the hose reel to be rewound on the rest in an orderly fashion and to ensure ease of withdrawal.

Each hose reel drum shall extend not more than 356mm from the mounting surface and shall have an overall diameter which does not exceed 762mm. The side plates of the hose reel shall have a continuous outer rim and shall be rigid in construction.

The diameter of the inner core on which the hose is wound shall not be less than 203mm. When the full length of the hose is coiled on the hose reel without the use of abnormal tension the rims on the side plates of the hose reel shall project at least 13mm beyond the external diameter of the coiled hose at any point.

The fitting to which the hose is attached on the hose reel shall be arranged in such a way that the hose reel shall be arranged in such a way that the hose is not restricted or flattened by the application of additional layers.



## 6 Pippings

The pippings shall be steel pipe to BS1387 heavy grade. The fittings used shall have welded flange or shall be suitable for screw jointing. All valves and fittings shall be rated at PN10 (minimum).

The piping shall be installed in accordance with the best commercial practice. Care shall be taken to ensure that the diameter is not restricted due to fabrication.

The pippings shall be supported suitably with allowance for the expansion. It shall not be subjected to mechanical or other damage.

The pipes shall be reamed and cleaned before assembly and the entire piping system shall be cleaned thoroughly prior to the installation of the nozzles.

All pipes passing through masonry walls, floors and ceilings shall be extended completely through and in the case of floors slabs 13mm above the slab.

The space between the pipe and sleeve shall be packed with asbestos rope or high temperature fibreglass.

## 7 Pipe Sleeves

When pipe passes through internal walls, slabs, beams etc, pipe sleeve shall be provided. Galvanised pipe sleeve shall generally be used except that brass or copper pipe sleeve shall be used for the case of copper pipe. The size of pipe sleeve shall be at least one size larger than the size of the pipe subject to a minimum annular space of 15mm between the sleeve and the pipe.

Sleeves through floor slabs shall be extended 25mm above finished floor level while sleeves through walls, beams etc shall have the sleeve ends flushed with the walls, beams etc.

The annular space between pipe and pipe sleeve shall be fully packed with non-combustible material to form an effective fire seal without hindering pipe expansion and contraction.

## 8 Pipe Supports

All pipe supports shall be of galvanized steel, ring-type clips or clamps and coated with rust preventive paint and the finish coat shall be black.

An approved supports shall be inserted between the pipe and clamp to ensure rigid support.

Each hanger shall be fixed rigidly to the main structure by means of expanding metal plugs and steel bolt and arranged to be loaded in shear.

The diameter of the hanger for various pipe sizes shall be adequate for the expected duty and shall not be smaller than sizes indicated in the following schedule:

<b>Diameter of Pipe to be Supported</b>	<b>Diameter of Tube Hanger</b>
25mm to 32mm	6.4mm
40mm to 50mm	9.5mm

The spacing of the pipe supports shall be adequate for the expected duty and shall not be greater than the spacing indicated in the following schedule:

<b>Pipe size</b>	<b>Spacing</b>
25mm	1.8m
32mm to 50mm	2.4m

#### 9 Colour Identification and Markings

The side of the hose reels shall be red.

Every hose reel shall be marked with the following:

- a The manufacture's name, trade name or mark, or the name, trade name, or mark of the vendor.
- b Instructions for the operation and use which shall include:
  - Turn on stop valve to release nozzle
  - Run out hose
  - Turn on water at nozzle
  - The hose shall be fully charged before winding it onto the reel.
- c Year of manufacture
- d Test pressure in kPa (psi)

### C Portable Fire Extinguishers

#### 1 General

- a Portable fire extinguishers shall be supplied and installed as specified hereinafter. All materials shall be new and unused, be of best quality and comply in all respect to the requirements of PNG Civil Fire Service.
- b Each fire extinguisher shall be supplied in fully charged condition and equipped with automatic safety valve, outer lid, hose, nozzle, brackets and all accessories.

All the components shall be of approved make, reliable, heat resistant and designed to suit the pressure and chemical used. The actuating mechanism shall be of fool proof and fast acting.

- c All extinguishers shall be located in conspicuous positions on brackets or stands at a height of about 1m above the floor.

## 2 Standards and Regulations

Portable Fire Extinguishers shall comply in all respects with the requirements of PNG Civil Fire Service and conform to the following British Standards:-

- a Portable ABC dry powder type fire extinguishers - BS 3465.
- b Portable carbon dioxide type fire extinguishers - BS 3326.

The Contractor shall be responsible for obtaining the necessary approval and certification by PNG Civil Fire Service.

## **D Service And Maintenance**

### 1 General

The work covered by this section is for the supply of all materials, appliances, labour and necessary incidentals for the service and maintenance of the whole of the fire fighting system supplied under this Contract.

The work to be performed under this section shall be in accordance with the best commercial practice, and shall be in strict accordance with this specification.

### 2 Workmanship & Material

The work described in this section shall be performed by workmen skilled in the service, maintenance and repair of fire fighting systems of the types supplied under this Contract and shall be executed in accordance with the best commercial practice.

All materials to be supplied in connection with works under this section shall be new and unused, and shall generally be of the best quality as regards manufacture and performance.

### 3 Supervision

The Contractor shall have a Foreman in charge of the service, maintenance and repair work to be carried out under this Specification. This foreman must be thoroughly competent in supervising the service, maintenance and repair of fire fighting systems of the types supplied under this Contract and shall be in the direct employ of the Contractor and acceptable to the Engineer.

The Contractor shall have in his direct employ, workmen who are especially skilled in the service, maintenance and repair of fire fighting systems of the types supplied under this Contract.

#### 4 Scope of Work

All machinery and equipment comprising the complete fire fighting equipment under this Contract shall be serviced and maintained strictly in accordance with servicing and Maintenance Schedules.

The Contractor shall advise the Engineer of any defects in any part of the plant observed during routine inspection and service, and shall repair such defects.

The Contractor shall also provide emergency repair services during normal working hours and also during overtime hours if required to do so by the Engineer.

#### 5 Servicing & Maintenance Schedule

The Contractor shall inspect and service all fire fighting equipment under this Contract at least once a month, except as otherwise stated or where as otherwise directed by the Engineer.

The minimum items of works to be performed at the monthly inspection and service shall be as detailed hereinafter.

#### 6 Hose Reel System

- o Check all valves and pipework for each system for any leak.
- o Physical inspection of every hose reel.

#### 7 Fire Alarm and Detection System

- o Conduct simulating tests on Master Fire Alarm Panel and Sub Panels.
- o Check the condition of batteries in Master Fire Alarm Panel, Sub Panels etc.

#### 8 Portable Fire Extinguisher

- o Physical inspection of all extinguisher in batches, to be completed in one year.
- o Conduct tests (whenever required by PNG Civil Fire Service) and renew Testing Certificate for all fire extinguishers every year.

### **E Testing And Commissioning**

#### 1 General

##### a Testing Procedure

The Contractor shall submit four (4) copies of testing procedure for the equipment or system to be tested, two (2) months before the tests for approval by the Engineer. The submission shall include but not be limited to the following:-

- o Out-line of the set-up of the test equipment
- o Details of each tests to be carried out

- o Expected test results
    - o Tables into which test results shall be entered.
  - b Calibration of Equipment and Instruments

All equipment and instruments used in the testing shall be checked and calibrated.
  - c Date of Tests

The Contractor shall inform the Engineer the date of tests, at least seven (7) days before the tests are conducted.
  - d Failure of Test

In the event of failure of any tests, the Contractor shall rectify any faults and defects and arrange for future tests at his own cost.
  - e Test Reports

After successful completion of tests for each equipment or system, four (4) copies of the Test Report shall be submitted to the Engineer.
  - f Testing and Inspection by PNG Civil Fire Service.

After the fire fighting system has been successfully commissioned, the Contractor shall make arrangement for the official testing and inspection by the officers of PNG Civil Fire Service. The Contractor shall conduct any tests as requested by PNG Building Act & Regulations (Chapter 301).
- 2 Hose Reel System
  - a Visual Inspection

After installation, the assembly shall be pressurized by opening the valve. Visual inspection of the pipework shall be conducted and no leak is permitted.
  - b Discharge Test

Two (2) numbers of hose reel per system at a location to be determined by the Engineer shall be tested for its discharge characteristic simultaneously.
- 3 Fire Alarm & Detection System
  - a Factory Testing & Inspection

Fire Alarm Consoles and Sub Panels shall be inspected and tested at the manufacturer's premises for proper functioning of the system and compliance with specification.
  - b Operational Test

Operational test for the whole of Fire Alarm and Detection System shall be conducted. In particular the proper control outputs from the Fire Alarm Consoles

and Sub Panels and the correct functioning of all components in the system shall be checked.

#### 4 Portable Fire Extinguisher

Two numbers ABC dry powder type and one number of carbon dioxide type portable extinguisher, selected at random by the Engineer shall be subjected to actual performance test. The Contractor shall replace or refill the used portable extinguishers.

### **PS 15.04 Painting**

#### A General

##### 1 Approval

All paints shall be suitable for use in humid tropical environment, and shall be to the approval of the Engineer. The Contractor shall furnish all necessary information to the paint manufacturer to enable him to supply the most suitable paint complying with the requirements of these Specifications.

##### 2 Sample Panels & Testing

The Contractor shall, when required, provide sample panels 600mm x 300mm showing a 150mm wide band of each coat forming the paint schemes being used at the Site for identification and control.

##### 3 Workmanship

The paints and workmanship shall comply strictly with the requirements of B.S. 6150, 1982 unless otherwise specified.

##### 4 Paints

All paints are to be obtained locally from a reputable local manufacturer whose products are equivalent or superior to those specified. A sufficient supply of all paints is to be maintained at Site, but paints which have been stored at Site for longer than two months or manufactured longer than 6 months shall not be used. The date of arrival at Site shall be marked on each container.

##### 5 Storage of Paints

Paints shall be stored in sealed containers in a lock-up store where they shall not be exposed to extreme temperatures. Any special storage conditions recommended by the manufacturer shall be observed.

Paints which have not been used within 'shelf life' period specified on the containers or within 6 months of the date of manufacture, whichever is the lesser, shall be replaced.

Paints from painters kettles shall be returned to the store at the end of each working period, where they shall be kept in sealed containers. Before they are re-issued for use, they shall be thoroughly mixed and no fresh paint or thinner shall be added.

## 6 Application

All paints shall be supplied from the store to the painters ready for application, and the addition of thinners or of any other material shall thereafter be prohibited. Any instruction given by the paint manufacturer shall be strictly followed.

The surfaces to be painted shall be perfectly dry, clean and free of all grease and salts before painting commences.

Each coat of paint shall be applied by the method specified to produce a continuous film of paint of uniform and even thickness. Successive coats shall have different shades for identification and each coat shall be thoroughly dry before the application of a further coat.

No paint shall be used after the expiration of the 'pot-life' stipulated by the manufacturer, and paints of limited 'pot-life' shall not be mixed with fresh paint or have thinners added to them.

## 7 Dropsheets & Protection Programme

The Contractor shall provide and use sufficient numbers of drop cloth, covers, tarpaulins and other screens to protect adjacent surfaces and shall remove all spatter and stains from such surfaces. The Contractor shall also protect his own works. Any damage to adjacent works or to any part of the premises due to painting carelessness or accidental performance of the Contractor shall be repaired or made good at the Contractor's expense. The Contractor shall arrange his programme in such a manner as to minimise the likelihood of paint work being damaged by other works in progress. The programme shall be to the approval of the Engineer.

All rags, waste, empty tins and other rubbish are to be removed from the Site. Care is to be taken that such materials do not accumulate with the risk of spontaneous combustion or damage to wall or floor surfaces.

### B Surface Treatment

All surfaces of non galvanized steelwork to be blast cleaned. Blast cleaning shall be carried out in accordance with B.S. 4232 to a second quality finish as specified therein. For touching up, wire brushing may be acceptable, subject to the Engineer's approval. Excessive burnishing of the metal through prolonged application of wire brushes shall be avoided.

After the surface is cleaned down, the specified priming coat shall be applied the same day. The priming coat shall not be applied until the preparation of the surface has been inspected and approved by the Engineer.

Galvanized surfaces shall be examined for rust marks at exposed edges and all damage to the zinc shall be cleaned and spot primed with zinc-rich primer. All steel surfaces to be painted shall be degreased with agent approved by the Engineer.

Primed steel shall be cleaned of dirt and grease and examined for damage. Damage areas shall be cleaned and spot primed.

### C Painting Scheme

## 1 General

For purposes of identification of painting schemes, reference has been made to paints manufactured by Nippon Paint. Paints from other manufacturers whose products are equal or better than those specified are acceptable with the Engineer's approval and provided that the total dry film thickness is not less than that for the respective schemes as specified.

## 2 Outdoor Exposed Galvanized Steel

1st Coat : Copon EA-9 Red Oxide Primer, 60 Microns.

2nd Coat : Nippon Polyurethane Recoatable Finish, 50 Microns.

## 3 Outdoor Galvanized Steel, Buried or Water Immersed

1st Coat : Copon Arocoat Brown, 150 Microns.

2nd Coat : Copon Arocoat Black, 150 Microns.

## 4 Indoor Galvanized Steel

1st Coat : Copon EA-9 Red Oxide Primer, 60 Microns.

2nd Coat : Copon EA-4 Finish, 50 Microns.

## 5 Outdoor Exposed Mild Steel

1st Coat : Nippon Zinc Rich Primer HS, 50 Microns.

2nd Coat : Copon 8048, 100 Microns.

3rd Coat : Nippon Polyurethane Recoatable Finish, 50 Microns.

## 6 Outdoor Mild Steel, Buried or Water Immersed

1st Coat : Copon Arocoat Brown, 150 Microns.

2nd Coat : Copon Arocoat Black, 150 Microns.

## 7 Indoor Mild Steel

1st Coat : Nippon Zinc Rich Primer HS, 50 Microns.

2nd Coat : Copon 8048, 150 Microns.

3rd Coat : Copon EA-4 Finish, 50 Microns.



**DIVISION 16.**

**ELECTRICAL WORKS**

## Division 16 Electrical

### Section 16010

#### PS13.01 General Requirements

- A. The Contractor shall furnish and complete the electrical works, including detailed design and engineering as necessary, in accordance with the specifications and requirements specified herein and other parts of Division 16 of the Particular Specifications and also fully complying with the requirements stated in Section 16010 and other sections of Division 16 of the Standard Specifications except any requirements contradicting those in this section of the Particular Specifications which shall take precedence.
- B. The Contractor shall arrange witness by the representatives of the Employer and Engineer, one person each during the shop test and inspection to be conducted in accordance with 3.08. of Section 16010 of the Standard Specifications, for which the Contractor shall allow for bearing and paying the travelling expenses (i.e., round air fares from the home place to the destination, inland transport expenses, and accommodation charges during the travel) for the Employer's and Engineer's persons attending to the respective shop test and inspection in his tender price .

Equipment requiring witness by the Employer's and Engineer's representatives in shop tests and inspections are listed below:

- PS1 Pump Control Panel (01-01 PCP01)
- PS1 Diesel Generator Set (01-01 GEN01)
- PS5 Incoming/Feeder Panel (01-05 IFP01)
- PS5 Pump Control Panel (01-05 PCP01/02/03)
- PS5 Diesel Generator Set (01-05 GEN01)
- PS10 Incoming/Feeder Panel (01-10 IFP01)
- PS10 Pump Control Panel (01-10 PCP01/02/03)
- PS10 Diesel Generator Set (01-10 GEN01)
- STP Diesel Generator Set (02 GEN01)
- STP UPS Panel (09 UPS01)
- STP Grit Chamber MCC (09MCC01)
- STP Aeration Blower Control Panels (04-BCP01/02/03/04/05)
- STP No.1/2 OD/Clarifier MCC (04MCC01)
- STP No.3 OD/Clarifier MCC (04MCC02)
- STP Utility Water and Disinfection MCC (06MCC01)
- STP Sludge Treatment MCC (07MCC01)
- STP No.1/2/3 Blower LCP (04LCP07)
- STP No.4/5 Blower LCP (04LCP08)

### Section 16111

#### PS 16.02 Cable Trays (Racks)

- A Cable trays (racks) shall be installed. The term "cable tray, or rack" shall include all necessary supports, fixing bolts and foundation bolts required to support the tray work. The traywork shall be laid out and designed so as to facilitate the installation of cables and dismantling of any section for maintenance. Positions of joints shall take structure

expansion joints into account to allow for differential movement of building structure. Wherever possible, standard fittings shall be used in preference to fabricated or special fittings.

- B All cables laid across floors to equipment, and which is not shown or specified as being in ducting or conduit, shall be installed on cable tray which is raised above the finished floor level.

## **Section 16112**

### **PS 16.03 Conduit**

- A Conduits shall be installed as follows:
  - Corrugated rigid polyethylene conduit (FEP) for underground cable installation.
  - Galvanized steel conduits for corrosive environments such as chlorinator room or chlorine container storage.
  - Galvanized steel conduit for normal environments.
- B The term conduit shall include all necessary supports, fixing bolts and foundation bolts required to support the conduit. The conduit shall be laid out and designed so as to facilitate the installation of cables and dismantling of any section for maintenance. Positions of joints shall take structure expansion joints into account to allow for differential movement of building structure. Wherever possible, standard fittings shall be used in preference to fabricated or special fittings.
- C Except for conduit passing through floor slabs or walls, when post drilling for the necessary hole may be undertaken, conduit to be concealed in the structural concrete shall installed before concrete is placed.

## **Section 16114**

### **PS 16.04 Trunking or Ducts**

The term trunking or ducts shall include all necessary supports, fixing bolts and foundation bolts required to support the trunking. The trunking shall be laid out and designed so as to facilitate the installation of cables and dismantling of any section for maintenance. Positions of joints shall take structure expansion joints into account to allow for differential movement of building structure. Wherever possible, standard fittings shall be used in preference to fabricated or special fittings.

## **Section 16120**

### **PS 16.05 Cables**

- A. Cable installation shall be carried out with utmost care so as not to cause any damages to existing cables and new cables using pullers, jacks and other necessary equipment and tools required under the supervision of experienced supervisors who have experience in similar works. Contractor shall submit a program for cable installation at least 14 days prior to the commencement of the work and also co-ordinate and obtain approval of the Engineer for the shutting down of the power and the plant for this purpose. Maximum period for shutting down the plant for cable installation shall be 12 hours or as agreed with the Engineer. Contractor shall take these facts into consideration when preparing his program. The Clause No. PS 1.01D shall also apply to this work
- B. The Cables Schedules are presented on the Drawings. A comprehensive cable schedule shall be prepared by the Contractor for connection of all equipment supplied

under this contract.

- C. All cables laid across floors to equipment, and which is not shown or specified as being in ducting or conduit, shall be installed on cable tray which is raised above the finished floor level. All cables shall be laid in one single length and no joints are allowed. The cable routing shall be selected in a way to allow a complete segregation of HV cables, low voltage power cables and control measuring and special cables.
- D. All underground cables shall be laid in corrugated rigid polyethylene conduits (FEP). The number and sizes of ducts shall be as detailed on the drawings.
- E. All power cables shall be dimensioned to give voltage drops in continuous service not exceeding 4 percent.
- F. Minimum cross section of power cables shall not be less than 2.5 mm<sup>2</sup> and control & measuring cables shall not be less than 1.5 mm<sup>2</sup>.
- G. All cables running outside buildings shall be unarmoured XLPE cables with conduits. All control and measuring cables shall be shielded screen cables.
- H. All cables entry points to buildings shall be made rodent-proof by sealing with a suitable material fill to be recommended by the cable manufacturer.
- I. All cables entry points to panels shall be made vermin-proof by connection through suitable cable glands fixed to the cable entry plate of the panel.
- J. Spare parts  
Spare cables (power cables less than 25 mm<sup>2</sup> size, control and instrumentation) to be supplied under this contract shall be listed and priced separately and 5 percent but not more than 1000m and not less than 100 m length of the total length shall be supplied of each type of cable.

## Section 16150

### PS 16.06 Induction Motors

The induction motors are specified in other part.

## Section 16320

### PS 16.07 Power Transformers

The transformers shall meet the operational and dimensional requirement as follows:

Transformer Tag Nos.	09R01
Power source	PNG Power Ltd., at 11kV to site
Purpose	to step-down 11kV to 415V
Type	oil immersed hermetically sealed, naturally cooled, double wound, core type
Number	1
Rated capacity	630 kVA
Rated voltage	11 kV/0.415 kV
System highest voltage	12 k V
Rated frequency	50 Hz

Rated percent impedance	5.5 percent
Protection	temperature (85 °C alarm and 90 °C trip), over current relay, ratio differential relay, grounding over-current relay, Buchholz relay, Oil level
Method of connection	
HV winding	Delta connection
LV winding	Star connection, neutral solidly earthed
HV winding	
Rated short-duration AC Power Frequency	
Withstand Voltage	28 kV
Impulse Withstand Voltage	75 kV
Vector group symbols	Dyn 11
Permissible winding	
Temperature (Measured by resistance method)	55 degree C
Bushing type current transformer	
CT Ratio (LV side)	1000/5 A
Rated Burden	30 VA
Neutral CT Ratio	500/5 A

The transformer shall be supplied, installed, tested and commissioned by PNG Power Ltd., at the project cost. The bus duct connection to the secondary terminals of the transformer shall be carried out by the Contractor in a close coordination with PNG Power Ltd. Further, the neutral of the transformer shall be solidly earthed to the low voltage system earth by connecting it to the earth terminal provided in the earth terminal box as shown on the tender drawings.

## Section 16410

### PS 16.08 Power Factor Correction Equipment

- A Static capacitors with series reactors shall be provided in each sewage lifting pump control panel for the pumping stations concerned, the low voltage static capacitor panel and in the air blower pump control panel at the STP to improve power factor up to 0.95 in lag measured at power receiving point, and they shall meet the operational and dimensional requirement as follows:

Static capacitor

Type indoor, hermetically sealed

Rated capacity

Plant Area	Rated Capacity and Quantity
PS1: Kaudi PS	25µF each for starters
PS2: Idubada PS	100µF each for starters
PS3: Hagara PS	100µF each for starters
PS4: Hanuabada PS	100µF each for starters
PS5: Konedobu PS	15kVar each for starters
PS6: Old Yacht Club PS	40µF each for starters
PS7: Stanley Esplanade PS	75µF each for starters
PS8: Sea Park PS	40µF each for starters
PS9: Davara PS	75µF each for starters
PS10: Lawes Road PS	25kVar each for starters
PS11: Koki PS	10kVar each for starters
PS12: Badili PS	15kVar each for starters
PS13: Kila Police PS	40µF each for starters

PS14: Konebada PS	40 $\mu$ F each for starters
PS15: Gabutu PS	100 $\mu$ F each for starters
PS16: Horsecamp PS	50 $\mu$ F each for starters
PS17: Kaugere PS	15kVar each for starters
STP LV Panel	50kVar x1 set, 30kVar x 2 sets
STP Blower Control Panels	25kVar each for starters

Low voltage feeder panel:

Rated voltage 0.42 kV

Rated frequency 50 Hz

Protection

Series reactor

Type

indoor, dry type

Rated capacity: shall be decided by the Contractor based on the corresponding circuit capacity of static capacity.

Rated voltage 0.42 kV

Rated frequency 50 Hz

#### B Spare parts

- |    |                                      |       |
|----|--------------------------------------|-------|
| 1) | MCCB, 100AF, 3P,                     | 1 pc  |
|    | MCCB, 50AF, 3P,                      | 5 pcs |
| 2) | MC (magnetic contactor), 100 A, 3 P, | 1 pc  |
|    | MC (magnetic contactor), 50 A, 3 P,  | 3 pcs |
| 3) | Static capacitor,                    |       |
|    | 25 $\mu$ F                           | 1 pc  |
|    | 40 $\mu$ F                           | 3 pcs |
|    | 50 $\mu$ F                           | 1 pc  |
|    | 75 $\mu$ F                           | 2 pcs |
|    | 100 $\mu$ F                          | 3 pcs |
|    | 10 kVar                              | 2 pcs |
|    | 15 kVar                              | 2 pcs |
|    | 25 kVar                              | 2 pcs |
|    | 30 kVar                              | 2 pcs |
| 4) | Static reactor,                      |       |
|    | 7 % D-Tuned 10 kVar                  | 1 pc  |
|    | 7 % D-Tuned 15 kVar                  | 1 pc  |
|    | 7 % D-Tuned 20 kVar                  | 1 pc  |
|    | 7 % D-Tuned 30 kVar                  | 1 pc  |

## Section 16425

### PS16.09 Low Voltage Switchboards

- A The Low Voltage Switchboard to be supplied under this project shall consist of twelve (12) sections for the pumping stations and two sections for the STP, namely PS X Incoming/Feeder panel, STP Incoming panel and Feeder panel. The pumping station incoming/feeder panels shall receive power from 415V PPL (PNG Power Ltd.) supply or the standby DG set supply at 415V and feed power at 415V to each pump control panel. The STP PPL/DG SET incoming panel (09LV01) shall receive power from PPL supply at 415V through the transformer or the standby diesel engine generator set and supply power at 415V to the low voltage feeder panel (09LV02).

The PPL incoming circuit breakers and the Generator incoming circuit breakers are electrically and mechanically interlocked to prevent parallel operation of the two supplies. The STP low voltage feeder panel (09LV02) shall distribute power at 415 V, 3-phase, 4-wire to blower control panels, motor control centres, lighting panels, etc.

- B The low voltage switchboards shall meet the operational and rating requirement as follows:

Tag Nos. and quantities

Description	Tag Numbers
PS2: Idubada PS Incoming/feeder panel	01-02 IFP01
PS3: Hagara PS Incoming/feeder panel	01-03 IFP01
PS4 Hanuabada PS Incoming/feeder panel	01-04 IFP01
PS5: Konedobu PS Incoming/feeder panel	01-05 IFP01
PS7: Stanley Eslanade PS Incoming/feeder panel	01-07 IFP01
PS9: Davara PS Incoming/feeder panel	01-09 IFP01
PS10: Lawes Road PS Incoming/feeder panel	01-10 IFP01
PS11: Koki PS Incoming/feeder panel	01-11 IFP01
PS12: Badili PS Incoming/feeder panel	01-12 IFP01
PS14: Konebada PS Incoming/feeder panel	01-14 IFP01
PS15: Gabutu PS Incoming/feeder panel	01-15 IFP01
PS17: Kaugere PS Incoming/feeder panel	01-17 IFP01
STP Incoming Panel	02 LV01
STP Feeder Panels	02 LV02

Purpose	to receive power from PNG Power Ltd. or the standby DG sets at 415 V, 3-phase, 4-wire and to supply them to the pump control panels for the pumping stations
Located at	to receive power from PNG Power Ltd. or the standby DG sets at 415 V, 3-phase, 4-wire and to supply it to the feeder panel for the STP generator houses or within the premises for the pumping stations
Type	electrical substation for the STP indoor or outdoor, free-standing, floor/ground mount, metal enclosed
Number	14
IP code	IP55 for the outdoor type, while IP54 for the indoor type
Dimension for reference	refer to the drawings
Structure	
Structural parts	Min. steel plate thickness (mm)
Side plate	2.3
Bottom plate	1.6
Roof	2.3
Ceiling	1.6
Separator	1.6
Door	3.2
Shielding plate	0.8
Nameplate	plastic plate, with engraved black letter on white back-ground
Rated voltage	AC 600 V
Rated short time current	capable of withstanding the system short-time current
Control voltage	

Control circuit	AC 240 V
Pilot lamp and protective device	AC 240 V
Inboard lighting and socket outlet	AC 240 V
Accessories	
Door key	1 set each
Inboard lighting	1 set each
Lighting door switch	1 set each
Test terminal	1 set each
Over current relay	
Type	Static type
Number	8 sets each for the PS incoming/feeder panels 8 sets for the STP incoming panel
Rated current	5 A
Tap range	the maximum tap to be equal to or over 3 times the corresponding circuit current
Under voltage relay	
Type	Static type
Number	1 set each for the PS incoming/feeder panels and 1set for the STP incoming panel
Rated voltage	600 V
Response value	to be adjustable
Lightning arresters	
Type	Gapless metal oxide type
Number	3 sets each for the PS incoming/feeder panels and 3sets for the STP incoming panel
Rated voltage	600 V
Rated short-duration AC Power Frequency Withstand Voltage	1.06 kV
Impulse Withstand Voltage	2.8 kV
Response voltage	1250 V
Measuring instruments	
Ammeter	
Voltmeter	
Power factor meter	
Power (Watt) meter	
Watt-hour meter	
Frequency meter	
Voltage transformer	
Type	moulded type
Number	8 sets each for any incoming panel
Rated voltage	600 V
Rated burden:	shall be proposed by the Contractor based on the corresponding circuit burden.
Accuracy	1.0 class (JIS C 1731)
Current transformer	
Type	moulded type
Number	8 sets each for any incoming panel
Rated current	5 A
Maximum voltage	600 V
Rated burden:	shall be proposed by the Contractor based on the corresponding circuit burden.
Over current	shall be higher than the rated breaking



current of the circuit

Air circuit breaker (ACB)

Type 4-pole, single throw, auto coupling type  
Withdrawal type for the STP incoming panel  
Fixed type for the PS incoming/feeder panel

## Number and Rated Current

Description	Numbers and Rated Current
PS5: Konedobu PS Incoming/feeder panel	400A, 2sets
PS10: Lawes Road PS Incoming/feeder panel	400A, 2sets
PS11: Koki PS Incoming/feeder panel	160A, 2sets
PS12: Badili PS Incoming/feeder panel	250A, 2sets
PS17: Kaugere PS Incoming/feeder panel	400A, 2sets
STP Incoming Panel	1600A, 1 set and 630A, 1 set

Rated insulation voltage 600 V

Closing method Motor operated spring or electromagnetic operation

Rated frequency 50 Hz

Breaking capacity not less than 60 kA  
(r.m.s symmetrical value)

## Moulded Case circuit breaker (MCCB)

Type 4-pole or 3-pole, single throw, auto coupling type

Number and Rated Current as shown on drawings

Rated insulation voltage 600 V

Closing method electromagnetic operation

Rated frequency 50 Hz

Breaking capacity not less than 60 kA  
(r.m.s symmetrical value)

## C Spare parts

## 1) ACB

Complete ACB 1600 AF, 4P	1 pc
ACB Motor Unit	1 pc
Shunt opening release coils	1 pc each rating
Under voltage release`	1 pc
Complete ACB 630 AF, 4P	1 pc
Complete ACB 400 AF, 4P	1 pc
Complete ACB 160 AF, 4P	1 pc

## 2) MCCB

Complete MCCB 200AF, 3P,	3 pcs
Complete MCCB 100AF, 3P,	3 pcs
Complete MCCB 50AF, 3P,	5 pcs
Shunt opening release coils	5 percent but not less than 2 pcs each
Auxiliary contacts each	5 percent but not less than 2 pcs

## 3) Complete set of spare parts as recommended by the manufacture for the PS incoming/feeder panels and the STP incoming panel including

Phase failure relay	
On delay timer	
PLC module	
Power supply for PLC	
4) Ammeter	
2000A AC	1 pc
1200A AC	1 pc
500A AC	1 pc
120A AC	1 pc
3) Volt meter	
500V AC	1 pc
4) Current transformer	
2000/5 A	3 pcs
1200/5 A	3 pcs
500/5 A	3 pcs
150/5 A	3 pcs
80/5 A	3 pcs
5) Surge Protective Devices	25% rounded up spare units of each supplied category and include 3 Nos. of fuses per each device.
6) Earth leakage relay	3 pcs
7) Potential Transformers	5 percent or 1 pc each rating
8) Core balance transformers	5 percent or 1 pc each rating
9) Control switch of each type	3 pcs each
10) Selector switch of each type	3 pcs each
11) Push button switches of each type	3 pcs each
12) Miniature circuit breakers of each type	3 pcs each
13) Micro relays f of each type	3 pcs each
14) Timers of each type	3 pcs each
15) Lamp for each indication	100 %
16) Fuse of each type	300 %
17) Fluorescent lamp	100 %

#### PS16.10 Motor Control Centres including Auxiliary Panels

A. Motor control centres (MCC) panels shall be provided to drive the plant loads. The MCC shall be composed of motor starters and hard relays and timers so that the panels shall function cooperatively to drive the plant loads. Manual mode operation circuits shall be provided in the MCC panels to cope with failures of programmable logic controllers (PLCs) while automatic mode operation circuits shall be provided in the PLCs.

B. Grit chamber motor control centre panel

Tag Nos.	02MCC01
Purpose	to drive the grit chamber facilities
Located at	electrical substation LV switchgear room
Type	indoor, free-standing, floor mount, metal enclosed, single face mount, withdrawal type
IP code	IP54
Internal subdivision	form 3b
Number	1 set
Dimension for reference	600mm width, 600mm depth and 2300mm height for each MCC panel
Motor starter	

1. .
  2. Joint boxes shall be provided at the inlet beginning point to tie the cables coming from the MCC, and the cables coming from the sludge chain scraper local unit control panel.
  3. direct on line starters for 2 units fine screens of 2.2 kW
  4. direct on line starters for 2 units grit collectors of 0.75 kW
  5. direct on line starters for 2 units grit pumps of 0.4 kW
  6. direct on line starters for 2 units sump drain pumps of 1.5 kW  
Joint boxes shall be provided adjacent to the to tie the cables coming from the MCC, and the cables coming from the sump drain pumps.
  7. direct on line reversible starter for 1 unit grit separator of 0.75 kW
  8. direct on line starters for 2 units oil discharge pumps of 0.75 kW
  9. direct on line starter for 1 unit scum screen of 0.4 kW
  10. direct on line reversible starter for 1 unit screening conveyer of 2.2 kW
  11. direct on line starter for 2 units fuel transfer pump of 0.4 kW
- Measuring instrument, protection relay and accessories
- 1 ammeter for incoming panel
  - 2 voltmeter for incoming panel
  - 3 voltage transformers
  - 4 current transformers
  - 5 grounding over current relay for all the loads
  - 6 running time meter for the sump drain pumps

C. No.1/2 OD/Clarifier motor control centre panel

Tag Nos.	04MCC01
Purpose	to drive the No1/2 OD/Clarifier facilities
Located at	Blower electrical room -1
Type	indoor, self-standing, metal enclosed, single face mount, withdrawal
IP code	IP54
Internal subdivision	form 3b
Number	1 set
Dimension for reference	600mm width, 600mm depth and 2300mm height for each MCC panel

Motor starter

1. direct on line starters for 8 units reactor tank mixer of 2.3 kW
2. power feed for 2 units air supply valves of 1.5 kW
3. direct on line starters for 4 units waste sludge pumps of 5.5 kW
4. direct on line starters for 2 units clarifiers of 0.75 kW
5. star-delta starters for 4 units return sludge pumps of 11 kW
6. direct on line starters for 2 units sump drain pumps of 1.5 kW
7. direct on line starters for 2 units scum pumps of 3.7kW

Measuring instrument, protection relay and accessories

1. ammeter for incoming panel
2. voltmeter for incoming panel
3. voltage transformers
4. current transformers
5. ammeter for the return sludge pumps
6. grounding over current relay for all the loads
7. running time meter for the waste sludge pumps, the return sludge pumps, the sump drain pumps, the scum pumps.

D. No.3 OD/Clarifier motor control centre panel

Tag Nos.	04MCC02
Purpose	to drive the No3 OD/Clarifier facilities

Located at	Blower electrical room -2
Type	indoor, self-standing, metal enclosed, single face mount, withdrawal
IP code	IP54
Internal subdivision	form 3b
Number	1 set
Dimension for reference	600mm width, 600mm depth and 2300mm height for each MCC panel

## Motor starter

1. direct on line starters for 4 units reactor tank mixer of 2.3 kW
2. direct on line starters for 2 units waste sludge pumps of 5.5 kW
3. direct on line starters for 1 unit clarifiers of 0.75 kW
4. star-delta starters for 2 units return sludge pumps of 11 kW
5. direct on line starters for 2 units sump drain pumps of 1.5 kW
6. direct on line starters for 2 units scum pumps of 3.7kW

## Measuring instrument, protection relay and accessories

8. ammeter for incoming panel
9. voltmeter for incoming panel
10. voltage transformers
11. current transformers
12. ammeter for the return sludge pumps
13. grounding over current relay for all the loads
14. running time meter for the waste sludge pumps, the return sludge pumps, the sump drain pumps, the scum pumps.

## E. Utility water and disinfection motor control centre panel

Tag Nos.	06MCC01
Purpose	to drive the utility water and disinfection facilities
Located at	sludge treatment building electrical room
Type	indoor, self-standing, metal enclosed, single face mount, withdrawal
IP code	IP54
Internal subdivision	form 3b
Number	1 set
Dimension for reference	600mm width, 600mm depth and 2300mm height for each MCC panel

## Motor starter

1. direct on line starters for 1 unit chlorine solution tank mixer of 1.5 kW
2. power feed for 1 unit utility TE water supply unit of 7.4 kW
3. direct on line starters for 2 units defoaming pumps of 3.7 kW
4. power feed at single phase, 240 V for 2 units auto strainer of 0.1 kW
5. power feed for 2 units UV device of 15 kW

## Measuring instrument, protection relay and accessories

1. ammeter for incoming panel
2. voltmeter for incoming panel
3. voltage transformers
4. current transformers
5. grounding over current relay for all the loads
6. running time meter for the defoaming pumps.

## F. Sludge treatment motor control centre panel

Tag Nos.	07MCC01
Purpose	to drive the utility water and disinfection facilities
Located at	sludge treatment building electrical room
Type	indoor, self-standing, metal enclosed, single face

	mount, withdrawal
IP code	IP54
Internal subdivision	form 3b
Number	1 set
Dimension for reference	600mm width, 600mm depth and 2300mm height for each MCC panel

#### Motor starter

1. power feed for 2 units dewatering units of 6.0 kW
2. direct on line reversible starters for 1 unit sludge cake conveyer of .3.7 kW
3. direct on line reversible starters for 2 driving units cake hopper of 2.2 kW
4. star-delta starters for 2 units polymer dissolving mixer of 11 kW
5. direct on line starters for 2 units polymer feeders of 0.4 kW
6. power feed for 1 units air compressor of 3.7 kW
7. direct on line starter for 2 units air dryer of 0.2 kW
8. direct on line starter for 2 units sump drain pumps of 1.5 kW
9. direct on line starter for 1 unit waste water tank mixer of 1.5 kW
10. direct on line starter for 2 units waste water pumps of 5.5 kW
11. direct on line starter for 2 units deodorization fans of 3.7 kW
12. power feed for 1 units motorised hoist of 3.2 kW

#### Measuring instrument, protection relay and accessories

1. ammeter for incoming panel
2. voltmeter for incoming panel
3. voltage transformers
4. current transformers
5. ammeter for the polymer dissolving tank mixer
6. grounding over current relay for all the loads
7. running time meter for the polymer dissolving tank mixer, the polymer feeder.

#### G. Spare parts

- 1) MCCB
 

Complete MCCB 100AF, 4P,	1 pc
Complete MCCB 50AF, 3P,	5 percent or 2 pcs
shunt opening release coils	5 percent or 2 pcs each rating
auxiliary contacts	5 percent or 2 pcs each rating
- 2) Ammeter
 

100A AC	1 pc
50A AC	1 pc
- 3) Voltmeter 500VAC 1 pc
- 4) Current transformers of each rating 5 percent or 1 pc each rating
- 5) Potential transformers of each rating 5 percent or 1 pc each rating
- 6) Core balance transformers 5 percent or 1 pc each rating
- 7) Auxiliary relay of each type 1 pc each
- 8) Time relay of each type 1 pc each
- 9) Earth leakage relay 2 pcs each type and rating
- 10) Residual Current Circuit Breakers 5 percent or 1 pc each rating
- 11) Control switch of each type 3 pcs each
- 12) Selector switch of each type 3 pcs each
- 13) Push button switches of each type 3 pcs each
- 14) Miniature circuit breakers of each type 3 pcs each
- 15) Micro relays of each type 3 pcs each
- 16) Hour run meters of each type 2 pcs each
- 17) Lamp for each indication 100 %
- 18) Fuse of each type 300 %
- 19) Fluorescent lamp 100 %

- 21) Magnetic contactor of each type 5 % or 1 pc each rating

**PS16.11 Pump/Blower Control Panels**

- A. Control panels shall be provided to drive the sewage pumps for the pumping stations or large capacity plant loads such as aeration blowers for the STP. The pump control panels for the smaller size pumps shall comprise incoming MCCBs, power feed MCCBs and motor starters and control circuits. On the other hand, the pump control panels for the pumping station larger size sewage pumps and for the STP air blowers shall comprise motor starters and control circuits only for manual mode operation to cope with failures of programmable logic controllers (PLCs). An automatic mode operation circuit shall be provided in the PLCs. There are 6 sets of combined pump control panels for the smaller size pumping stations, 20 sets of the pump control panels for the larger size pumping stations and 5 sets of the blower control panels for the STP to be installed under this stage as follow:
1. Combined pump control panels at PS1 Kaudi PS, PS6 Old Yacht Club PS, PS13 Kila Police PS;
  2. Combined pump control panel at PS8 Sea Park PS;
  3. Combined pump control panel at PS14 Konebada PS;
  4. Combined pump control panel at PS16 Horsecamp PS;
  5. Pump control panels at PS 2 Idubada PS, PS3 Hagara PS, P34 Hanuabada PS;
  6. Pump control panels at PS5 Konedobu PS, PS17 Kaugere PS;
  7. Pump control panel at PS7 Stanley Espalnade PS;
  8. Pump control panel at PS9 Davara PS;
  9. Pump control panel at PS10 Lawes Road PS;
  10. Pump control panels at PS11 Koki PS;
  11. Pump control panels at PS12 Badili PS;
  12. Pump control panel at PS15 Gabutu PS;
  13. Blower control panels (tag nos. 04BCP01 to 04BCP05) to drive air blowers.
- B. Combined pump control panels for PS1 Kaudi PS/PS6 Old Yacht Club PS/ PS13 Kila Police PS

Tag Nos:

Description	Tag Numbers
PS1: Kaudi PS pump control panel	01-01 PCP01
PS6: Old Yacht Club PS control panel	01-06 PCP01
PS13: Kila Police Pump PS Control Panel	01-13 PCP01

- Purpose to receive PPL supply or DG set power supply, to drive the sewage pumps
- Located at generator house of each pumping station
- Type indoor, free-standing, floor mount, metal enclosed,
- IP code IP54
- Number 3
- Dimension for reference 800mm width, 600mm depth and 2300mm height
- Structure same as the low voltage switchboard
- Nameplate plastic plate, with engraved black letter on white background
- Rated voltage AC 600 V
- Motor starter Star-delta with closed transition type for 5.5kW squirrel cage motor and 25 µF static capacitor ,
- Flush mount devices, measuring instrument, protection relay and accessories
1. 1 no. each watt-hour meter for PNG Power Ltd., supply,

2. 1 no. each watt meter for PNG Power Ltd., supply,
3. 1 no. each volt meter with position selection switch to read 3 phase voltages for PNG Power Ltd., supply,
4. 1 no. each ammeter with position selection switch to read 3 phase currents for PNG Power Ltd., supply,
5. 1 no. each power factor meter for PNG Power Ltd., supply,
6. 1 no. each volt meter with position selection switch to read 3 phase voltage for DG set power supply,
7. 1 no. each ammeter with position selection switch to read 3 phase currents for DG set power supply,
8. 1 no. each ammeter with position selection switch to read 3 phase currents for each star-delta starter,
9. 15 nos. each current transformers,
10. 2 nos. each running time meters,
11. 1 no. each under voltage relay,
12. 3 nos. each over current relays,
13. 5 nos. each grounding fault relays with zero phase current transformers.

C. Combined pump control panel for PS8 Sea Park PS

Tag Nos.

Description	Tag Numbers
PS8: Sea Park PS pump control panel	01-08 PCP01

Purpose	to receive PPL supply or DG set power supply, to drive the sewage pumps
Located at	generator house of Sea Park pumping station
Type	indoor, free-standing, floor mount, metal enclosed,
IP code	IP54
Number	1
Dimension for reference	800mm width, 600mm depth and 2300mm height
Structure	same as the low voltage switchboard
Nameplate	plastic plate, with engraved black letter on white background
Rated voltage	AC 600 V
Motor starter	Star-delta with closed transition type for 7.5kW squirrel cage motor and 40 $\mu$ F static capacitor,

Flush mount devices, measuring instrument, protection relay and accessories

1. 1 No. each watt-hour meter for PNG Power Ltd., supply,
2. 1 No. watt meter for PNG Power Ltd., supply,
3. 1 No. volt meter with position selection switch to read 3 phase voltages for PNG Power Ltd., supply,
4. 1 no. ammeter with position selection switch to read 3 phase currents for PNG Power Ltd., supply,
5. 1 No. power factor meter for PNG Power Ltd., supply,
6. 1 no. volt meter with position selection switch to read 3 phase voltage for DG set power supply,
7. 1 no. ammeter with position selection switch to read 3 phase currents for DG set power supply,
8. 1 no. ammeter with position selection switch to read 3 phase currents for each star-delta starter,
9. 15 nos. each current transformers,
10. 2 nos. running time meters,
11. 1 no. under voltage relay,
12. 3 nos. over current relays,
13. 5 nos. grounding fault relays with zero phase current transformers.

## D. Combined pump control panel for PS14 Konebada PS

Tag Nos.

Description	Tag Numbers
PS14: Konebada PS pump control panel	01-14 PCP01

Purpose	to receive PPL supply or DG set power supply, to drive the sewage pumps
Located at	generator house of Konebada pumping station
Type	indoor, free-standing, floor mount, metal enclosed,
IP code	IP54
Number	1
Dimension for reference	800mm width, 600mm depth and 2300mm height
Structure	same as the low voltage switchboard
Nameplate	plastic plate, with engraved black letter on white background
Rated voltage	AC 600 V
Motor starter	Star-delta with closed transition type for 7.5kW squirrel cage motor and 40 $\mu$ F static capacitor,

Flush mount devices, measuring instrument, protection relay and accessories

1. 1 No. each watt-hour meter for PNG Power Ltd., supply,
2. 1 No. watt meter for PNG Power Ltd., supply,
3. 1 No. volt meter with position selection switch to read 3 phase voltages for PNG Power Ltd., supply,
4. 1 no. ammeter with position selection switch to read 3 phase currents for PNG Power Ltd., supply,
5. 1 No. power factor meter for PNG Power Ltd., supply,
6. 1 no. volt meter with position selection switch to read 3 phase voltage for DG set power supply,
7. 1 no. ammeter with position selection switch to read 3 phase currents for DG set power supply,
8. 1 no. ammeter with position selection switch to read 3 phase currents for each star-delta starter,
9. 15 nos. each current transformers,
10. 2 nos. running time meters,
11. 1 no. under voltage relay,
12. 3 nos. over current relays,
13. 5 nos. grounding fault relays with zero phase current transformers.

## E. Combined pump control panel for PS16 Horsecamp PS

Tag Nos.

Description	Tag Numbers
PS16 Horsecamp PS	01-16 PCP01

Purpose	to receive PPL supply or DG set power supply, to drive the sewage pumps
Located at	generator house of Horsecamp pumping station
Type	indoor, free-standing, floor, metal enclosed,
IP code	IP54
Number	1
Dimension for reference	800mm width, 600mm depth and 2300mm height
Structure	same as the low voltage switchboard
Nameplate	plastic plate, with engraved black letter on white background



Rated voltage	AC 600 V
Motor starter	Star-delta with closed transition type for 11kW squirrel cage motor and 50 $\mu$ F static capacitor,
Flush mount devices, measuring instrument, protection relay and accessories	
1.	1 No. each watt-hour meter for PNG Power Ltd., supply,
2.	1 No. watt meter for PNG Power Ltd., supply,
3.	1 No. volt meter with position selection switch to read 3 phase voltages for PNG Power Ltd., supply,
4.	1 no. ammeter with position selection switch to read 3 phase currents for PNG Power Ltd., supply,
5.	1 No. power factor meter for PNG Power Ltd., supply,
6.	1 no. volt meter with position selection switch to read 3 phase voltage for DG set power supply,
7.	1 no. ammeter with position selection switch to read 3 phase currents for DG set power supply,
8.	1 no. ammeter with position selection switch to read 3 phase currents for each star-delta starter,
9.	15 nos. current transformers,
10.	2 nos. running time meters,
11.	1 no. under voltage relay,
12.	3 nos. over current relays,
13.	5 nos. grounding fault relays with zero phase current transformers.

F. Pump control panels for PS2 Idubada PS/PS3 Hagara PS/ PS4 Hanuabada PS  
Tag Nos.

Description	Tag Numbers
PS2 Idubada PS pump control panel	01-02 PCP01
PS3 Hagara PS pump control panel	01-03 PCP01
PS4 Hanuabada PS pump control panel	01-04 PCP01

Purpose	to drive the sewage pumps
Located at	generator house of each pumping station
Type	indoor, free-standing, floor mount, metal enclosed,
IP code	IP54
Number	1 each (3 in total)
Dimension for reference	800mm width, 600mm depth and 1900mm height
Structure	same as the low voltage switchboard
Nameplate	plastic plate, with engraved black letter on white background
Rated voltage	AC 600 V
Motor starters	2 units each star-delta starters with closed transition type for 22 kW squirrel cage motor and 100 $\mu$ F static capacitor,
Flush mount devices, measuring instrument, protection relay and accessories	
1.	1 no. each ammeter with position selection switch to read 3 phase currents for each star-delta starter,
2.	6 nos. current transformers for each panel,
3.	2 nos. running time meters for each panel,
4.	2 nos. each grounding fault relays with zero phase current transformers for each panel.

G. Pump control panels for PS5 Konedobu PS/PS17 Kaugere PS  
Tag Nos.

Description	Tag Numbers
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PS5 Konedobu PS pump control panel	01-05 PCP01/02/03
PS17 Kaugere PS pump control panel	01-017 PCP01

Purpose	to drive the sewage pumps and the delivery valves
Located at	generator house of each pumping station
Type	indoor, free-standing, floor mount, metal enclosed,
IP code	IP54
Number	3 each (6 in total)
Dimension for reference	600mm width, 600mm depth and 1900mm height
Structure	same as the low voltage switchboard
Nameplate	plastic plate, with engraved black letter on white background
Rated voltage	AC 600 V
Motor starters	auto-transformer type for 55 kW squirrel cage motor and 15 kVar static capacitor,
Flush mount devices, measuring instrument, protection relay and accessories	
1.	1 no. ammeter with position selection switch to read 3 phase currents for each auto-transformer starter,
2.	3 nos. current transformers for each starter
3.	1 no. running time meters for each starter,
4.	1 no. grounding fault relays with zero phase current transformers for each starter.

#### H. Pump control panels for PS7 Stanley Esplanade PS

Tag Nos.

Description	Tag Numbers
PS7 Stanley Esplanade PS pump control panel	01-07 PCP01

Purpose	to drive the sewage pumps
Located at	generator house
Type	indoor, free-standing, floor mount, metal enclosed,
IP code	IP54
Number	1
Dimension for reference	800mm width, 600mm depth and 1900mm height
Structure	same as the low voltage switchboard
Nameplate	plastic plate, with engraved black letter on white background
Rated voltage	AC 600 V
Motor starters	star-delta with closed transition type for 15 kW squirrel cage motor and 75 $\mu$ Fr static capacitor,
Flush mount devices, measuring instrument, protection relay and accessories	
1.	1 no. ammeter with position selection switch to read 3 phase currents for each starter,
2.	3 nos. current transformers for each starter
3.	1 no. running time meters for each starter,
4.	1 no. grounding fault relays with zero phase current transformers for each starter.

#### I. Pump control panels for PS9 Davara PS

Tag Nos.

Description	Tag Numbers
PS9 Davara PS pump control panel	01-09 PCP01

Purpose	to drive the sewage pumps
---------	---------------------------

Located at	generator house
Type	indoor, free-standing, floor mount, metal enclosed,
IP code	IP54
Number	1
Dimension for reference	800mm width, 600mm depth and 1900mm height
Structure	same as the low voltage switchboard
Nameplate	plastic plate, with engraved black letter on white background
Rated voltage	AC 600 V
Motor starters	3 numbers star-delta with closed transition type for 15 kW squirrel cage motor and 75 $\mu$ F static capacitor,
Flush mount devices, measuring instrument, protection relay and accessories	
1.	1 no. ammeter with position selection switch to read 3 phase currents for each starter,
2.	3 nos. current transformers for each starter
3.	1 no. running time meters for each starter,
4.	1 no. grounding fault relays with zero phase current transformers for each starter.

## J. Pump control panels for PS10 Lawes Road PS

Tag Nos.

Description	Tag Numbers
PS10 Lawes Road PS pump control panels	01-10 PCP01/02/03

Purpose	to drive the sewage pumps and the delivery valves
Located at	generator house
Type	indoor, free-standing, floor mount, metal enclosed,
IP code	IP54
Number	3
Dimension for reference	700mm width, 600mm depth and 1900mm height
Structure	same as the low voltage switchboard
Nameplate	plastic plate, with engraved black letter on white background
Rated voltage	AC 600 V
Motor starters	auto-transformer type for 75 kW squirrel cage motor and 25 kVar static capacitor,
Flush mount devices, measuring instrument, protection relay and accessories	
1.	1 no. ammeter with position selection switch to read 3 phase currents for each auto-transformer starter,
2.	3 nos. current transformers for each starter
3.	1 no. running time meters for each starter,
4.	1 no. grounding fault relays with zero phase current transformers for each starter.

## K. Pump control panels for PS11 Koki PS

Tag Nos.

Description	Tag Numbers
PS11 Koki PS pump control panels	01-11 PCP01/02

Purpose	to drive the sewage pumps
Located at	generator house of
Type	indoor, free-standing, floor mount, metal enclosed,
IP code	IP54
Number	2

- Dimension for reference 600mm width, 600mm depth and 1900mm height
- Structure same as the low voltage switchboard
- Nameplate plastic plate, with engraved black letter on white background
- Rated voltage AC 600 V
- Motor starters auto-transformer type for 37 kW squirrel cage motor and 10 kVar static capacitor,
- Flush mount devices, measuring instrument, protection relay and accessories
  1. 1 no. ammeter with position selection switch to read 3 phase currents for each auto-transformer starter,
  2. 3 nos. current transformers for each starter
  3. 1 no. running time meters for each starter,
  4. 1 no. grounding fault relays with zero phase current transformers for each starter.

L. Pump control panels for PS12 Badili PS

Tag Nos.

Description	Tag Numbers
PS12 Badili PS pump control panels	01-12 PCP01/02/03

- Purpose to drive the sewage pumps and the delivery valves
- Located at beside to the pump wet well
- Type outdoor, free-standing, ground mount, metal enclosed,
- IP code IP55
- Number 3
- Dimension for reference 600mm width, 600mm depth and 1900mm height
- Structure same as the low voltage switchboard
- Nameplate plastic plate, with engraved black letter on white background
- Rated voltage AC 600 V
- Motor starters auto-transformer type for 45 kW squirrel cage motor and 15 kVar static capacitor,
- Flush mount devices, measuring instrument, protection relay and accessories
  1. 1 no. ammeter with position selection switch to read 3 phase currents for each auto-transformer starter,
  2. 3 nos. current transformers for each starter
  3. 1 no. running time meters for each starter,
  4. 1 no. grounding fault relays with zero phase current transformers for each starter.

M. Pump control panels for PS15 Gabutu PS

Tag Nos.

Description	Tag Numbers
PS15 Gabutu PS pump control panel	01-15 PCP01

- Purpose to drive the sewage pumps
- Located at generator house
- Type indoor, free-standing, floor mount, metal enclosed,
- IP code IP54
- Number 1
- Dimension for reference 800mm width, 600mm depth and 1900mm height
- Structure same as the low voltage switchboard
- Nameplate plastic plate, with engraved black letter on white background

Rated voltage	AC 600 V
Motor starters	star-delta with closed transition type for 22 kW squirrel cage motor and 100 $\mu$ F static capacitor,
Flush mount devices, measuring instrument, protection relay and accessories	
1.	1 no. ammeter with position selection switch to read 3 phase currents for each starter,
2.	3 nos. current transformers for each starter
3.	1 no. running time meters for each starter,
4.	1 no. grounding fault relays with zero phase current transformers for each starter.

## N. Blower control panels for STP

Tag Nos.

Description	Tag Numbers
STP blower control panels	04 BCP01/02/03/04/05

Purpose	to drive the aeration blowers
Located at	generator house
Type	indoor, free-standing, floor mount, metal enclosed,
IP code	IP54
Number	5
Dimension for reference	600mm width, 600mm depth and 1900mm height
Structure	same as the low voltage switchboard
Nameplate	plastic plate, with engraved black letter on white background
Rated voltage	AC 600 V
Motor starters	auto-transformer type for 75 kW squirrel cage motor and 25 kVar static capacitor,
Flush mount devices, measuring instrument, protection relay and accessories	
1.	1 no. ammeter with position selection switch to read 3 phase currents for each auto-transformer starter,
2.	3 nos. current transformers for each starter
3.	1 no. running time meters for each starter,
4.	1 no. grounding fault relays with zero phase current transformers for each starter.

## D Spare parts

1. Magnetic motor starters of each type 5 percent or 1 pc each of different rating (including contactor and thermal overload relay)

**PS16.12 Local Control Panels**

- A. For the STP, local control panels shall be provided adjacent to equipment concerned to control the equipment manually by combination of the MCCs concerned.

## B. Fine screen local control panel

Tag Nos.	02LCP01
Purpose	to control the fine screens
Type	outdoor, stand-type, metal enclosed,
IP code	IP55
Number	1
Dimension for reference	600mm width, 300mm depth and 700mm height
Structure	min. steel plate thickness: 2.3mm

Nameplate	plastic plate, with engraved black letter on white back-ground
Rated voltage	AC 600 V
Mounted switches	as shown on the drawing
C. Grit collector local control panel	
Tag Nos.	02LCP02
Purpose	to control the grit collectors
Type	outdoor, stand-type, metal enclosed,
IP code	IP55
Number	1
Dimension for reference	500mm width, 300mm depth and 700mm height
Structure	min. steel plate thickness: 2.3mm
Nameplate	plastic plate, with engraved black letter on white back-ground
Rated voltage	AC 600 V
Mounted switches	as shown on the drawing
D. Grit pump local control panel	
Tag Nos.	02LCP03
Purpose	to control the grit pumps
Type	outdoor, stand-type, metal enclosed,
IP code	IP55
Number	1
Dimension for reference	500mm width, 300mm depth and 700mm height
Structure	min. steel plate thickness: 2.3mm
Nameplate	plastic plate, with engraved black letter on white back-ground
Rated voltage	AC 600 V
Mounted switches	as shown on the drawing
E. Grit separator local control panel	
Tag Nos.	02LCP04
Purpose	to control the grit separator
Type	outdoor, stand-type, metal enclosed,
IP code	IP55
Number	1
Dimension for reference	400mm width, 300mm depth and 700mm height
Structure	min. steel plate thickness: 2.3mm
Nameplate	plastic plate, with engraved black letter on white back-ground
Rated voltage	AC 600 V
Mounted switches	as shown on the drawing
F. Oil discharge pump local control panel	
Tag Nos.	02LCP05
Purpose	to control the oil discharge pumps
Type	outdoor, stand-type, metal enclosed,
IP code	IP55
Number	1
Dimension for reference	500mm width, 300mm depth and 700mm height
Structure	min. steel plate thickness: 2.3mm
Nameplate	plastic plate, with engraved black letter on white back-ground
Rated voltage	AC 600 V

	Mounted switches	as shown on the drawing
G.	Scum screen local control panel	
	Tag Nos.	02LCP06
	Purpose	to control the scum screen
	Type	outdoor, stand-type, metal enclosed,
	IP code	IP55
	Number	1
	Dimension for reference	400mm width, 300mm depth and 700mm height
	Structure	min. steel plate thickness: 2.3mm
	Nameplate	plastic plate, with engraved black letter on white back-ground
	Rated voltage	AC 600 V
	Mounted switches	as shown on the drawing
H.	Sump drain pump local control panel for the grit chamber	
	Tag Nos.	02LCP07
	Purpose	to control the sump drain pumps
	Type	indoor, wall-mount type, metal enclosed,
	IP code	IP54
	Number	1
	Dimension for reference	500mm width, 300mm depth and 700mm height
	Structure	min. steel plate thickness: 2.3mm
	Nameplate	plastic plate, with engraved black letter on white back-ground
	Rated voltage	AC 600 V
	Mounted switches	as shown on the drawing
I.	Oxidation ditch mixer local control panels	
	Tag Nos.	04LCP01/02/03/04/05/06
	Purpose	to control the oxidation ditch mixers
	Type	outdoor, stand- type, metal enclosed,
	IP code	IP55
	Number	6
	Dimension for reference	500mm width, 300mm depth and 700mm height
	Structure	min. steel plate thickness: 2.3mm
	Nameplate	plastic plate, with engraved black letter on white back-ground
	Rated voltage	AC 600 V
	Mounted switches	as shown on the drawing
J.	Blower local control panel for No.1/2 oxidation ditches	
	Tag Nos.	04LCP07
	Purpose	to control the air blowers for No.1/2 oxidation ditches
	Type	indoor, stand- type, metal enclosed,
	IP code	IP54
	Number	1
	Dimension for reference	600mm width, 300mm depth and 700mm height
	Structure	min. steel plate thickness: 2.3mm
	Nameplate	plastic plate, with engraved black letter on white back-ground
	Rated voltage	AC 600 V
	Mounted switches	as shown on the drawing
K.	Blower local control panel for No.3 oxidation ditch	
	Tag Nos.	04LCP08

Purpose	to control the air blowers for No.3 oxidation ditch
Type	indoor, stand- type, metal enclosed,
IP code	IP54
Number	1
Dimension for reference	500mm width, 300mm depth and 700mm height
Structure	min. steel plate thickness: 2.3mm
Nameplate	plastic plate, with engraved black letter on white back-ground
Rated voltage	AC 600 V
Mounted switches	as shown on the drawing
L. Clarifier local control panels	
Tag Nos.	05LCP01/02/03
Purpose	to control the clarifiers
Type	outdoor, stand- type, metal enclosed,
IP code	IP55
Number	3
Dimension for reference	400mm width, 300mm depth and 700mm height
Structure	min. steel plate thickness: 2.3mm
Nameplate	plastic plate, with engraved black letter on white back-ground
Rated voltage	AC 600 V
Mounted switches	as shown on the drawing
M. Waste sludge pump local control panels	
Tag Nos.	04LCP09/10/11
Purpose	to control the waste sludge pumps
Type	outdoor, stand- type, metal enclosed,
IP code	IP55
Number	3
Dimension for reference	500mm width, 300mm depth and 700mm height
Structure	min. steel plate thickness: 2.3mm
Nameplate	plastic plate, with engraved black letter on white back-ground
Rated voltage	AC 600 V
Mounted switches	as shown on the drawing
N. Return sludge pump local control panels	
Tag Nos.	05LCP05/06/07
Purpose	to control the return sludge pumps
Type	indoor, stand- type, metal enclosed,
IP code	IP54
Number	3
Dimension for reference	500mm width, 300mm depth and 700mm height
Structure	min. steel plate thickness: 2.3mm
Nameplate	plastic plate, with engraved black letter on white back-ground
Rated voltage	AC 600 V
Mounted switches	as shown on the drawing
O. Scum pump local control panels	
Tag Nos.	05LCP07
Purpose	to control the scum pumps
Type	outdoor, stand- type, metal enclosed,
IP code	IP55



- |                         |  |
|-------------------------|--|
| Number                  | 3  |
| Dimension for reference | 500mm width, 300mm depth and 700mm height                      |
| Structure               | min. steel plate thickness: 2.3mm                              |
| Nameplate               | plastic plate, with engraved black letter on white back-ground |
| Rated voltage           | AC 600 V   |
| Mounted switches        | as shown on the drawing  |
- P. Sump drain pump local control panel for the sludge pump rooms
- |                         |  |
|-------------------------|--|
| Tag Nos.                | 05LCP08/09   |
| Purpose                 | to control the sump drain pumps                                |
| Type                    | indoor, wall-mount type, metal enclosed,                       |
| IP code                 | IP54   |
| Number                  | 2  |
| Dimension for reference | 500mm width, 300mm depth and 700mm height                      |
| Structure               | min. steel plate thickness: 2.3mm                              |
| Nameplate               | plastic plate, with engraved black letter on white back-ground |
| Rated voltage           | AC 600 V   |
| Mounted switches        | as shown on the drawing  |
- Q. Chlorine tank mixer local control panel
- |                         |  |
|-------------------------|--|
| Tag Nos.                | 06LCP01  |
| Purpose                 | to control the chlorine tank mixers                            |
| Type                    | indoor, stand type, metal enclosed,                            |
| IP code                 | IP54   |
| Number                  | 1  |
| Dimension for reference | 500mm width, 300mm depth and 700mm height                      |
| Structure               | min. steel plate thickness: 2.3mm                              |
| Nameplate               | plastic plate, with engraved black letter on white back-ground |
| Rated voltage           | AC 600 V   |
| Mounted switches        | as shown on the drawing  |
- R. Defoaming pump local control panel
- |                         |  |
|-------------------------|--|
| Tag Nos.                | 06LCP02  |
| Purpose                 | to control the defoaming pumps                                 |
| Type                    | outdoor, stand type, metal enclosed,                           |
| IP code                 | IP54   |
| Number                  | 1  |
| Dimension for reference | 500mm width, 300mm depth and 700mm height                      |
| Structure               | min. steel plate thickness: 2.3mm                              |
| Nameplate               | plastic plate, with engraved black letter on white back-ground |
| Rated voltage           | AC 600 V   |
| Mounted switches        | as shown on the drawing  |
- S. Polymer tank mixer local control panel
- |                         |  |
|-------------------------|--|
| Tag Nos.                | 07LCP01  |
| Purpose                 | to control the polymer tank mixers                 |
| Type                    | indoor, stand type, metal enclosed,                |
| IP code                 | IP54   |
| Number                  | 1  |
| Dimension for reference | 500mm width, 300mm depth and 700mm height          |
| Structure               | min. steel plate thickness: 2.3mm                  |
| Nameplate               | plastic plate, with engraved black letter on white |

	back-ground
Rated voltage	AC 600 V
Mounted switches	as shown on the drawing
T. Polymer feeder local control panel	
Tag Nos.	07LCP02
Purpose	to control the polymer feeders
Type	indoor, stand type, metal enclosed,
IP code	IP54
Number	1
Dimension for reference	500mm width, 300mm depth and 700mm height
Structure	min. steel plate thickness: 2.3mm
Nameplate	plastic plate, with engraved black letter on white back-ground
Rated voltage	AC 600 V
Mounted switches	as shown on the drawing
U. Polymer feed pump local control panel	
Tag Nos.	07LCP03
Purpose	to control the polymer feed pumps
Type	indoor, stand type, metal enclosed,
IP code	IP54
Number	1
Dimension for reference	500mm width, 300mm depth and 700mm height
Structure	min. steel plate thickness: 2.3mm
Nameplate	plastic plate, with engraved black letter on white back-ground
Rated voltage	AC 600 V
Mounted switches	as shown on the drawing
V. Sludge cake conveyer local control panel	
Tag Nos.	07LCP04
Purpose	to control the sludge cake conveyer
Type	indoor, stand type, metal enclosed,
IP code	IP54
Number	1
Dimension for reference	400mm width, 300mm depth and 600mm height
Structure	min. steel plate thickness: 2.3mm
Nameplate	plastic plate, with engraved black letter on white back-ground
Rated voltage	AC 600 V
Mounted switches	as shown on the drawing
W. Sludge cake hopper local control panel	
Tag Nos.	07LCP05
Purpose	to control the sludge cake hopper
Type	indoor, stand type, metal enclosed,
IP code	IP54
Number	1
Dimension for reference	500mm width, 300mm depth and 700mm height
Structure	min. steel plate thickness: 2.3mm
Nameplate	plastic plate, with engraved black letter on white back-ground
Rated voltage	AC 600 V
Mounted switches	as shown on the drawing

- X. Air Dryer local control panel
- |                         |  |
|-------------------------|--|
| Tag Nos.                | 07LCP06  |
| Purpose                 | to control the air dryer                                       |
| Type                    | indoor, stand type, metal enclosed,                            |
| IP code                 | IP54   |
| Number                  | 1  |
| Dimension for reference | 500mm width, 300mm depth and 700mm height                      |
| Structure               | min. steel plate thickness: 2.3mm                              |
| Nameplate               | plastic plate, with engraved black letter on white back-ground |
| Rated voltage           | AC 600 V   |
| Mounted switches        | as shown on the drawing  |
- Y. Sump drain pump local control panel for the sludge treatment building
- |                         |   |
|-------------------------|---|
| Tag Nos.                | 07LCP07                                   |
| Purpose                 | to control the sump drain pumps           |
| Type                    | indoor, wall-mount type, metal enclosed,  |
| IP code                 | IP54                                      |
| Number                  | 1   |
| Dimension for reference | 500mm width, 300mm depth and 700mm height |
- Z. Waste water tank local control panel
- |                         |  |
|-------------------------|--|
| Tag Nos.                | 07LCP08  |
| Purpose                 | to control the waste water tank mixer and waste water pumps    |
| Type                    | outdoor, stand type, metal enclosed,                           |
| IP code                 | IP55   |
| Number                  | 1  |
| Dimension for reference | 600mm width, 300mm depth and 700mm height                      |
| Structure               | min. steel plate thickness: 2.3mm                              |
| Nameplate               | plastic plate, with engraved black letter on white back-ground |
| Rated voltage           | AC 600 V   |
| Mounted switches        | as shown on the drawing  |
- AA. Deodorization fan local control panel
- |                         |  |
|-------------------------|--|
| Tag Nos.                | 07LCP09  |
| Purpose                 | to control the deodorization fans                              |
| Type                    | indoor, stand type, metal enclosed,                            |
| IP code                 | IP54   |
| Number                  | 1  |
| Dimension for reference | 500mm width, 300mm depth and 700mm height                      |
| Structure               | min. steel plate thickness: 2.3mm                              |
| Nameplate               | plastic plate, with engraved black letter on white back-ground |
| Rated voltage           | AC 600 V   |
| Mounted switches        | as shown on the drawing  |

## Section 16450

### PS 16.13 Earthing Systems

- A. TN-C-S earthing system shall be established at the pumping stations and the sewage treatment plant. TN-S system shall be applied to the equipment powered by the UPS,

while TN-C system shall be applied to the rest utilizing power source neutral to be earthed.

- B. There shall be independent earthing system for the PPL supply and the standby generator power supply. It shall be achieved by providing the interlock between the PPL incoming circuit breaker and that of the DG set.
- C. Tinned copper tape shall be laid surrounding the electrical substation as a main earth loop, to which the earthing rods and the earthing terminal are connected to make the earthing system complete.

## Section 16610

### PS 16.14 UPS System

- A. There shall be one each UPS system installed on the pumping stations, the flow meter chamber and the sewage treatment plant. The UPS systems for the pumping stations shall be general use all-in-one type, while that for the sewage treatment plant shall comprise a battery panel, a charger panel and an inverter panel. The UPS systems shall be provided to supply uninterrupted power at 240 V, single-phase, 3-wire to the following equipment.

Micro PLC, wireless modem/gateway, flow meter (if any) and level meter for each pumping station

Micro PLC, wireless modem/gateway, flow meter for the flow meter chamber at the receiving well to which the Badili pumping station pumps the sewage.

- 08PLC01/02: Programmable logic controller No.1 and No.2 located at the administration building monitoring room
- 04RIO01: remote I/O modules located at the blower electrical room -1
- 04RIO04: remote I/O modules located at the blower electrical room -2
- 07RIO01: remote I/O modules located at the sludge treatment building electrical room
- 09RIO01: remote I/O modules located at the electrical substation LV switchgear room
- 08OS01: Operator station for the pumping stations located at the administration monitoring room
- 08OS02: Operator station for the sewage treatment plant located at the administration monitoring room
- 08SER01: Industrial workstation server -1 located at the administration building monitoring room
- 08SER02: Industrial workstation server -2 located at the administration building monitoring room
- 08ENG01: Engineering station located at the administration building monitoring room

- B. The UPS devices for the pumping stations and the flow meter chamber shall be mounted inside telemeter panels with 1 kVA output to back up the micro PLCs and the GPRS modems/gateways.

- C. The battery panel of the STP UPS system shall meet the operational and rating requirement as follows:

Tag Nos.            01UPS01

Purpose:            to store power from the rectifier during normal time and to supply

	power at 240 V DC, single-phase, 2-wire to the inverter panel during power failure
Location	electrical substation LV switchgear room
Number	1
Type	cathode absorption seal type lead-acid battery
Input voltage	2.23 V per each battery cell
Rated capacity	200 AH/HR. 54 cells.

- D. The charger panel of the STP UPS system shall meet the operational and rating requirement as follows:

Tag Nos.	019UPS01
Purpose	to rectify AC power supplied at 415 V, 3-phase and 4-wire and supply DC power to the inverter and the batteries
Location	electrical substation LV switchgear room
Number	1
Type	thyristor or transistor type, floating charge, 3-phase full-wave rectification
Rated capacity	100 A
Output DC voltage	120 V applying for 54 cells of batteries.

- E. The inverter panel of the STP UPS system shall meet the operational and rating requirement as follows:

Tag Nos.	01UPS01
Purpose	to supply uninterrupted AC power at 230 V, single-phase and 2-wire to duty equipment aforementioned
Location	inlet/mini-hydro facilities power receiving room
Number	1
Type	thyristor or transistor type, pulse width modulation inverter
Operating method:	inverter constant operation with synchronous and uninterruptible change over from normal power supply
Rated capacity	7.5 kVA
Output voltage	240 V AC to the duty equipment

## Section 16620

### PS 16.15 Standby Diesel Generator Set

- A. In order to meet the emergency power requirements on failure of PPL power supply a stand-by diesel generating sets of each capacity shall be installed in the generator room of the Electrical Substation for the pumping stations and the sewage treatment plant. They shall supply power at 415 V, 3-phase, 4-wire to the incoming panels at the pumping stations and the sewage treatment plant. Each standby generator set shall comprise a diesel engine, an alternator, a day tank, a bulk storage tank for the STP only, engine silencer, a built in generator panel and necessary accessories.

- B. The Generator sets shall meet the operational and rating requirement as follows:

Tag Nos., capacities and number (quantity)

Description	Tag Numbers	Number (Set)	Alternator Output (kVA)	Engine Output (PS)
PS1: Kaudi PS	01-01 GEN01	1	20 or over	24 or over
PS2: Idubada PS	01-02 GEN01	1	50 or over	58 or over
PS3: Hagara PS	01-03 GEN01	1	50 or over	58 or over
PS4: Hanuabada PS	01-04 GEN01	1	50 or over	58 or over

PS5: Konedobu PS	01-05 GEN01	1	200 or over	232 or over
PS6: Old Yacht Club PS	01-06 GEN01	1	20 or over	24 or over
PS7: Stanley Esplanade PS	01-07 GEN01	1	37.5 or over	44 or over
PS8: Sea Park PS	01-08 GEN01	1	20 or over	24 or over
PS9: Davara PS	01-09 GEN01	1	50 or over	58 or over
PS10: Lawes Road PS	01-10 GEN01	1	250 or over	290 or over
PS11:Koki PS	01-11 GEN01	1	75 or over	87 or over
PS12: Badili PS	01-12 GEN01	1	150 or over	174 or over
PS13: Kila Police PS	01-13 GEN01	1	20 or over	24 or over
PS14: Konebada PS	01-14 GEN01	1	20 or over	24 or over
PS15: Gabutu PS	01-15 GEN01	1	50 or over	58 or over
PS16:Horsecamp PS	01-16 GEN01	1	20 or over	24 or over
PS17: Kaugere PS	01-17 GEN01	1	200 or over	232 or over
Kila Kila STP	01-01 GEN01	1	375 or over	434 or over

Purpose to back up critical loads during PPL power failure  
 Location generator house for each pumping station except PS7-Stanley Esplanade  
 beside the pump wet well for PS7-Stanley Esplanade  
 electrical sub-station generator room for the STP  
 Other Engine and alternator to coupled directly without interposing gear arrangement, and common bed to be provided to fix them to floor

#### Diesel engine

Type: stationary heavy duty, turbo charged compression/ignition, multi cylinder 4-stroke operation  
 Overload: 10% (for 1 hour once during 6 hours); 50% (for 1 minute once during 6 hours)  
 Starting method: starter motor driven by 24 V DC power  
 Cooling system: radiator built-in, blower fan  
 Revolution: 1500 rpm  
 Fuel system: electronic controlled unit injectors  
 Governing system electronic control

#### Alternator

Type: self-excited, self-ventilated, air cooled, splash-proof, synchronous alternator  
 Overload: 10% (for 1 hour once during 6 hours); 50% (for 1 minute once during 6 hours)  
 Voltage: 415 V  
 Frequency: 50 Hz  
 Number of poles: 4  
 Number of phases: 3, (neutral to be brought out)  
 Power factor: 0.8 lagging  
 Efficiency: not less than 0.9 (including excitation and field loss)  
 Voltage regulation: automatic and static  
 Insulation class: "H" for stator, rotor and stator windings

### Load Arrangement

The critical loads to be backed up by the standby generators are listed below.

Description	Critical Loads	Output (kW/kVA)
PS1 Kaudi PS/ PS6 Old Yacht Club PS/ PS13 Kila Police PS	Pump UPS	5.5kW x 1 set 1kVA x 1 set
PS2 Idubada PS/ PS3 Hagara PS/	Pump	22kW x 1 set

PS4 Hanuabada PS	UPS	1kVA x 1 set
PS5 Konedobu PS / PS17 Kaugere PS	Pump UPS	55kW x 2 sets 1kVA x 1 set
PS7 Stanley Esplanade PS	Pump UPS	15kW x 1 set 1kVA x 1 set
PS8 Sea Park PS	Pump UPS	7.5kW x 1 set 1kVA x 1 set
PS9 Davara PS	Pump UPS	15kW x 2 sets 1kVA x 1 set
PS10 Lawes Road PS	Pump UPS	75kW x 2 sets 1kVA x 1 set
PS11 Koki PS	Pump UPS	37kW x 1 set 1kVA x 1 set
PS12 Badili PS	Pump UPS	45kW x 2 sets 1kVA x 1 set
PS14 Konebada PS	Pump UPS	7.5kW x 1 set 1kVA x 1 set
PS15 Gabutu PS	Pump UPS	22kW x 1 set 1kVA x 1 set
PS16 Horsecamp PS	Pump UPS	11kW x 1 set 1kVA x 1 set
Kila Kila STP	Fine screens Grit collectors Grit pumps Sump drain pumps Grit separator Oil discharge pump Scum screen Screenings conveyer Fuel transfer pump OD mixers Aeration blowers Air supply valves Sump drain pumps UV Disinfection units UPS Small power	2.2kW x 2 sets 0.75kW x 2 sets 2.2kW x 2 sets 1.5kW x 1 set 0.75kW x 1 set 0.75kW x 1 set 0.4kW x 1 set 2.2kW x 1 set 0.4 kW x 1 set 2.3kW x 6 sets 75kW x 2 sets 0.2kW x 2 sets 1.5kW x 2 sets 15kW x 2 sets 7.5kVA x 1 set 18 kW x lump 20 %

- C. Fuel supply to the engine shall be maintained by a day tank located in the DG room. For the STP, two fuel transfer pumps shall be provided to connect the day tank and a bulk storage tank by necessary piping, control cocks, drain cock and all other fittings. Level meters/indicators shall be installed in the day tank and the bulk storage tanks. The level meters shall be of submersible hydro static type with analogue signals. Detection system shall convert level into remaining fuel volume and shall indicate the level/volume near the fuel tank and the operator station at administration building monitoring room. Mechanical level gauge shall also be fitted to the day tank and the bulk storage tank.
- D. The engine silencer shall meet the operational and rating requirement as follows:
- |                   |  |
|-------------------|--|
| Purpose           | to reduce sound noise generated by engine exhaust air  |
| Number            | 1 each   |
| Attenuation level | 80 dB A for the outdoor type and 75 dB A for the indoor type at 1 m away from the attenuator |

- E. The Generator panel shall meet the operational and rating requirement as follows:
- |                                    |   |
|------------------------------------|---|
| Purpose                            | to control the generator, to receive and feed generated power to the critical loads through the incoming panels at 415 V, 3-phase, 4-wire |
| Type                               | indoor, generator-mounted, metal enclosed,  |
| Number                             | 1 each  |
| Dimension for reference            | according to the manufacturer's standard  |
| Structure                          | same as the low voltage switchboards (09LV01/02)  |
| IP code                            | IP54  |
| Nameplate                          | plastic plate, with engraved black letter on white background   |
| Rated voltage                      | AC 600 V  |
| Rated short time current           | capable of withstanding the system short-time current   |
| Inboard lighting and socket outlet | AC 240 V  |
| Accessories                        |   |
| Door key                           | 1 set   |
| Inboard lighting                   | 1 set   |
| Lighting door switch               | 1 set   |
| Test terminal                      | 1 set   |
| Over current relay                 |   |
| Type                               | static type   |
| Number                             | 2   |
| Rated current                      | 5 A   |
| Tap range:                         | the maximum tap to be equal to or over 3 times the corresponding circuit current  |
| Measuring instruments              |   |
| Ammeter                            |   |
| Voltmeter                          |   |
| Frequency meter                    |   |
| Wattmeter                          |   |
| Watt-hour meter                    |   |
| Power factor meter                 |   |
| Hour run meter                     |   |
- All analogue signals shall be transmitted to the PLC (09PLC01/02) by twisted pair screened cables, if measuring instruments are provided by measurement items. Multi digital type measuring device may be applied instead of individual measuring instrument.
- |                     |   |
|---------------------|---|
| Voltage transformer |   |
| Type                | molded type   |
| Number              | 3 each  |
| Rated voltage       | 440 V   |
| Rated burden:       | shall be decided by the Contractor based on the corresponding circuit burden. |
| Accuracy            | 1.0 class (JIS C 1731)  |
| Current transformer |   |
| Type                | moulded type  |
| Number              | 3 each  |
| Rated current       | Primary suitable to each generator, secondary 5 A                             |
| Maximum voltage     | 460 V   |
| Rated burden:       | shall be decided by the Contractor based on the corresponding circuit burden. |
| Over current        | shall be higher enough than the rated breaking current of the circuit         |



Air circuit breaker (ACB)/Moulded case circuit breaker	
Type	fixed, 4-pole, single throw and auto-coupling type
Number	1 each
Rated insulation voltage	600 V
Rated current	as shown on the drawings
Closing method	electromagnetic operation
Rated frequency	50 Hz
Breaking capacity (r.m.s symmetrical value)	not less than 50 kA
Auto voltage regulator	
Battery and charger	Maintenance free battery pack with a trickle charger

F. Spare parts

1)	Fuel pump	1 pc
2)	Cartridge, Fuel filter	4 sets each
3)	Cartridge, Oil filter	4 sets each
4)	Air filter	2 sets each
5)	Fan belt set	1 set each
6)	Alternator belt	1 pc each
7)	Auxiliary relay of each type	1 pc each
8)	Time relay of each type	1 pc each
9)	Protection relay of each type	1 pc each
10)	Indication / warning lamp	100 %
11)	Control switches of each type	2 pcs each
12)	Fuse of each type	300 %

G. Training of Staff

Two operating staffs shall be trained on following areas.

- (i) Load calculation and generator selection
- (ii) Operation and Maintenance of generators.

## Section 16950

### PS 16.16 Electrical Testing - General

- A Works testing and inspection shall be carried out at the manufacturer's works in accordance with the Contract documents and the Contractor shall, in addition to any obligations under the Conditions of Contract, inform the Engineer's duly appointed representative of the date when the equipment will be ready for inspection and witness testing.
- B The tests shall be carried out prior to delivery of the equipment to Site. The Contractor shall not deliver equipment to Site without the Engineer's prior approval in writing.
- C If the tests are beyond the resources of the manufacturer he shall make arrangements for these to be carried out elsewhere. Any variation of this requirement shall be agreed and confirmation in writing obtained from the Engineer.
- D The Contractor shall supply four un-priced copies of all sub-orders including those for items manufactured at his works. Two copies of each of these sub-orders shall be forwarded to the Engineer and two to the appointed representative. The sub-orders shall

indicate the works for which the item is required, state in detail the inspection and test requirements, give sufficient information for ready identification and shall state that these items will be subject to witness test and inspection.

- E Unless otherwise stated the Engineer reserves the right to witness test all equipment.
- F Witnessed testing will normally be waived on standard types of small motors made by approved manufacturers and small components used in the manufacture of units of equipment, minor installation materials and cable.
- G Motors of 15 kW to 75 kW shall be witness tested for performance to IEC 34-1 in the proportion indicated unless otherwise specified.
- H All motors of 75 kW and above shall be witness tested for performance to IEC 34-1 unless otherwise specified.
- I The Contractor shall carry out tests as stated in the current appropriate International Standard; performance tests and such other tests as are necessary, in the opinion of the Engineer's Representative, to determine that the Plant comply with the Specification either under test conditions in the manufacturer's works, on site or elsewhere or in the ordinary working.
- J All cast metal components designed for the retention of liquids, e.g. pump casings, gear boxes, engine crank cases, etc. shall be checked for soundness after machining, etc., but before assembly or painting, by treating with paraffin or similar method.
- K Where tests and inspection have been completed to the Engineer's satisfaction and when the test certificates, curves, etc., have been checked, the Engineer will confirm acceptance in writing and the equipment shall not be incorporated in the work or delivered until this acceptance has been received.
- L Four copies of all test certificates and curves shall be supplied to the Engineer's Representative within two weeks of completion of any witnessed tests.
- M Where witness tests are not required the test certificates and curves shall be forwarded to the Engineer's Representative within two weeks after instructions to waive witness tests have been received.
- N On each test certificate sufficient information to enable the Engineer to issue a release certificate including the specification contract number and details, shall be given for ready identification of the material or equipment to which the certificate refers.
- O No inspection or passing by the Engineer or the Engineer's Representative of the work, equipment or materials covered by this Contract, whether carried out or supplied by the Contractor, shall release him from any of his obligations under the Contract.
- P Electrical equipment shall be inspected for workmanship, suitability of purpose and functionality. The Contractor shall provide test equipment in order to simulate operation of the equipment under site conditions. A test plan shall be established and approved by the Engineer. The Engineer shall not be requested to inspect the equipment until the Contractor has satisfied himself that the equipment meets all requirements of the Specification and is functionally correct.
- R The Engineer reserves the right to require the Contractor to meet any extra costs which are occasioned by failure of the Contractor to comply with the above testing and inspection requirements, including the provision of test certificates, curves, etc., which

in the opinion of the Engineer, are due to insufficient care having been taken by the Contractor or his sub-contractor before presenting the equipment for inspection or tests. If unauthorised delivery has taken place the Contractor may be required to arrange for the plant to be returned to the manufacturer for inspection and/or witness testing by the Engineer's Representative at the Contractor's expense.

- S All apparatus, instruments and connections required for the tests shall have been tested for accuracy and safety and certified as such within the preceding twelve months.
- T Any equipment used in the testing of the equipment shall in all respects comply with the appropriate safety regulations and/or requirements regarding electrical apparatus for the safety of the equipment and the men working thereon.

#### **PS 16.17 Manufacturer's Works Acceptance Tests on Electrical Equipment**

- A The Contractor shall carry out further specified tests as follows in addition to any tests stated or implied by the foregoing general section of this clause.

- B **Switchgear and Motor Control Assemblies**

The whole of the switch and control gear shall be witness tested as integral units for a complete sequence of operation and as laid down in BS EN 60439 and based on the completeness of the circuits in the final manufactured form within the manufacturer's works. The following tests shall be carried out:

- 1 Primary injection tests to ensure correct rates and polarity of current and voltage transformers and of the current operated protection relays and direct acting coils, over their full range of settings.
- 2 Balance earth fault stability test by primary current injection. Care must be taken to reproduce accurately the burdens of interconnecting cables. A further test to ensure correct polarity must be made after assembly.
- 3 Tests on auxiliary relays at normal operating voltages by operation of associated remote relays.
- 4 Correct operation of sequencing and control circuits at normal operating voltages by operation of local control switches, and simulation of operation from remote control positions.

- C **Circuit Breakers**

All circuit breakers shall be subject to the following tests:

- 1 Routine tests including HV pressure test, millivolt drop tests and mechanical tests.
- 2 To ensure the operation of the dc closing coil and satisfactory closing of the circuit breaker with the voltage of the coil down to 80 percent of its rated voltage, and that mal-operation does not occur with a voltage on the coil of 120 percent of its rated voltage.
- 3 Interchangeability of withdrawable identically equipped circuit breakers, and checking of all mechanical and electrical interlocks.

Type test figures for heat test runs performed on identical panel types shall be made available.

- D **Transformers**

Transformers shall be subject to works routine tests, which shall also include the following:

- 1 measurement of winding resistance;
- 2 ratio polarity and phase relationship;
- 3 impedance voltage;
- 4 load losses;
- 5 no load losses and no load current;
- 6 insulation resistance;
- 7 induced over-voltage withstand;

8 separate source voltage withstand.

Type test certificates shall be provided for the following:

- 1 impulse voltage withstand;
- 2 temperature rise.

**E Cables**

All HV cables and armoured cables shall be subject to routine tests in accordance with the relevant British Standard Specification. Test certificates shall be provided against each drum and/or cable length. The tests carried out on every cable length and/or drum at manufacturer's premises shall include:

- 1 high voltage dc insulation pressure test, between cores, each core to earth, metallic sheath or armour as applicable;
- 2 insulation resistance test;
- 3 core continuity and identification;
- 4 conductor resistance test.

**F Pressure Switches and Gauges**

All pressure switches and vacuum and pressure gauges shall be subject to routine tests in accordance with the relevant British Standard Specification.

**G Motors**

Motor tests shall be carried out in accordance with the requirements of BS EN 50347 as applicable. The test shall obtain the overall efficiency and other figures in accordance with the guarantees given in the Technical Schedules.

**PS 16.18 Manufacturer's Works Acceptance Tests on PLC Equipment and Associated Equipment**

- A The Contractor shall carry out further specified tests as follows in addition to any tests stated or implied by the foregoing general section of this clause. The tests shall be carried out on the fully assembled control panel containing the PLC and associated equipment in order to demonstrate correct functional operation of the hardware and software systems.
- B The Contractor shall prepare for the approval of the Engineer a detailed Functional Acceptance Test (FAT) document which shall fully detail the scope of the tests to be carried out and the tests themselves.
- C The tests shall encompass the normal modes of operation and failure modes and shall demonstrate correct functionality of the system or systems in accordance with the Functional Design Specification (FDS).
- D The PLC programme or programmes shall be tested by means of a test rig designed to input and receive digital and analogue signals. Using this test rig it shall be possible to fully simulate the operation of the controlled equipment in order to demonstrate correct functional operation of the hardware and software systems.
- E The analogue to digital conversion shall be tested by means of a calibrated current source, digital to analogue outputs shall be tested by means of ramping the output channel and measuring the current by means of a calibrated current meter.
- F Common mode and series mode rejection on analogue inputs shall be tested by means of a calibrated signal generator producing an output voltage of 5 V minimum over the specified frequency range and a calibrated oscilloscope or ac voltmeter shall be connected to an appropriate second stage point on the analogue input channel being tested.
- G All inputs and outputs to the PLC and associated equipment shall be made through the field terminal connections of the control panel containing the PLC and associated

equipment.

- H The Contractor shall demonstrate the rejection of the control system to radio frequency interference by means of a one Watt hand held radio transmitter held one metre from the control panels. The panel doors shall be open for this test with the operational programme running. There shall be no malfunctions of the system caused by the radio transmission which shall be in the UHF frequency range.
- I Six weeks prior to these tests the Contractor shall submit for approval a test plan for the logical sequence testing of the PLC and associated equipment.

### **PS 16.19 Manufacturer's Works Acceptance Tests on Uninterruptible Power Supplies**

- A The Contractor shall carry out further specified tests as follows in addition to any tests stated or implied by the foregoing general section of this clause and the tests shall be carried out on the fully assembled unit utilising the batteries that are to be supplied with the unit.
- B The Contractor shall demonstrate the following:
  - 1 change-over from full load with mains present to full load on battery supply;
  - 2 carry out a discharge test on the system at full load and for the specified duty bridging time period;
  - 3 carry out recharge test after operation for the specified duty bridging time at full load. The UPS shall supply the full load during the recharge cycle.

## **Section 16950**

### **PS 16.20 Maintenance tools**

- A. The Contractor shall furnish tools and equipment for maintaining the pumping stations and the sewage treatment plant as listed below but not limited.  
The tools and the equipment furnished shall be internationally reputed makes, latest models, user-friendly operation, and new products.
- B. The necessary accessories shall be furnished for the tools / equipment to function properly.
- C. Tools and equipment
  - 1) Voltage detector 12 kV
 

number	: 2 sets
detecting rated voltage	: AC 1 kV to 12 kV
indication	: light and sound signals
power supply	: dry cell batteries
accessory	: carrying case
  - 2) Voltage detector 600 V
 

number	: 5 sets
detecting rated voltage	: AC 100V to 600V
indication	: light and sound signals
power supply	: dry cell batteries
accessory	: carrying case
  - 3) Portable three phase relay test set
 

number	: 3 sets
--------	----------

- |                        |   |
|------------------------|---|
| power supply           | : AC 240 V, 50 Hz   |
| ratings                | : current output 0 to 50 A<br>voltage output 0 to 750 V                                       |
| availability for relay | : current relay<br>voltage relay<br>differential relay<br>time limit relay<br>auxiliary relay |
| accessories            | : test clamps and cables  |
- 4) Portable phase angle indicator
- |              |  |
|--------------|--|
| number       | : 3 sets   |
| power supply | : AC 415 V, 50 Hz  |
| ratings      | : current 0.5 A<br>voltage 0 to 240 V<br>phase angle 0 to 360 degree |
| accessories  | : measurement leads  |
- 5) Insulation tester for 1000V / 2000M-ohm
- |                 |                                     |
|-----------------|-------------------------------------|
| number          | : 3 sets                            |
| power supply    | : dry cell batteries                |
| test voltage    | : 1000V                             |
| measuring range | : 1 to 2000 M-ohm                   |
| accessories     | : leads with clams<br>carrying case |
- 6) Digital multi-meter DC/AC/Ohm
- |                 |                                   |
|-----------------|-----------------------------------|
| number          | : 10 sets                         |
| power supply    | : dry cell batteries              |
| indication      | : digital indication on LCD       |
| measuring range | : AC 100 to 600 V                 |
| accessories     | : leads with clams, carrying case |
- 7) Digital power tester
- |                 |  |
|-----------------|--|
| number          | : 3 sets   |
| power supply    | : AC 240 V, 50 Hz  |
| measuring range |  |
| AC/DC voltage   | : 15 V to 600 V  |
| AC/DC current   | : 500 m A to 20 A  |
| Watt            | : 7.5 W to 12 k W  |
| Frequency       | : 50 Hz to 500 Hz  |
| accessories     | : power supply cable, leads with clams, earthing adapter |
- 8) Capacitance meter
- |                 |   |
|-----------------|---|
| number          | : 2 sets                                    |
| power supply    | : dry cell batteries / solar cell batteries |
| indication      | : digital indication on LCD                 |
| measuring range | : 300 pF to 1,000 $\mu$ F                   |
| accessories     | : test leads with clamps, carrying case     |
- 9) Phase rotating meter
- |               |   |
|---------------|---|
| number        | : 5 sets                                    |
| power supply  | : dry cell batteries / solar cell batteries |
| voltage range | : 100 to 600 V                              |



so that the tools / equipment can be stocked neatly. The Contractor shall submit a shop drawing showing tool arrangement in the maintenance tool cabinet to the Engineer for approval.

**END OF DIVISION 16**



## SECTION 16000 – ELECTRICAL WORKS (BUILDING SERVICES)

### PS 16.21 Lightning Protection System

#### A Lightning Protection System

The lightning protection system for the building shall comply with the recommendations of the PNGS 1022: AS 3000 and AS 1768 or British Standard Code of Practice BS 6651: 1992 “The Protection of Structures Against Lightning”.

The system shall comprise of:-

- i) Roof conductors.
- ii) Down conductors to the ground level.
- iii) Earth termination.
- iv) Bonding (to prevent side flashing).
- v) Dynasphere.

Roof conductors shall be 1” (25mm) x 1/8” (3mm) copper conductors and shall run on the roof. The conductor tapes shall be fixed at 4 ft. (1,200mm) intervals by purpose made clips.

Down conductors shall be 1” (25mm) x 1/8” (3mm) copper tape securely clamped to the air terminations and to the earth electrode at the ground level. The down conductor shall run on the outside of the building and shall be secured at 3 ft (900mm) intervals with purpose made clips. The down conductor shall be as direct and as vertical as possible.

Joints in run of all copper tapes shall be made by means of double riveted and soldered overlapping joints. A test joint shall be provided at 18” above ground level. A PVC conduit shall be used to protect the down conductor from 8 ft. downwards.

Earth electrodes shall be 5/8” (16mm) dia. “copperweld” rods driven into the ground. The down conductor shall be connected to the earth electrodes with tinned copper or brass clamps.

A concrete earth chamber complete with cover shall be used to protect each earth electrode and for future inspection and testing. Sufficient earth electrodes shall be installed such that the general earth resistance will be less than 10 ohms.

All metalwork including water pipes, gas pipes, handrails, air conditioning units, window frames, cladding, metal roofs etc. in the vicinity of the lightning protection system shall be bonded to it to avoid the danger of side flashing.

For the same reason the lightning protection system earth shall be bonded to the main electrical earth as well as any other earthing system present in the structure.

Dynasphere can be used as an alternative to air termination on each building where lightning protection is provided.

## B Testing and Commissioning

The complete installation or any part thereof shall be tested, both before and after connecting up to the requirements of the Engineer.

The Contractor shall be responsible for all electrical tests at the Site and shall be represented by a qualified Engineer during the whole of the period required for the tests. All materials and equipment supplied or erected under this Contract which fails the tests shall be replaced or rectified at once by the Contractor without cost to the Employer and the tests shall be repeated.

All tests shall be conducted in the presence of, and to the satisfaction of the Engineer. The Contractor shall supply all necessary instruments, apparatus, connections, skilled and unskilled labour required for the tests to the satisfaction of the Engineer, the cost of work shall be included in the Contract Price.

The Contractor shall make accurate records of all tests and shall furnish test certificates and a schedule of the results in an approved form. Four copies of such schedule and of each test certificate will be required.

Any circuit or section of the installation failing to reach the required standard for acceptance shall be made good by the Contractor without cost to the Employer.

The minimum of site tests to be carried out on each completed section of the electrical installation shall be as follows:-

- a) Soil resistivity tests and electrode and earthing system tests.
- b) Insulation resistance tests.
- c) Continuity tests.
- d) Tests to prove correct operation of interlocks, tripping and closing circuits, indications, etc.
- e) Vector group and phasing tests.
- f) Protective gear timing tests as may be necessary.
- g) Rotational tests on all motors.
- h) Polarity tests to verify that single pole switches are installed in the phase or live conductor to each circuit and not in the neutral conductor.
- i) A test to verify the continuity of all conductors in every wiring circuit, correct connections to terminals of all socket outlets and effective bonding to earth of each terminal and socket.
- j) Insulation resistance tests to earth and between conductors before and after fitting of lamps.
- k) Insulation resistance tests on any electrical apparatus supplied and/or erected under this or other Contract before and after connecting such apparatus to the supply.

- l) Earth continuity tests for each final sub-circuit and the completed installation.
- m) Any other test required by the supply authority before giving supply. Contractor will arrange for and pay for the tests by the supply authority.

## PS 16.22 Site Lighting Columns

### A General

For all structural lighting columns comply with PNG structural requirements and proper engineering practise.

Unless otherwise specified, all columns and brackets shall be tapered octagonal or tapered round type as specified, made up of hot dip galvanised interchangeable sections to comply in all respects to the drawings, Bill of Quantities and Notes. They shall be manufactured to comply with the latest edition of PNGS 1022, AS 3000: 1991 or B.S. 5649: Part 1 of Part 8. The base plate (for planted type columns), brackets arms and spigots shall be manufactured as separate units suitable for mounting or fixing into the columns.

### B Design Loading

The columns shall be designed to withstand loading comprising of:

- a) Loads of wind speed up to 35m/sec.
- b) The loads due to the weight of the column and accessories, lighting luminaries and associated control gear, the bracket arms and spigots.
- c) Other applied loads.

### C Fabrication

Each column section shall be mechanically formed and longitudinally welded by continuous automatic gas shielded electric arc process (M.I.G. Process) or continuous automatic electric resistance welding, to PNGS 1022, AS 3000: 1991 or B.S. 5135 : 1984. The sections shall be constructed so as to overlap each other by a minimum of 1.5 times the diameter of the immediate lower section (external across face dimension) and to be easily assembled on site by using simple tools without employing welding. The manufacturer shall provide a mark on the finished column sections indicating the minimum overlapping position of 1.5 times the external across-face dimension.

### D Material

The column and accessories shall be fabricated from the following materials:

COMPONENT	MATERIAL
Column and Door	Steel to BS EN 10025 Grade Fe 510C or BS EN 10025 Fe 430C or BS 1387 : 1985 or JIS G3452 : 1978 as per calculation.
Bracket Arm and Spigot	Steel to BS EN 10025 Fe 430C or BS 1387: 1985 or JIS G3452 : 1978
Base Flange	Steel to BS EN 10025 Fe 360A
Base Plate	Steel to BS EN 10025 Fe 360A

## E Protection Against Corrosion

Individual sections of the column, base-plate, door, spigots and brackets arms shall be protected against corrosion by hot dipped galvanising, internally and externally in accordance with B.S. 729:1971 or ASTM Standard A123. All welding work shall be done before galvanising.

The treatment prior to galvanising shall include degreasing, rinsing, pickling, further rinsing and fluxing.

The minimum average weight of the zinc coating shall be 460 gm/m<sup>2</sup> for any individual test area. The galvanised column and spigots/bracket arms shall be of prime finish and of good uniformity, i.e. free from injurious defects, such as blister, flux and uncoated spot.

The planted section of the column shall be factory-coated with bitumen using the hot dipping process conforming to AASHTO M 190.

## F Bracket

Bracket shall be suitable for horizontal mounting 60 mm diameter on a 9 m column as indicated on the Drawings and the BOQ. The vertical penetration to column shall be 110 mm and locked by means of two 10mm Allen Screios. The bracket shall be arranged so as to give a 5 degree uplift. A tubular steel spigot of appropriate dimensions of the luminaire shall be welded at the end of each bracket. Bracket shall be treated as described in Clause 8.5 before being hot-dip galvanised.

## G Doors, Door Openings and Opening for Wiring to Decorative Signs/Lights

A hinged weather-proof flush-type or overlapping door, hinged on the upper side, shall be provided complete with an anti-vandal locking device over the door opening of each column as shown in the relevant drawings. The door openings shall have internal reinforcement to compensate for the loss of stiffness of the column caused by forming the door openings.

In addition, an opening of 16 mm diameter complete with rubber plug shall be provided on the column at a height of 5.6 m above the finished ground level for wiring to decorative lighting/signs. The opening shall be located on the same side of the column as the door opening.

## H Baseboard

A piece of galvanised perforated steel baseboard shall be included in the base compartment for cable termination of the control gear assembly. The baseboard shall have suitable dimensions as indicated in the drawings and securely fixed in position inside the column.

## I Earthing Terminal

Columns shall be provided with a corrosion-resistant earthing terminal having substantial contact surface for the attachment of an earthing lead. The terminal shall be provided close to the door opening inside the columns. Where a bolt is used, it shall be at least 6 mm in diameter and 20mm in length and provided with two suitable washers and nuts, the bolts, nuts and washers made of stainless steel.

J Service Slots

For the planted type column, the service slot shall be on the same side and vertically below the service door.

For the flange mounted type of column, the cable entry shall be through the flange plate having a hole of suitable diameter as shown in the drawings and a suitable duct for cable entry shall also be provided at the concrete base.

K Flange and Anti-sink Base Plate

For the flange mounted type of column, a flange plate of substantial thickness as shown in the drawings shall be welded onto the column. As for the planted type column, a detachable anti-sink base plate shall be supplied. The anti-sink plate, bolt, and nut etc. shall be hot-dip galvanised after manufactured and treated as in clause 8.5.

L Factory Testing of the Columns

L1 A sample of all types of columns and bracket arms shall be tested at the factory of manufacture in the presence of the S.O.’s Representative. The tests shall comprise of:

- a) Dimensional and weight measurement of column and bracket.
- b) Temporary Deflection Test:

The column is to be mounted horizontally and rigidly supported for the distance equivalent to planting depth from the base, and loaded, as a cantilever at a point from the top of the column (excluding the bracket arm). The temporary deflection measured at the point of application of load shall not exceed 150mm and the load to cause 150mm deflection at the top of the column (excluding the bracket arm) shall be as follows:

Column Mounting Height (m)	6	7	8	9	10	11	12
Loading to cause 150mm deflection at top of column (excluding bracket arm) (N)	1340	1120	1230	800	700	550	480

The deflection test shall be carried out with the column placed in the two weakest positions.

- c) Galvanised Test

The column and brackets shall be subjected to the galvanising thickness test as laid down in BS 729:1971.

- d) Bitumen Test

The bitumen coating on the pole base shall be subjected to thickness test.

- e) Material Test

Steel material used for the manufacturing the poles and brackets shall be subjected to test for compliance with BS EN 10025 (Grade 43C or Grade 50C).

The supplier shall state the test method and the reference standards together with the tender. The test method and the reference standards shall be subjected to the approval of PNG Power.

f) Welding Test

The welded portions of the columns and brackets shall be subjected to the welding test as stipulated in the British Standard B.S. 5135 or equivalent Standard approved by the S.O.'s Representative.

The minimum percentage penetration for the longitudinal seam weld shall be 60%.

g) Mechanical Property Test

A small piece of steel plate of adequate size shall be cut off from the base of the sample pole of this test.

The tensile strength and yield of the sheet metal shall be measured. The test results shall comply with the limits specified in BS EN 10025 for Grade 510C and 430C steel as follows:

	Fe 510C	Fe 430C
Tensile Strength (N/mm <sup>2</sup> )	490 to 640	430 to 580
Yield Strength (Min. N/mm <sup>2</sup> )	355	275

L2 A verified Test Report for the above shall be submitted by the manufacturer.

L3 All expenses incurred for the tests shall be borne by the Electrical Contractor and shall be deemed to have been included in the Contract Price.

M Terminal Block

The terminal block shall be of a type manufactured for use in road lighting installation. They shall have facilities for double fusing loop-in loop-out terminals. The cut-out bases shall have a supply cable contact block rating of at least 50A and shall be capable of accepting circular cable cores up to 25mm<sup>2</sup> copper 2 core or 4 core as required. The cut-out shall be provided with adequate shrouding to prevent across phasing with live metal.

N Cable Terminations and Internal Wiring

All cables terminated into the terminal blocks in the columns shall be provided with compression cable lug termination. The cable lug shall be of gunmetal or brass type.

An appropriate type of earthing clamp shall be provided to bond the armouring of the cables which will be effectively earthed.

Heat shrinkable sleeves must be used for all cable termination.

O Erection of Columns

Columns shall be installed in accordance with the manufacturer's recommendation and as per drawings. The contractor shall peg out the positions of the columns for the approval of the Engineer's before planting the columns.

The columns shall be erected such that the service doors shall face the opposite side to the oncoming traffic except at parapets of bridges and retaining walls. At such locations the orientation of the service doors shall be determined by the Engineer's. After erecting the column, the backfill shall be compacted by means of a suitable ramming equipment and the uprightness of the columns shall be verified with the use of a plumb line or equivalent device.

**PS 16.23 Site Lighting Luminaries**

A General

The luminaire shall be complete with integral control gears as a unit and shall be designed for both side entry and post top mounting and suitable for use with 100W/150W/250W/400W High Pressure Sodium Vapour (HPSV or SON) Tubular Lamp and on a supply voltage of 240 Volt., +5%, -10% 50 Hz.

B Conformity With Standards

The luminaire and its associated electrical components shall comply with and be tested to the following IEC Standards together with all current amendments.

ITEM	STANDARD
Luminaire	IEC 60598 Parts 1 & 2
Lamp	IEC 60662
Lampholder	IEC 60598 Part 1
Ballast	IEC 60922 & IEC 60923
Ignitor	IEC 60926 & IEC 60927
Capacitor	IEC 61048/61049
Others	Relevant IEC Standards

C Luminaire Construction

- a) The luminaire shall be so designed and constructed that it is capable of providing the service for which it is intended. Sound engineering principles shall be adopted throughout and the luminaire shall be designed to enable ease of maintenance and replacement of lamp, control gear, reflector and lamp holder without the use of special tools.
- b) The main supporting structure of the luminaire shall be constructed from die-cast aluminium alloy material such that no undue deterioration in its safety, performance or appearance during normal life when operating in all climatic conditions prevailing in a tropical country such as heavy rains, high winds, high humidity and hot day-time temperatures. It shall be robustly constructed to withstand vibration in normal use.
- c) The luminaire shall be designed so that condensation shall not fall on any operating part which may fail or deteriorate as a result.

- d) All luminaire shall be new, totally enclosed and protected against contact with live or moving parts inside the enclosure. The following Index of protection (IP) are required:-

IP 55 or higher for the optical compartment of the luminaries.  
IP 43 or higher for the main luminaire housing and control gear compartment.

Full details of the IP system can be referred to in IEC 60529 : 1989.

- e) Access to the interior of the luminaire shall be from the top or bottom.
- f) Material used for the construction of the luminaire shall be recyclable. Glass/Fibre glass reinforced polyester (GRP/FRP) material is not acceptable.
- g) Hinges and clips of the top housing cover if used, shall be robust and made of stainless steel and simple to operate and shall not be liable to accidental detachment during installation of maintenance.
- h) The top cover or luminaire canopy giving access to the interior of the luminaire shall in the closed position, be firmly attached to the fixed position of the luminaire. In the open position, it shall be attached in such a way that there is no likelihood of it becoming accidentally detached and thereby damaging any part of the luminaire or the bracket or the column.
- i) Attachment of the luminaire to its bracket arm shall be by means of clamps or jam bolts and designed to accommodate spigot sizes as shown in the table. A minimum of two (2) locking bolts/jam screws shall be provided.
- j) The minimum depth of penetration of the bracket arm shall be as shown in the table. The mounting arrangement and attachment of the luminaire shall be such as to withstand a wind speed of 150 km per hour on the projected surface of the assembly without due deflection.

Rating of Lamp	Diameter of Bracket (mm)	Diameter of Side Entry (mm)	Min. Depth of Penetration (mm)
100 watt	50	40 – 60	100
150 watt	50	40 – 60	100
250 watt	50	40 – 60	100
400 watt	50	40 – 60	100

- k) All parts which carry the weight of the luminaire and internal accessories shall be provided with suitable locking devices to prevent the dislodgement of any part of the luminaire by vibration either in service or during maintenance.

#### D The Optical System

- a) The design of the optical system shall incorporate a one piece full bowl reflector and shall be replaceable as a unit, independent of the canopy. The reflector shall be made of pure aluminium with a minimum thickness of 1mm, be electrically brightened, anodised and chemically treated to give high reflectance.



- b) The optical compartment shall be tested and certified to IP 55 or higher.
- c) The luminaire shall incorporate provisions to enable adjustments to shift the main light distribution towards the axis of the road to suit different road widths. Such adjustments shall be simple and positive and shall be firmly retained in clearly identified positions. Photometric data shall be supplied for all the possible adjustments. These data may be supplied in computer diskettes together with software in the CIE format.
- d) The bowl shall be designed and constructed such that when in the closed position, it will be firmly held. The bowl shall be easily detached from the canopy without having to use any tool and at the same time will not be detached when in the opened position during maintenance.
- e) The bowl shall be made of glass or acrylic material. Where acrylic material is used, it shall be stabilised against deformation, deterioration or discoloration due to the lamp and/or solar radiation.
- f) The bowl shall be clear or prismatic. In the case of prismatic bowls, the fluted surface shall form the inner surface to facilitate cleaning.
- g) The gasket shall be a one piece tropicalised weather resistant type made of suitable soft resilient material that will not cause crazing of the bowl.

E Lamp

- a) The lamp to be accommodated in the luminaire shall be 100/150/250/400 watt tubular clear type High Pressure Sodium Vapour (HPSV) lamp.
- b) The lamp shall comply with the requirements of IEC 60662 together with all current amendments.
- c) The minimum lumen output specifications of the lam shall be as follows:

Lamp (Watt)	Lamp Cap Type	Colour Corrected Temperature C.C.T	Lumen Output (Lm)		Initial Luminous Efficacy Lumen per Watt
			Initial, at 100 hrs.	After 2000 hrs	
100	E 40	2000K – 2100K	9500	9200	100
150	E 40	2000K – 2100K	14500	13500	90
250	E 40	2000K – 2100K	28000	26500	100
400	E 40	2000K – 2100K	48000	46000	112

- d) The lamp shall not take longer than 4 minutes after the initial ‘switch on’ to attain 80% of its guaranteed lumen output at the rated voltage 240 Volts, +5%, -10% and frequency 50 Hertz. The re-ignition period after an interruption of the supply shall not be longer than 1 minute to attain 80% of its lumen output.
- e) The average luminous flux of the lamp shall not depreciate more than 10% of initial value after 10,000 switched operating hours.
- f) The average mortality rate for the 100/150/250/400 watt HPSV lamp shall not be greater than 100% at 12,000 switched operating hours.

## F Lampholder And Associated Supports And Brackets

- a) The lampholder shall be made of non-metallic, heat resistant material and be rigidly fixed onto the optical compartment.
- b) The lampholder shall be an E40 type for the 100/150/250/400 watt HPSV lamp. The lampholder shall be complete with an appropriate brake system to prevent loosening of the lamp.
- c) The lampholder together with its supports and brackets shall withstand normal usage throughout the life of the luminaire.
- d) A lamp fully inserted shall be rigidly held with its axis substantially coincident with that of the lampholder under the normal conditions of wind, vibration and mechanical shock.
- e) The E40 lampholder shall be rated for 4.5kV pulse.

## G Electrical Control Gear

### G1 General

- a) The luminaire shall be furnished complete with integral electrical control gear comprising of inductive ballast, capacitors and ignitor.
- b) The electrical control gear shall be mounted on a suitable module unit and shall be easily removable and replaceable as a unit without the use of any special tools.
- c) Electrical connection and disconnection of the electrical control gear unit from the luminaire shall be through a plug and socket type connection/terminal block such that incoming supply cables need not be removed when removing the electrical control gear module.

### G2 Ballast

- a) The ballast shall be solidly filled with polyester compound and enclosed in a sheet steel or die cast aluminium container or vacuum impregnated with polyester resin of not less than thermal class 'H' (180 °C in accordance with IEC 60085 : 1984).
- b) The ballast shall be reactor type and comply fully with IEC 60922 – “Ballast for Discharge Lamps : General and Safety Requirements” and IEC 60923 – “Ballast for discharge lamps (excluding tubular fluorescent lamps) – Performance Requirements”.
- c) The rated voltage of the ballast shall be 240 Volt, 50 Hz (Nominal) and shall be suitable for operation on a 240 Volt, +5%, -10%, 50 Hz supply system. All terminals shall be of screw connector type.
- d) The lamp current crest factor of the ballast shall not exceed 1.8 for  $\pm 6\%$  voltage variations. At normal operating temperature, the maximum ballast losses, as per IEC 60923 shall not exceed 16 watt for the 100 Watt HPSV lamp, 18 watt for the 150 Watt HPSV lamp, 27 watt for the 250 Watt HPSV lamp and 39 watt for the 400 Watt HPSV lamp.

### G3. Ignitor Or Starter

- a) The ignitor shall be solid state, fully electronic, non-timed, superimposed multiple-pulse type which does not require the use of tapped ballast to ignite the HPSV lamp.
- b) The ignitor shall be fully encapsulated and totally sealed against the ingress of moisture.
- c) The ignitor shall have a casing temperature rating of not less than 90°C.
- d) The case of the unit shall carry a label showing the connections and listing the operating voltage and precautions to take during its removal. The ignitor shall be mounted with nut and lock washer.
- e) The ignitor shall comply with and be tested to IEC 60926 and IEC 60927 together with all current amendments.

### G4 Capacitor

- a) The capacitors shall comply with and be tested to IEC 61048/61049: 1991.
- b) The capacitors shall have a minimum voltage rating of 250 Volt and a casing temperature rating not less than 85°C and shall be of sufficient capacity to raise the power factor of the circuit to not less than 0.85 lagging. The capacitors shall be housed in extruded aluminium or thermoplastic canisters and mounted with nut and lock washer.
- c) Capacitors shall not be fused but incorporate a safety discharge resistor.

### H Internal Wiring, Terminal Block And Earthing Terminal

#### H1 Internal Wiring

- a) The luminaire shall be completely pre-wired, requiring only the connection of the electrical power supply cables to the terminal and the earth continuity conductor to the earthing terminal.
- b) The control gear looping cables shall be non-hygroscopic heat resistant copper-core flexible cable, with a temperature rating of not less than 105 °C and marked on the insulation and securely clipped. The minimum size of the cable shall not be less than 1 sq. mm.
- c) PTFE insulation or the equivalent, rated to a minimum of 250°C shall be used for leads to the lampholder.

#### H2 Terminal Block

- a) A readily accessible barriered terminal block with the 'live' and 'neutral' connections clearly and indelibly marked for the connection of incoming supply cables shall be provided as close as possible to the point of entry of the supply cables. The terminal block shall be made of non-inflammable material.

- b) A means of clamping the electrical supply cables shall be provided in the luminaire to relieve the termination's of strain where they are connected to the terminals. The cable clamp arrangement shall not damage the insulation of the cables.

### H3 Earthing Terminal

- a) A separate terminal for the connection of an earth continuity conductor, clearly and indelibly marked shall be provided.
- b) All exposed metal parts and other parts accessible when the luminaire is opened for maintenance and liable to become live in the event of an insulation fault shall be permanently and reliably connected to this earthing terminal.

## PS 16.24 Outdoor Weather Proof Feeder Pillars

### A General

The Feeder Pillars shall be supplied completed assembled with control gear and all internal electrical and mechanical interconnections and structural parts for voltages up to and including 1000 volts A.C. It shall comply with and be tested to the requirements of B.S. 5486.

### B Fabrication

The contractor shall submit design drawings showing the plan, elevations, sections, layout and construction details of the feeder-pillar for the approval of the Engineer's prior to fabrication. The plinth, foundation work, etc. shall be included in the design drawing.

The feeder-pillar housing shall comprise of a drip canopy with sufficient overhang, rigid welded channelled steel framework as specified in the drawings and/or Bill of Quantities and/or Notes. Anti-corrosive treatment shall be applied to the pillar and it shall be painted. A non perishable resilient gasket shall be provided all around the edge of the feeder door.

On the front and rear sides of the feeder-pillar, the following sign and lettering of 90mm height shall be stencilled in red paint.

**DANGER**

**LIVE ELECTRICITY**

**415 V / 240V**

Side panels and front and back doors shall be fabricated from 12 swg sheet steel as specified in the drawings. The feeder pillar shall rest on an angle iron base where suitable holes have been prepared to accommodate foundation bolts and to secure the feeder-pillar onto the concrete foundation.

The door of the feeder pillar shall be rigidly reinforced bonded and hinged internally to the main frame to prevent unauthorised access. The feeder pillar shall be of lockable type as approved by the Engineer's. The feeder-pillar shall be self-ventilated and weatherproof, and such ventilation openings shall be protected by wire mesh to prevent the entry of vermins, rodents and birds.

A suitable size wire mesh glass window shall be provided to facilitate reading of the kWh meter.

A pocket of suitable size for housing A4 size documents shall be fitted onto the inside of feeder-pillar as specified in the drawings.

The hinged door must be earthed using copper braid as shown in the drawings.

If a stainless steel feeder pillar is specified, all material including framework, panels, bolts and nuts used in the manufacture shall be totally stainless steel. The side panels and front and back doors shall be fabricated from 14 SWG stainless steel. Not additional anti-corrosion and paint treatment are required unless otherwise stated.

#### C Factory Inspection

The contractor shall make arrangements for a joint inspection and to witness the electrical test at the factory prior to transportation to the site. All costs incurred shall be deemed to be included in the tender price. Test certificates shall be issued upon completion of all tests.

#### D Foundation

The site for the foundation of the feeder-pillar shall be excavated and filled where required, compacted and levelled before the reinforced concrete base is constructed to a minimum of 300 mm (or otherwise specified) above the finished ground level and 700mm. below the finished ground level. Cable entry ducts shall also be provided as specified in the drawings.

#### E Earthing

The earthing system for the feeder-pillar shall comply with the requirements of BS 7671:1992 (formerly known as the IEE Wiring Regulations), PNGS 1022, AS 3000: 1991, PNG POWER requirements and in accordance with the drawings.

Each feeder-pillar shall be effectively earthed by using 25mm diameter copper jacketed steel core rods 25mm x 3mm copper tape and heavy duty inspection chamber with removable cover, etc.

#### F Switching Circuit

The time switch supplied for the control of the luminaries etc, shall be of the synchronous/step motor wound handset dial, plug-in type. It shall incorporate a 24 hours spring reserve. The time switch shall be suitably rated and operational on 240V, 50 Hz supply.

#### G Contactors

The contactor supplied shall comply to PNGS 1022, AS 3000: 1991 or B.S. 5424 : Part 1 with uninterrupted ratings, mechanical duty class 2 and utilisation category of minimum AC3. The contactor coils shall be fully tropicalised and wound for continuous operation for 240/415 V, 50 Hz supply. The contacts of the contactor shall be rated for the breaking capacity on the connected load.

#### H By-pass Switch and Selector Switch

A single and three phase by-pass switch as applicable shall be connected in parallel with the contactor for use in the event of the failure of the contactor. This by-pass switch shall be manufactured to B.S. 5419 and shall be capable of breaking the load connected without undue wear or damage. A four position selector switch shall be provided to select the mode of operation and shall be appropriately labelled.

#### I Miniature Circuit Breakers

Unless otherwise indicated in the Drawings and/or Bill of Quantities, miniature circuit breakers (MCBs) shall have breaking capacity not less than 6 kA (rms) and of B-type with Class 3 energy limiting characteristics. They shall comply with IEC 60898, fully tropicalised and suitable for use on a 240/415V, 50 Hz a.c system and in an ambient temperature of 40°C.

They shall be quick-make, quick-break and trip free type complete with de-ion arc interrupters. The tripping elements shall be of thermal magnetic type with inverse time delay overcurrent and instantaneous short circuit characteristics. The response to overload shall be independent of variations on ambient temperature.

They shall be manually operated by means of toggle type handle having visual indication of whether the breaker is opened, closed or tripped. Multiple breakers shall be provided with a common trip mechanism for simultaneous operation of all the poles.

#### J Termination

All cables terminated into the various components including incoming and outgoing cables must be terminated through compression glands and heat shrinkable sleeves.

### **PS 16.25 Low Voltage Underground Cables**

#### A General

The Contractor shall submit, for the approval of the Engineer, a program of work for the excavation of cable trenches, laying of cables, reinstatement of trenches, etc., one (1) week before the work is to be executed.

#### B Types of Cables

##### Power Cables

Power cables shall be manufactured and tested in accordance with:-

- a) M.S. 274 or B.S. 6346 or PNGS 1022, AS 3000: 1991 and shall have high conductivity plain copper stranded conductors, insulated with PVC suitable for a voltage of between 600 and 1000 V, laid together and bedded with PVC, armoured with galvanised steel wires and sheathed with PVC; or
- b) B.S. 6480 Part 1 or PNGS 1022, AS 3000: 1991 and shall have high conductivity plain copper stranded conductors, insulated with strong long-fibred paper, uniform in texture, free from metallic particles, mass impregnated with non-draining

insulating oil compound suitable for a voltage of between 600 and 1000 V, lead alloy sheathed and served; or

- c) B.S. 6480 Part 1 or PNGS 1022, AS 3000: 1991 and shall have high conductivity plain copper stranded conductors, insulated with strong long-fibred paper, uniform in texture, free from metallic particles, mass impregnated with non-draining insulating oil compound suitable for a voltage of between 600 and 1000 V, lead alloy sheathed, double steel tape armoured and served.

#### C Earthing Conductors

Cables from street-lighting cut-outs and earthing cables to luminaries shall be 2.5 sq. mm PVC/PVC cables bundled together with cables ties and terminated with lugs where necessary.

#### D Lengths of Cables

The lengths of each type of cable indicated on the Drawings and/or in the BOQ are for tendering purposes only. The Contractor shall ascertain the length of each cable required before placing orders for cables. The actual length of each cable installed shall be measured on site and the Contractor shall be paid according to the rate specified in the Contract. The rates quoted shall include any wastage due to cutting to lengths, terminations, etc.

#### E Cable Routes

Cable routes shown on the Drawings are for tendering purposes only. The Contractor shall, after consulting the Engineer, peg out cables routes for the Engineer's approval prior to excavation of the cable trenches.

#### F Cable Trenches

Unless otherwise specified, cable trenches shall be 750 mm deep. They shall be of sufficient width as to enable provision of adequate spacing between cables but in any case shall not be less than 450 mm wide.

Trenches shall be as straight as possible and shall have vertical sides which shall be timbered where necessary so as to avoid subsidence damage. The bottoms of trenches shall be firm and of smooth contour and any objects likely to damage the cable sheathing shall be removed. Material excavated from trenches shall be placed or removed so as to prevent nuisance or damage to adjacent areas or buildings.

Trench excavation and backfilling shall be so executed that all roads, walls, sewers, drains, pipes, cables, structures, etc., shall be reasonably secured against risk of subsidence damage. Provision shall be made during excavation and until interim restoration has been completed for reasonable access of persons and vehicles to the areas of buildings adjacent to the trenches.

Where a trench passes from a footway to a roadway or at other positions where a change in level is necessary, the bottom of the trench shall rise and/or fall gradually.

The Contractor shall provide pumps and other appliances for the necessary pumping required for the disposal of water so as to prevent any risk of the cables and other

materials to be laid in the trench from being detrimentally affected. Where necessary, bailing shall be provided.



## G Cable Ducts

At road crossing, sewerage pipe crossings, water pipe crossings, paved areas, concrete areas and where specified by the Engineer, cables shall be protected by galvanised steel pipes buried to a depth of 900 mm below finished ground level. The pipes shall be heavy duty pipes complying with B.S. 1387, complete with screwed and socketed joints. Unless otherwise specified, the pipes shall be 150 mm in diameter.

Where it is necessary to cross drains, culverts or similar obstructions which are too deep for the cables to be buried below, galvanised steel pipes as specified above shall be provided. The pipes shall be supported at each end in a concrete block and shall project through the blocks into the ground to a depth of at least 750mm.

All ducts shall be extended at least 600mm beyond paved areas, concrete areas, drains, road crossings, pipe crossings, etc.

Cables entering the buildings shall be protected by pitch fibre ducts of 150mm diameter complying with B.S. 4108, complete with bend pieces, buried to a depth of 900 mm and encased in 75mm of concrete all round. The ducts shall be installed with a gradient so as to drain away any water in the ducts. All ducts passing through walls shall be effectively sealed and made water-tight.

Unless otherwise approved by the Engineer, the number of cables installed in each duct shall be such that the space factor shall be not less than 60%. A drawn wire shall be provided for each duct.

Unless specified to be provided by others, the above galvanised steel pipes and/or pitch fibre ducts shall be provided by the Contractor whether or not they are shown on the Drawings.

## H Cable Termination

Unless otherwise permitted, all cable termination and jointing works shall be carried out in the presence of the Engineer. A plastic laminated plate engraved with details such as size of cable, number of cores, date of commissioning, date of jointing, length of cable, distance of cable joint, etc., shall be securely fixed near the termination.

## I Termination of PVC Insulated Armoured Cables

PVC/SWA/PVC cables shall be provided with compression cable gland termination. The cable gland shall be of gunmetal or brass and shall grip both the inner and outer PVC sheath of the cable. It shall be so designed that any strain on the cable is taken by the steel wire armouring which shall be effectively sealed between the gland itself and the outer cable sheath.

### Termination of Paper Insulated Cables

PILCDS and PILCDSTAS paper insulated cables, unless otherwise specified, shall be terminated by the heat shrinkable method.

The cables shall be tested for moisture before termination is commenced. Samples of paper both from the layers nearest to and furthers from the conductor shall be immersed in transformer oil or paraffin wax heated to a temperature of approximately 115°C. If any

residual moisture is present, this will be detected immediately through the presence of bubbles. Samples of paper shall be tested singly and shall not be touched by hand, but shall be gripped with a pair of tweezers.

Phasing and insulation resistance tests shall be taken on each length of cable laid before termination is commenced.

The heat shrinkable termination materials used shall be supplied in a complete kit to suit various sizes of cable and to provide stress controlled, non-tracking, environmentally sealed termination. They shall consist of high permittivity, high resistivity, heat shrinkable, stress controlled, UV stable, non-tracking polymeric materials and heat-activated sealants to prevent ingress of moisture and contamination.

Terminations shall meet the performance tests of IEC 112, IEC 446 and IEC 507, Section 3. They shall also have the following performance characteristics:-

- |    |  |   |                            |
|----|--|---|----------------------------|
| a) | A.C. Voltage withstand<br>for 15 minutes, 50 Hz                                  | : | 4.0 kV phase to earth      |
| b) | A.C. Voltage withstand<br>for 4 hours, 50 Hz                                     | : | 4.0 kV phase to earth      |
| c) | Impulse Voltage withstand<br>10 positive and 10 negative,<br>1.2/50 microseconds | : | 8.0 kV peak phase to earth |
| d) | Continuous A.C. Voltage  | : | 1.5 kV phase to earth      |
| e) | Insulation Resistance Between<br>Phase Conductor and Ground                      | : | > 1000 Megaohms            |

## K Cable Jointing

Jointing of cables shall be undertaken only by competent and fully experienced jointers.

Cable boxes, compounds and jointing materials used shall be of an approved type. Every cable joint shall be started and finished on the same day.

Wherever cables are to be jointed in the open during wet weather conditions, the Contractor shall take all necessary precautions to prevent moisture from getting into the cables. Where cables sheaths are to be used as earth continuity conductors, the glands shall have the necessary contact surface to provide a low resistance path under fault conditions.

Phasing and insulation resistance tests shall be taken before jointing is commenced.

Core numbers printed on papers shall be observed when jointing and, whenever possible, such numbers shall be maintained throughout the system. Core numbers '0', '1', '2' and '3' shall denote neutral, red, yellow and blue phases respectively. In the case of 2-core cables, core number '1' shall denote the phase conductor and '0' the neutral. Crossing of cores in the cable boxes shall be avoided wherever possible and connections shall be consistent with the foregoing requirements.

## L Cable Markers

Cable markers with lettering and signs as shown on the Drawings shall be provided by the Contractor at every change of direction of underground cable routes and every 15 m on straight runs. Cable markers shall be of heavy duty reinforced concrete construction and shall be approved by the Engineer.

The cable marker shall form a trapezoidal block with a 100 mm square top face and 150 mm square bottom face, and shall be 400 mm in height as shown on the Drawings. The top face shall be indented in bold lettering with the initials "L.V." and a directional sign or signs indicating the direction/directions of the cable route. The cable marker shall be buried to a depth of 300mm or any other depth as directed by the Engineer. Cable joint markers of similar construction but with the symbol "X" shall be provided and installed at every cable joint in a similar manner.

## M Cable Laying and Installation

All cables shall be handled, laid and installed according to this Specification, the latest edition of the IEE Wiring Regulations, the cable manufacturer's recommendations and ERA Reports, using proper installation equipment, all to the satisfaction of the Engineer.

All cables shall be supplied in complete lengths to suit the circuits they serve and no straight through joints shall be used. Straight through joints in the cable shall only be permitted in every exceptional circumstances such as those arising from unavoidable limitations in manufactured length. Where straight through joints or other approved joints or other approved joints are permitted by the Engineer, the cost of such joints shall be borne by the Contractor. No joints in the cable will be allowed unless approved in writing by the Engineer.

The minimum bending radius of the cables shall be in accordance with Table 52C of the latest edition of the IEE Wiring Regulations. Wherever cables are cut, the ends shall be immediately sealed in an approved manner unless it is intended to proceed with cable jointing or termination immediately.

Unless otherwise permitted by the Engineer, no cable shall be laid and/or covered up to the absence of the Engineer.

### (a) Cable Laid Direct in Ground

Before any cable is laid, the trench shall be thoroughly inspected and any debris and other sharp objects shall be removed. The bottom of the trench shall be covered with a layer of clean sand 75mm thick. The cables shall then be laid on this bedding in an orderly manner without overlapping and crossing each other. 75mm of clean sand shall cover the laid cables and shall be spread over the trench before placing the cable protective covers.

Cable protective covers shall be of clay bricks. The bricks shall be new, well burnt and in complete pieces. They shall be laid lengthwise from end to end along the entire route of the underground cable if the cable size is not more than 120 sq. mm. For cable sizes in excess of 120 sq. mm, more than one row of bricks shall be laid. Each cables shall be separately protected by these bricks and the cover shall have at least 25mm overhang on each side of the cable.

The trench shall then be backfilled with earth and shall be compact in layers of 150mm using a mechanical rammer. An orange coloured multi-strand nylon rope of minimum 6 m diameter shall be laid at a depth of 300mm along the trench to identify the cable route. At every 10 m interval, an extra 2 m of nylon rope shall be coiled and laid. The finished surface shall be left proud by 50 mm to allow for subsidence and the Contractor shall be responsible for the removal of any surplus material to a position indicated by the Engineer.

The surface of the refilled trench shall be temporarily reinstated and maintained in a thoroughly safe condition until complete consolidation of the soil has been achieved. As soon as the soil has consolidated, the trench shall be made good to its original condition, all to the satisfaction of the Engineer.

(b) Cable Installed In Precast Concrete Trenches

Methods of installation of cables in precast concrete trenches shall be in accordance with Type L, Type M, or Type N of Table 9A of the latest edition of the IEE Wiring Regulations. However, if the method is not specified, the cables shall be installed as directed by the Engineer.

Cables laid in the bottoms of trenches shall be in accordance with Method Type L of Table 9A of the latest edition of the IEE Wiring Regulations.

Cables installed on trench walls shall be in accordance with Method Type M or Type N of the latest edition of the IEE Wiring Regulations and shall be secured on a cable tray by means of saddles at suitable intervals. In the case of single core cables, whether secured individually or in a group to the cable tray, non-ferrous saddles shall be used.

Cable trays shall be fabricated from perforated hot-dipped galvanised sheets finished in an orange enamel. The minimum thickness of the sheet steel used shall be 1.5mm for cable trays with widths of up to 300mm, and 2.0mm for widths exceeding 300mm. Cable trays shall be supported at least 25mm from the trench wall by mild steel brackets at 600mm intervals. Brackets shall be anti-rust treated and painted with one coat of primer. Samples of cable trays and brackets shall be submitted to the Engineer for approval prior to installation.

To provide electrical continuity, all cable joints shall be bridged by means of tinned copper type of dimensions not less than 25mm x 3 mm. All saddles for cables on cable trays shall be installed by bolts, washers and nuts. All tees, intersection units, adaptor units, etc., shall be factory manufactured unless otherwise approved by the Engineer. Trenches inside buildings shall be filled with clean sand up to a level the cable ducts.

(c) Cable Run on Walls and Under Floor Slabs

Cable run on walls and under floor slabs shall be mounted on perforated hot-dipped galvanised sheet steel cable trays. The construction and finish of the cable trays and the method of installation of cables on cable trays shall be as described in Sub-Section 2.12 (b) above.

Cable trays shall be suspended from floor slabs by hangers or mounted on walls by brackets at 600mm intervals. The materials and finishes used for the hangers,

brackets and other suspending and supporting structures shall be the same as those described for brackets in Sub-Section 2.12 (b) above.

Where cable trays pass through floors or fire resistant walls, the surrounding holes shall be sealed to the full thickness of the floor or wall with non-hygroscopic fire-resisting material of minimum 2-hours fire rating as approved by the local supply authority (PNG Power).

#### **PS 16.26 Testing And Test Certificates**

On completion of the installation work on site and before the Certificate of Practical Completion is issued, the contractor shall at his own expense, arrangement for all necessary tests to be carried out on the installation by competent person as part of the tests required of him for the whole installation under this contract. The tests to be carried out shall be as prescribed in the Electricity Regulations 1994, B.S. 7671:1992 or PNGS 1022, AS 3000: 1991 including all amendments (formerly known as the IEE Wiring Regulations), IEC 60364 and other test deemed necessary by the Engineer.

In the event the installation fails any of these tests, the Contractor shall, at his own expense, take such measures as are necessary to remedy the defects and the installation shall not be considered as completed until it complies with the requirements of all such test.

The tests to be carried out by the Contractor shall consists of the following tests (where applicable) :-

- a) Continuity of final circuit conductors.
- b) Continuity of protective conductors including main and supplementary
- c) Insulation resistance.
- d) Insulation of site-built assemblies.
- e) Protection by electrical separation.
- f) Protection by barriers or enclosures provided during erection
- g) Insulation of non-conducting floors and walls.
- h) Polarity
- i) Earth fault loop impedance
- j) Earth electrode resistance
- k) Functional testing of all types of switches and switchgear.
- l) Alignment and uprightness of the columns and the tilting angle of the bracket arms.
- m) Luminance and illuminance readings in accordance with the computer plots.

Two sets of Supervision and Completion Certificate and Test Certificate including copies of all the test results and drawings as prescribed in the PNG Electricity Commission Regulations 1991 shall be submitted to the Engineer's within two weeks after the

completion of the testing. The aforesaid Certificates shall be properly bound in hard cover and tilted.

**PS 16.27 Service And Maintenance**

During the Defects Liability Period, the Contractor shall be responsible for the service and maintenance for the complete installation. All works shall be carried out by competent person. All labour, transport, equipment, materials, tools and parts necessary to service the installation and/or rectify the defect due to manufacturing/installation faults shall be supplied/executed at the Contractor's cost.

The service and maintenance to be performed and defects to be rectified and made good shall include but not limited to the following :-

- a) Replacing or making good all luminaries, lamps, ballasts, capacitors, ignitors, control gears, switches, socket outlets, isolators, mcb, mccb, fuses, time switches, contactors, relays, meter, etc.
- b) Replacing all consumable items that do not meet the manufacturer's guaranteed or declared life span.
- c) Straightening columns and replacing missing doors and covers.
- d) Replacing and making good all loose/damaged cable terminations, damaged cables, mechanical support linkages, earth electrode chambers and covers, etc.
- e) Making good damage to roads, building, drains, cables, pipes, concrete areas, paved areas, turfed areas, etc. which had not been properly made good arising out of his work.
- f) All other works deemed necessary by the Engineer.

All works shall be carried out as soon as the Contractor is informed by the Engineer, then advise the owner and shall be completed within a reasonable time except under emergency situation as stipulated in the Supplementary Conditions for Electrical Work. If the Contractor fails to comply with the above requirements, the Engineer reserves the right to engage a third party to carry out the work, in which case, the Contractor shall be responsible for all the expenses incurred.

**PART II**

**OCEAN OUTFALL**

## Part II Ocean Outfall

### Section 01010 Summary of Works

#### PS 1.01 General

- A. This Part II of Particular Specifications relates to the construction of ocean outfall that comprises a part of the Sewage Treatment Plant (STP) to be constructed under the POMSSUP. The ocean outfall is to discharge treated effluent from the STP into the sea.
- B. This Part II shall be read in conjunction with the Standard Specifications, except the specifications and requirements of the Standard Specifications contradicting those specified herein that shall take precedence.

#### PS1.02 Scope of the Works

- A. The Contractor shall carry out and complete the construction of the ocean outfall, including detailed design as specified herein, for which the works include, but is not limited to, the followings:
  - 1 marine survey and soil survey along the alignment of the ocean outfall
  - 2 Detailed Design of ocean outfall for a buried submarine outfall pipeline with a diffuser, 800mm nominal diameter, approximately 900 m long;
  - 3 Transplanting of corals from the 30m wide corridor for the ocean outfall to the area 50m away from the centreline prior to the commencement of excavation works ocean bed preparation and trench excavation plus pipe protection;
  - 4 protection works for the diffuser risers on the outfall;
  - 5 navigational marks and buoy for the outfall; and
  - 6 reinstatement of the spot of the “corridor” on the reef which will be excavated for crossing of the Ocean Outfall from Vabukori village to their fishery, to the state of the existing level, flatness for walking
- B. The Contractor is required to complete the detailed design and construction of an ocean outfall, partially or wholly buried in trench in the seabed with concrete and/or rock surround as shown on the Drawings utilizing special expertise and experience in such works of his own resources and/or a specialist subcontractor(s) so as to complete an ocean outfall that is well protected from damages caused by the wave force or water flow in the Papuan Lagoon to a possible maximum extent.
- C. The basic design for the ocean outfall work has been prepared on the basis of construction using the bottom pull method of installation. The Contractor shall conduct survey and investigation of the site conditions, in particular paying attention to the impact of wave flow and wave force, as well as environmental and ecological conditions of the Papuan Lagoon and surrounding areas along the alignment of the ocean outfall to Be constructed, and carry out detailed design and engineering based on the provided basic design whilst taking into full consideration of the site conditions and environmental and ecological conditions around the working places. The Contractor shall allow for these costs in his tender, and the Employer will not consider any extra costs incurred in account of any unforeseeable causes over the rates/prices quoted in his tender, except the provisional sum item on which the Contractor shall submit his quotation to agree upon the prices prior to the commencement of the works therefor in accordance with the procedures provided for in the Conditions of Contract.

#### PS 1.03 Drawings



- A The drawings for the construction of the ocean outfall given in the Tender (or Contract) Drawings show only the basic plan for the ocean outfall.
- B. Compliance with Drawings
1. All work, during its progress and upon completion shall conform to the lines, elevations and grades as shown on the Drawings.
  2. The Contractor shall complete the detailed design based on the Contract Drawings and also on the result of marine survey and soil survey for the Engineer's approval.
  3. The Contractor shall complete the proposed work in every detail as specified.
  4. Should any detail or details be omitted from the Drawings and Specifications, which are essential to its intended completeness, then it shall be the responsibility of the Contractor to design such detail or details and furnish and install them so that upon completion, the Works will be acceptable, operational and ready for use.
- C Further drawings may be issued to the Contractor by the Engineer as work progresses.
- D Interpretive Drawings
- 1 Any additional drawings which the Contractor requires to interpret the drawings for the use of his employees and/or subcontractor(s) shall be prepared by the Contractor.
  - 2 Four copies of each shall be supplied to the Engineer, if required by him.
- E The Employer accepts no responsibility for any omissions or the correctness of the representation of existing features on the Drawings.

#### PS 1.04 Local Conditions

- A These data are provided as an indication of the type of conditions in which the Contractor's plant will have to operate and particular attention should be paid to concrete curing and corrosion conditions. In the event of the Tender being awarded to the Contractor, he shall satisfy himself as to the accuracy of the information provided.
- B The site conditions shall be taken as follows:

Max. ambient temperature                      36 °C  
 Min. ambient temperature                      10 °C  
 Ambient humidity range                        60 - 80 %  
 The change in sea level to be about 0.5m during neap tides and about 1.0m during spring tides  
 Semidiurnal tides M2 and S2 to be dominant;

M2		S2		K1		O1	
g <sup>0</sup> (degree)	H.M (m)	g <sup>0</sup> (degree)	H.M (m)	g <sup>0</sup> (degree)	H.M (m)	g <sup>0</sup> (degree)	H.M (m)
279	0.49	250	0.29	194	0.28	153	0.14

Source: Admiralty Tide Tables Pacific Ocean edited by the United Kingdom 2004

#### PS 1.05 Ocean Outfall

- A At the location of the ocean outfall the seabed is irregular. There are boulder corals, rock outcrops, and boulders of rock. Patches of sand occur in among the boulders.
- B A bathymetric survey was carried out over the outfall alignment for the length of about 1000m, for 120m width. The plan and profile shown on the Drawings was based on information obtained during these surveys.

- C Approximately 240 boulder corals were confirmed within 15 metres range for both side of the alignment by the survey. All the boulder corals within the 30m range must be transplanted in the area more than 50 metres away from the centreline of the alignment.
- D There is an “underwater corridor” from Vabukori village to a fishery ahead of offshore of Pari village. Residents in Vabukori village have been using the underwater corridor at the spring tides for fishing. The contractor shall first do a survey for the headman and the residents for the detail of the underwater corridor.
- E The Ocean Outfall crosses the underwater corridor at some point about 400m to about 750m from the shore. The contractor shall reinstate the crossing point to the existing status so that the residents will be able to use the corridor after construction work.
- F In the event of the Tender being awarded to the Contractor, he shall satisfy himself as to the accuracy of the information provided.
- G As described in PS 1.02 B, the concept of the outfall design is that the pipe be mostly buried in trench to ensure its safety and stability under all weather conditions with its diffuser protected by rocks.
- H The Contractor shall first survey to confirm the location of corals for transplanting. The contractor shall prepare the transplanting plan and submit it to the Engineer for approval.
- I The contractor shall conduct soil survey for 3 points with 3 samples of 5 metres deep borehole sampling and physical testing after transplanting of all the corals
- J The contractor shall conduct detailed design and submit the design and work plan to the Engineer for approval
- K The contractor shall clear a swathe in the seabed to the levels and width as shown on the drawings. The rates for clearing shall include, but not by way of limitation, for:

## **Section 01041**

### **PS 1.06 Project Co-ordination**

The Contractor shall co-ordinate with the Port office, Ministry of Fisheries, other contractors, private and public utility organizations with regard to the execution of work, connections to the work, and delivery of materials subject to approval of the Engineer.

### **PS 1.07 Notification to Fishermen and residents in Vabukori village**

The Contractor shall deliver to each fisherman, registered with the Ministry of Fisheries, to fish in the area and residents in Vabukori village affected by the outfall construction, a written notice at least one month in advance of commencing any construction work, which will involve restrictions in, or temporary inaccessibility to, the area. The said notice shall state when operations will start and approximately when they will end, and the nature of such operations. The notices shall be printed on A4 paper with wording similar to that below, in English.

### ***NOTICE***

*To The Fishermen and Residents of Vabukori and Kila Kila area*

*Within the next few weeks, work will be started on the installation of an ocean outfall as part of the Port Moresby Sewerage System Upgrading Project. We should complete the work by .....*

*This work may cause some inconvenience but will be of permanent benefit.*

*We will appreciate your co-operation if you will be alert when fishing or sailing in the area.*

*Underwater corridor to the fishery from Vabukori village will be reinstated as it is after the construction work.*

*Please report all inconvenience to the job superintendent or call the office at the number given below.*

*This work is being performed for the Independent Public Business Corporation on behalf of the Government of Papua New Guinea by:*

*(Insert name, address and telephone number of the Contractor in this space)*

*We will endeavour to complete this work as rapidly as possible and with a minimum of inconvenience to you.*

*Signed :*

*Title :*

## **Section 01050**

### **PS 1.08 Field Datum**

The base station used for the oceanographic survey was an existing manhole located close to the Terminal Manhole for the outfall. The level of the base station is -0.600 m AMSL. The coordinates of the base station of IP-29 are: 101913.421N, 109440.055E.

## **Section 01300**

### **PS 1.09 List of Submittals**

The Contractor shall submit a list of all submittals showing the forecast date for submission of each item at the commencement of the Contract. Extension of time will not be granted because of the Contractor's failure to make timely and correctly prepared and presented submittals with allowance for checking and review periods as specified in Section 01300 of the Standard Specifications.

### **PS 1.10 Outfall Requirements**

- A In addition to the specified submittals, the following are required for the outfall:
- 1 calculations and drawings:
    - a detailed design drawings, structural calculation, BOQ, specifications of material/equipment for pipes, specials, diffuser and pull-head;
    - b existing coral distribution and transplanting plan

- c soil survey sample
- d buoyancy devices;
- e concrete mix designs
- f as-built drawings showing weld details;
- g details of pipe trench;
- h installation method;
- i pre-construction survey,
- j final survey;
- k test head.
- 2 qualifications and certificates:
  - a welders' qualifications;
  - b surveyors' experience;
  - c instrument calibration;
  - d certification of pipe mill.
- 3 details of proposed methods for pipeline construction:
  - a environmental protection provisions and monitoring programme;
  - b pipe fabrication;
  - c stockpiling of pipes and handling of pipes and materials;
  - d concrete batching;
  - e concrete curing;
  - f welding;
  - g trenching for pipelines;
  - h trenching equipment;
  - i installation of outfall;
  - j bedding, elimination of spans, backfill;
  - k survey equipment and procedure;
  - l diffuser/pull head hydrostatic test;
  - m outfall hydrostatic test.
- 4 materials for approval, samples, demonstrations:
  - a bedding and backfill materials;
  - b jointing.
- 5 reports:
  - a detailed design report
  - b coral transplanting report
  - c soil survey report
  - d pipe fabrication test results and progress;
  - e deliveries of coating materials, test results, and progress on coating and lining;
  - f delivery of pipes, etc.;
  - g concrete test results ;
  - h jointing inspected;
  - i dredging logs;
  - j pre-excavation surveys, if undertaken;
  - k post-excavation surveys;
  - l final surveys;
  - m outfall hydrostatic test results.

#### **PS 1.11 Record Documents**

- A The Contractor shall maintain one record copy of all Drawings, Specifications, Addenda, Variations, Approved Submittals, Correspondence and Transmittals at the Site in good order and readily available to the Employer, the Engineer and the Engineer's Representative.
- B In addition to the requirements of the Technical Specifications, Record Documents shall be clearly and correctly marked and the Record Specifications annotated by the Contractor to show all changes made during the construction process at the time the changed Work is

installed and the Works as executed complete with:

- 1 existing & finished levels
- 2 National Grid coordinates;
- 3 profiles of the outfall pipeline;
- 4 dimensions;
- 5 reinforcing steel details;
- 6 details of supports left in place;
- 7 locations of all structures;
- 8 invert and cover levels of all chambers;
- 9 connection details and locations;
- 10 details of pipe materials and bedding;
- 11 any other information requested by the Engineer.

- C Draft Record Documents shall be submitted to the Engineer for his approval, and then finalized in accordance with any amendments required by him. Record Document submission shall be as specified in the Specifications and shall include:
- 1 five bound sets of “As-Built “ Record Drawings on paper to A1 size;
  - 2 five bound sets of “As-Built “ Record Drawings on paper to A3 size;
  - 3 one set of first copy mylars (negatives) to A1 size; two sets of compact disks containing the record drawings and all operation and maintenance manuals in MS Word and AutoCAD, or other approved format.
  - 4 The Engineer will make available to the Contractor an electronic copy of the tender drawings and specification; two, legal copies of all the software used on compact disks, registered in the name of WMA.
- D Each drawing shall have the Contract Number & Drawing Number detailed to the approval of the Engineer. Computer files containing Auto CAD Drawings shall be maintained as seamless Drawings.
- E No final payment shall be made except for work that has been completed in accordance with the Specification and has been duly presented on the “As-Built” Record Documentation. The Contractor shall not be entitled to any extra payment or extension of time for the preparation or changes thereto of the As-Built Record Documentation.

## **Section 01450**

### **PS 1.10 Environmental Protection**

The Contractor shall include the work and cost of implementing, maintaining and enforcing environmental mitigation measures during the execution and construction of the works. The Contractor shall ensure that all work is carried out with the minimum environmental impact and shall ensure that all mitigation measures are undertaken in accordance with the Environmental Management Plan provided by the Employer.

### **PS 1.11 Environmental Protection Requirements for Off Shore Operations**

- A All activities performed by the Contractor under this Contract must be in full compliance with the terms of the Environmental Management Plan and environmental permits issued for the Project by regulatory authorities. The Contractor shall carry out the monitoring programme and mitigation measures specified herein. The monitoring programme shall commence within 28 days of the Commencement Date of the Works and shall continue until 182 days after completion of the outfall.
- B The work is to be carried out in coastal area of Port Moresby which contains sensitive

environmental features such as coral and marine fisheries which must be fully protected from adverse environmental impacts. The Contractor shall be responsible for fulfilling the terms of the Environmental Management Plans developed for the work, and all conditions of environmental permits issued for the work.

- C The work shall be carried out in accordance with the provisional mitigation given as Appendix I to this Part II of Particular Specifications.
- D The Contractor shall carry out works in such a manner as minimizing adverse impacts on the water quality, marine and benthic and fish populations during the execution of the works. He shall organise his method of works to minimise impacts on the trench excavation and backfill areas, and adjacent affected sites.
- E Approximately 240 boulder corals were confirmed within 15 metres range for both side of the alignment by the survey. All the boulder corals within the 30m range must be transplanted in the area more than 50 metres away from the centreline of the alignment.
- F New location of the corals must be decided in consideration of depth, duration of sunshine in the water and correct growth of the corals.
- G The Contractor shall monitor the growth or lives of corals through the construction and report the results to the Engineer for confirmation. The contractor shall re-transplant corals at the instruction of the Engineer.
- H The Contractor shall submit drawings showing the existing status of distribution of the corals for the range including new location of corals around the alignment, and new arrangement of all the corals after the transplant.
- I The contractor shall submit drawings showing the excavation and reinstatement of the point of crossing of the underwater corridor to the Engineer for approval.
- I All marine plant and methods of works shall be such as minimizing water pollution.
- J The Engineer may inspect the Contractor's plant to be used to ensure it is suitable to minimise impacts of works. Mechanical grabs for excavation and placement of construction materials shall be designed and maintained to avoid spillage while lifting. Barges and other plant equipment shall be properly maintained so as to avoid leakage of excavated material or material to be placed on the works.
- K The Contractor shall design and implement methods of works which:
  - 1 minimise leakage of silty matters from excavation point by using silt fence or protector;
  - 2 minimise disturbance to the seabed while trench digging and laying pipeline by using silt fence or protector;
  - 3 minimise leakage of dredged material during lifting and removal;
  - 4 ensure that spoils that have to be removed are taken to the approved areas;
  - 5 secure a level and safety reinstatement of "underwater corridor";
  - 6 prevent avoidable deterioration in water quality at the site by use of silt fence, etc. and
- L The Contractor shall present to the Engineer for approval a detailed plan of proposed work methods and environmental mitigation measures which describe how he proposes to carry out off-shore construction operations and the environmental protection measures and monitoring programme to be employed. The plan shall include such details as relevant

times and tides, measures which will minimise disruption to other vessels, impacts on corals and marine/estuarine life, procedures to be adopted for securing barges or other vessels, equipment to be used, management of trenching, material placement, and pipe installation.

- M The Contractor shall not be permitted to excavate, dredge or otherwise alter the sea bottom to allow vessel access into shallow waters.
- N Details for any proposals for deposition of materials in shallow waters to provide working platforms, etc., must be submitted to the Engineer for comprehensive reviews by the Employer and other government agencies for environmental impact reviews. Permission for deposition of such materials shall be denied if, in the opinion of the Engineer, such deposition would result in unacceptable adverse environmental impact.

## **Section 02221**

### **PS 2.01 Outfall Trench Excavation**

- A The outfall main shall be protected as shown on the Drawings.
- B Prior to excavating a trench for the installation of the outfall pipe, the Contractor shall first clear a swathe in the seabed to the levels and width as shown on the Drawings by removing all boulders, rock outcrops, sand and any other debris or materials of any kind, and for disposing of the same to an approved location.
- C The elevations of the cleared seabed surface will be ascertained by a post-clearance survey to be undertaken under the Contract by a surveyor designated by the Employer. The results of this survey will be confirmed by the Engineer to determine the final route and elevation of the outfall.
- D The Contractor shall be responsible for designs of transitions in the profile to suit the concrete thickness and stiffness and submerged weight of the pipe for construction.
- E The Contractor shall ensure that the trench and bedding are constructed and maintained in accordance with the Specification and the alignment, typical cross sections and longitudinal profiles as shown on the Drawings or as directed by the Engineer.
- F Prior to the start of the offshore trenching clearance and bedding work, the Contractor shall submit full details of his proposed methods, plant, equipment and procedures to the Engineer for approval
- G The Contractor shall submit details of his proposed excavation methods, including the proposed depths, widths, and profiles to the Engineer for approval. These details shall match the arrangements shown on the Drawings as closely as possible. The Contractor shall satisfy himself that all information provided on the Drawings is correct and that excavation of the trench to the proposed depths, widths, profiles and slopes will be in accordance with the requirements of the Contract; provided, however, that no additional payments shall be allowed over the tender price, except the provisional sum items for which the prices shall be agreed based on the Contractor's quotation prior to the commencement of the works.
- H Blasting will not be permitted.
- I The Contractor shall propose and use suitable equipment and methods for the clearing of

the seabed and excavating the trench through the materials encountered.

- J The Contractor shall keep proper records, drawings and logs to the Engineer's satisfaction, of the movement and activities of all his craft, including all operational information, together with all delays and interruptions in the operations with the causes thereof. These logs shall be available for inspection by the Engineer at all times. Copies shall be submitted to the Engineer at such intervals as the Engineer requires.
- K From time to time the Engineer may instruct, and the Contractor shall carry out, monitoring and recording of the major items of the offshore excavation process. The Contractor shall provide the necessary instrumentation, sensors, calibration, data storage and displays and shall ensure the proper operation thereof.
- L Excavation and trenching equipment
- 1 The excavation and trenching equipment provided by the Contractor shall be of sufficient capacity to meet the requirements of the quantity of material to be trenched and removed and the overall completion date for the Works. The equipment provided shall be subject to the approval of the Engineer. Approval shall not relieve the Contractor of his responsibilities under the Contract.
  - 2 The Contractor shall supply and maintain a reliable positioning system on board the excavation/trenching barge(s). The Contractor shall also set up GPS equipment or an alternative proven system to align the trenching barge(s) along the submarine pipeline route.
- M Pipe alignment and profile
- 1 The horizontal alignments of the outfall are defined in the Drawings but may be modified, with the approval of the Engineer.
  - 2 The vertical alignment of the outfall shall be such that the installed outfall pipe shall everywhere fall towards the diffuser. The minimum gradient shall be 3 in 1000.
  - 3 The elevation of the bottom of the trench at any point shall be no higher than the design profile less the design bedding thickness at that point, and shall be subject to the negative tolerance of 300mm locally and 100mm averaged over any 100m length.
  - 4 The elevation of the top of the bedding shall be not more than 100 mm above the profile shown in the approved drawings and shall be subject to a negative tolerance of 200 mm locally and 100 mm averaged over any 100 m lengths. High ridges or spots extending above the design level shall be removed. The bedding shall be sensibly level across its width.
  - 5 The minimum widths of the bedding for the pipeline and diffuser shall be as indicated on the Drawings according to the configuration of sinker of the HDPE pipes. The maximum bedding width is not prescribed, but the Contractor shall be responsible for fully backfilling all sections of trench, whatever its width, in accordance with the Specification and Drawings.
  - 6 The horizontal and vertical alignments and the minimum width of the bedding and trench define the minimum core of the clear corridor required for the pulling operation. Bedding shall be placed wider and trench shall be cut wider and deeper if necessary to ensure that this corridor is achieved.
  - 7 The Contractor shall be responsible for the choice of trench side slopes to achieve stability of the slopes and to suit the proposed trenching equipment. In loose materials, the side slopes shall be cut in such a way that the trench shall be stable under the conditions that prevail at the Site. Slopes and methods of slope stabilisation shall be clearly indicated in the detailed design drawings produced by the Contractor and shall be subject to approval by the Engineer.
  - 8 If the trench is excavated to a greater depth or width than required, or on an unacceptable alignment, then the Contractor shall backfill such areas to ensure that the finished work complies with the required dimensions and location, unless the



Engineer agrees otherwise. The Contractor shall bear the cost of over-excavation or mis-excavation of the trench as well as of the consequent backfilling required.

- 9 Once excavated to the specified requirements, the bedding and trench shall be maintained until pipe installation and backfilling and protection works are complete.

**N Disposal of excavated material**

- 1 The Contractor will be responsible for arranging for all necessary licences and permits for the disposal of the material excavated offshore to an approved dumping ground. The Contractor shall comply with any conditions attached to the licence and with any other requirements for the use of the dumping ground, and shall be responsible for transporting and dumping all excavated material in the areas allocated for his use.
- 2 The Contractor may propose alternative disposal arrangements, but shall be entirely responsible for obtaining all necessary approvals and for paying any charges in connection therewith. In the event that disposal in the vicinity of the outfall is permitted, then the following restrictions shall apply, in addition to any restrictions imposed by the Government or any other authority:
  - a The highest extremity of any dumped spoil within 200 m of the outfall shall not be more than 1.5 m above the pre-existing sea bed at that location;
  - b No spoil shall be dumped closer than 25 m to the pipe centre line;
  - c The deposition of the excavated materials shall be performed carefully using a previously approved method. The excavated materials shall be discharged gradually and carefully over the whole area in order to build up the level of the deposited material uniformly over the whole area;
  - d The Contractor shall carry out hydrographic surveys, diving and underwater video camera inspections to ensure that the excavated material is being placed uniformly over the sea bed in a satisfactory manner. Such surveys shall accurately plot the data with reference to absolute values of co-ordinates (i.e. using a GPS positioning system);
  - e No excavated material shall be placed closer than 25 m to living coral of any kind.
- 3 Any materials which are brought ashore from offshore excavations shall be disposed of off the Site to the Contractor's tip onshore.

**PS 2.02 Pipe Bedding**

- A All land-ward side pipes shall be laid in granular bedding, except where otherwise stated or where concrete surround is to be provided.
- B The fines content (passing the 63 micron sieve) shall not exceed 5 percent in any material placed underwater. No material placed underwater shall have a grading which is subject to liquefaction.
- C Samples of the various types of bedding and pipe surround materials to be used shall be submitted to the Engineer for approval before they are used. The actual materials used shall conform strictly with the approved samples, which shall be kept for reference until the completion of the Works. The Contractor shall be responsible for testing, at his own cost, to confirm that the materials comply with the specified requirements.
- D Materials shall be in accordance with the gradings specified and subject to the Engineer's approval as stated above. The specific gravity of the material shall be not less than 2.6.
- E The gravel used for sub-sea bedding shall comply with the grading limits as follows:

Sieve (mm)	Cumulative weight passing sieve as percentage of total weight	
	Min	Max
125	90	100

63	10	50
31.5	0	10

## Section 02700

### PS 2.03 Pipes

- A The outfall shall be constructed of HDPE pipe in accordance with Standard Specification and as detailed hereunder.
- B Detailed design of the outfall will be made to established codes of practice, typically BS 8010: Part 3 and Det Norske Veritas, Rules for Submarine Pipeline Systems. Detailed design will be finalised in close conjunction with the installation contractor, taking into account installation methods, soils profiles, environmental conditions and available backfill material.
- C The Contractor shall provide the following submittals:
- 1 Information related to the physical and chemical characteristics of the HDPE material proposed for the project.
  - 2 Information on the welding compound machine
  - 3 Diffuser factory drawings
- D HDPE pipes shall comply with the last editions of the following standards:
- ASTM D 1248 - Polyethylene Plastic Moulding and Expansion Specification
  - ASTM D 3350 - Polyethylene Plastic Pipes and Fittings materials Specification
  - ASTM F 714 - Polyethylene Pipe (SDR-PR) based on external diameter Specification
  - American Society of Water Works – Standard C 906
  - ASTM D 618 - Methods for Accommodation of Plastic Materials and Electrical for Tests Standard
  - ASTM D 2321 - Thermoplastic Flexible Pipe for Underground installation Standard
  - ASTM D 2657 - Polyethylene Pipe to be joined by heat and Fittings standards
  - ASTM D 2774 - Recommended Practice for Underground Installation of Thermoplastic Pressure Pipe
- E The pipe and accessories should be totally homogenous and free of visible cracks, holes, foreign material, or other hazardous defects. The pipe should as uniform as commercially possible in colour, opacity, density and other physical properties.
- F Pipes shall be manufactured according to the following:
- 1 Reference standard : ASTM F 714
  - 2 Minimum rigidity of the pipe for the outfall and diffuser pipe sections SDR 21
  - 3 Minimum rigidity of the pipe for the top port sections – SDR 17
- G The pipes and fittings should be made of high density polyethylene, of extra high molecular weight (HDPE). The pipe material will comply with the Type III, Class C, Category 5, Grade P 34, as defined by standard ASTM D1248. Material complying with the requirements of the classification of elements PE 345434C in accordance with Standard ASTM D 3350, is also adequate to manufacture piping products under this specification. The pipe and fittings will be built with resin which complies or exceeds designation PE 3408 of the Plastic Pipe Institute.
- H All bolts, nuts and other non HDPE components will be made with Monel 400.
- I The flanged adapters and the flanges must comply or exceed the criteria herein described. The flanges should have the assigned pressure to comply or exceed the pipe capacity for

high pressure to which they connect. All the materials indicated in this section should be from a manufacturer which has at least five years of experience minimum in the manufacture of articles made with HDPE material.

- J The following factory tests should be made as a quality control measure. The Engineer shall be informed a minimum of three weeks notice of any test to be made. The test results should be delivered to the Engineer.
- 1 The samples accommodation before or during the tests will be subjected to the approval of the Engineer. When arbitrage samples are required, the samples should be accommodated in line with Procedure A of ASTM D 618 Standard, at 23° C more or less 2° C and 50 percent relative moisture, at least 40 hours before the test.
  - 2 The tests should be carried out under the same temperature and moisture conditions, unless otherwise specified.
  - 3 Flatten three samples of pipe in an appropriate press until the internal diameter has been reduced to 40 percent of the original internal diameter of the pipe. The rate of the load shall be uniform at 50 mm per minute. When examined under normal light or with eyes without support, it shall not present evidence of cut, cracking, breaking or separation of the pipe walls.
  - 4 Carry out the joint tightening test according to the norm ASTM D3212 with the exception that the transference bars of the cut load and of the supports shall be replaced with 150 mm wide support blocks that can be flat or with contour to suit the external contour of the pipe.
  - 5 The flattening and joint tightening tests should not be taken as quality test control but considered to qualify the performance of the pipe as specified. The Contractor should present certified copies of the reports detailing the required results of the HDPE pipe tests.
- K The pipe mill shall be licensed and shall be subject to the approval of the Engineer on the basis of proven track record and the Engineer's inspection of the production facilities.
- L The inside diameter and wall thickness of the outfall pipe shall be no less than the minimum dimensions shown in the Drawings. The length of the pipe sections shall be the maximum which the pipe manufacturer can produce by his normal processes and which can readily be transported to Site. Shorter lengths of pipe, bends and specials shall be supplied as necessary to enable changes of grade or direction to be made.
- M The straightness of the pipes shall be such that in no place does the wall of the pipe deviate by more than 6mm from a string line drawn between the ends of the pipe - or such lesser amount as may be necessary to ensure that the lining is placed evenly. Straightness shall be checked along four lines at equal spacing around the circumference.
- N Prior to any fabrication of pipes or specials, the Contractor shall submit full details of his proposals to the Engineer for approval. This information shall include but not be limited to:
- 1 diameter, thickness and length of pipes and specials, together with relevant calculations;
  - 2 joint design, including details of pipe ends;
  - 3 proof of competence of welders;
  - 4 QA procedures and approvals.
- O All pipes shall be subjected to a hydrostatic pressure test to standard test pressure in accordance with API 5L. The test pressure shall be maintained for at least 20 seconds and shall be recorded on an automatic pressure recorder - results of which shall be sent with other records of pipe manufacture and testing to the Engineer as part of the quality certification process.

- P Each pipe and fitting shall be indelibly marked with the diameter, class and works test pressure, works test certificates, delivery notes and the like. The marks shall be painted on the inside of the pipes close to one end, or at an alternative location agreed with the Engineer.

**PS 2.04 Outfall Diffuser and Pull-head**

- A The Contractor shall be responsible for the final design, construction and structural integrity of the diffuser and pull-head for the outfall, and for the imposition of only safe working loads during the installation of the outfall.
- B The pull-head for the outfall may include a sleeve over the diffuser length. The annulus between the pull-head sleeve and the diffuser shall be filled with cement grout after installation. The Contractor shall submit to the Engineer for approval design calculations and detailed fabrication drawings of all parts of the diffuser and the pull-heads showing dimensions, welding details, material specifications and the like.
- C The pull-head for the outfall shall be designed to prevent rotation of the outfall. The pull-head shall be designed to smooth the bedding and not to dig into the bedding.
- D The Contractor shall provide all the necessary materials, equipment and personnel for the design, supply, fabrication, testing and installation of the diffuser and pull-head.
- E If a pull-head or any other temporary works are left in place they shall be protected against corrosion in the same way as the permanent works and shall be taken into account in the cathodic protection design.
- F Pull-head materials shall conform to API 5L, steel grade B, or BS 3601, steel grade 430. Flanges shall comply with the requirements of BS 4504. Material for plates, strip and structural steel sections used in the fabrication of the pull-heads shall be in accordance with BS 1501: Part 1, BS 4360 or other relevant standards.
- G Bends, tapers and tees shall comply with BS 534.
- H The dimensions of the diffuser and pull-heads shall not differ from the lengths shown on the approved fabrication drawings by more than  $\pm 2\text{mm}$ .

**PS 2.05 Buoyancy and Flooding/dewatering Systems**

- A The Contractor shall design and provide buoyancy devices and a system for flooding the outfall pipeline during the installation phases.
- B Buoyancy tanks shall be designed to provide sufficient upward force to lift the pull-head off the trench bottom so as to prevent the pull-head digging into the bottom during the pulling operation.
- C In addition, the Contractor may design and attach buoyancy devices at regular intervals along the pipelines to reduce the pulling load. The design shall be such that the lateral and vertical stability of the outfall are not adversely affected. Attachment shall be by means of multiple circumferential straps, designed to carry the full buoyancy force of each device with one strap unserviceable. Provision shall be made for removing these buoyancy devices after completion of the pulling operation.
- D All designs shall be submitted to the Engineer for approval.

**PS 2.06 Pipe Installation**

- A The Contractor shall prepare and provide for the Engineer's approval, detailed drawings and description of his proposed method of installation. The description shall include but not be limited to step-by-step procedures for all the stages of launching and installation (including methods of correcting transverse misalignment and rotation of the outfall) giving details of the equipment, friction factors, pull loads, temporary buoyancy, pipeline stresses, safety factors and the like. The Contractor shall take all necessary measurements, such as those needed to calculate the submerged weight of the pipes, to enable him to calculate pull loads.
- B The Contractor shall supply all materials, plant, equipment and personnel for the successful completion of the installation of the outfall. The Contractor shall be responsible for the design, stability and safe working loads of all temporary facilities and equipment necessary to install the outfall on the pre-excavated trench bottom without overstressing the pipeline or damaging the external or internal coatings.
- C The Contractor shall assess the environmental conditions likely to prevail at the site during installation of the outfall pipeline, having taken into account any information shown in the Drawings. Such information is not warranted by the Employer nor the Engineer and the Contractor shall make use of and interpret the same on his own responsibility.
- D The Contractor shall calculate stability of the pipe using methods set out in DNV 1981 or other method approved by the Engineer. The Contractor shall determine the limiting criteria for all environmental conditions (wind speed and direction, wave height and period, current velocity, etc.) at which various actions shall be taken. The Contractor shall submit these criteria to the Engineer for comment, together with contingency plans to ensure the stability and integrity of the pipeline setting out clearly and logically and supported by calculations the steps to be taken to determine weather forecasts; the actions to be taken - e.g. removal or flooding of buoyancy tanks, addition of sinker on the pipeline ; the time for these actions; the conditions for which the various actions would be taken; the lead time for the decisions and the responsibility chain for taking and implementing the decisions.
- D Hydrographic surveys, diving and underwater video camera inspections shall be carried out as directed by the Engineer, to ensure that the launching and installation of the outfall are performed satisfactorily and in accordance with the Specification. Any damage to the outfall pipeline during installation and backfilling shall be repaired by the Contractor in an approved manner at his own cost.
- E The Contractor shall supply and maintain a positioning and communications system to monitor all operations during the pulling of the outfall pipeline. Backup systems shall also be provided so that positioning and communication during the pulling operations are guaranteed at all times.
- F The positioning and survey system shall be such that the position of the outfall can be determined to within  $\pm 0.5\text{m}$  horizontally and  $\pm 0.1\text{m}$  vertically. The pipelines shall be within  $\pm 1\text{m}$  of the designed alignment horizontally.
- G The outfall shall be installed such that it is in no place closer than 300 mm to rock and such that the permanent bending radius at any point shall not be less than the bending radius specified, or such greater radius that may be required to limit stresses and crack widths to allowable values.

- H The following sections define the procedures that the Contractor shall follow if he proposes to install the pipelines by the bottom-pull method. If an alternative method of installation was proposed by the Contractor and approved by the Employer before the Contract was awarded, then the procedures shall be in accordance with such alternative and additional specification requirements as were approved by the Employer.
- I The Contractor shall be responsible for the design, supply and fabrication of a suitable offshore pulling arrangement that is capable of pulling the maximum likely load of the pipeline, using a pull winch of suitable capacity. The safety factor of the pull winch during operation with respect to the pulling load shall be at least 1.5. The proposed system shall have suitable instrumentation to monitor and record pulling loads, hold back forces, amount of cable paid out and other relevant data during the pulling operation.
- J All cables and each element of the pulling system shall be tested and certified for at least the maximum anticipated pull load times appropriate factors of safety.
- K The Contractor shall be solely responsible for ensuring that uncontrolled flotation of pipework does not occur during construction.
- L Detailed designs and method statements for all operations shall be submitted to the Engineer for approval.

**PS 2.07 Bedding, Surround, Rock Armour and Filter Layers**

- A Prior to the start of bedding and backfilling and embankment work, the Contractor shall submit details of his proposed methods, plant, equipment, materials and procedures to the Engineer for approval.
- B Gravel bedding and pipe surround shall be carried out using a tremie system, grab or other previously approved system. The material shall be discharged gradually and carefully and uniformly, thereby building the level upwards in a systematic manner. Bottom dump will not be permitted. Along those sections where spans occur in the outfall pipeline, the Contractor shall ensure that the spans are eliminated before the pipe is filled with water and before pipe surround is placed. The Contractor's proposed method of eliminating spans shall be to the approval of the Engineer. The tremie arrangements shall be such that the bedding does not segregate: this may be assisted by limiting the height of the free fall from the tremie discharge.
- C The Contractor shall take all necessary precautions throughout the operation, to ensure that no excessive vertical or lateral loads or both are exerted on the pipeline. Furthermore the Contractor shall take special care not to displace or damage the outfall.
- D The Contractor shall allow for hydrographic surveys, diving and underwater video camera inspections to ensure that the material is properly placed and that the specified profiles and thicknesses have been achieved.
- E The Contractor shall pay particular care to ensure that the pipe follows the profile to ensure that the pipe nose does not dig in at low points on concave curves or bear down by cantilevering at convex curves. The Contractor shall monitor and control the level and position of the pull nose at all times during each pull. Monitoring level shall be undertaken using a method approved by the Engineer to achieve the accuracy of measurement of level to within 50mm.
- F The Contractor shall keep proper records, drawings and logs to the Engineer's satisfaction, of the movement and activities of all his craft, including all operational information,

together with all delays and interruptions in the operations with the causes thereof. These logs shall be available for inspection by the Engineer at all times. Copies shall be submitted to the Engineer at such intervals as the Engineer requires.

- G From time to time the Engineer may instruct, and the Contractor shall carry out, monitoring and recording of the major items of the offshore activities. The Contractor shall provide the necessary instrumentation, sensors, calibration, data storage and displays and shall ensure the satisfactory operation thereof.

#### **PS 2.08 Backfilling Equipment**

- A The backfilling equipment provided by the Contractor shall be of sufficient capacity to meet the requirements of the quantity of materials to be backfilled and the backfilling schedule for the Works. The equipment provided shall be kept in working condition at all times until backfilling is completed and shall be subject to the approval of the Engineer, but approval by the Engineer shall not relieve the Contractor of his responsibilities under the Contract.
- B The Contractor shall supply and maintain a reliable positioning system on board the backfilling barge(s). The Contractor shall set up GPS equipment or an alternative proven system to align the backfilling barge(s) along the submarine pipeline route.

#### **PS 2.09 General Testing**

- A General

For the outfall, upon completion of the diffuser and pull-head and prior to launching, a temporary testing head shall be welded to the land-ward end of the diffuser. The pull-head and diffuser shall then be subjected to a hydrostatic test. The Contractor shall submit details of this proposed testing procedure, which shall generally follow the hydrostatic testing procedure to the Engineer for approval. Upon its completion no more alterations or other work shall be performed on the diffuser or pull-head. Any alterations shall be reason for another hydrostatic test.

On completion of the test, the diffuser shall be drained of water.

- B Stone. Bedding and protective stone (armour) testing shall be performed at the Contractor's expense by a testing laboratory selected and coordinated by the Contractor and approved by the Engineer to determine conformance with the requirements of these Specifications. Satisfactory test results will not constitute approval of all stone in the proposed quarry and will not relieve the Contractor of its responsibility to use a satisfactory source. The Owner reserves the right to sample and test, at its expense and at any time during the Work, stone materials delivered to the site. All costs involved in testing of material which are not in conformance with the Specifications shall be borne by the Contractor. Rejected materials shall be promptly removed from the site and disposed in accordance with all applicable laws and regulations, at no cost to the WMA.

The following tests shall be performed on stone materials proposed for the Work. Frequency of samples, the tests and test methods shall be as noted.

1. Specific gravity: ASTM C97, Every barge load of each material
2. Gradation: ASTM C136, Every barge load of each material
3. Abrasion: ASTM C535, Every third barge load of each material

Material may be tested, if the Contractor desires to, in the quarry or source stockpile with the frequency of testing based on volumes equivalent to those stated above, in which case the Engineer has the option to direct the Contractor to retest for gradation at the

Contractor's expense during barge loading. It is anticipated that the Engineer will retest at the job site.

### **PS 2.10 Hydrostatic Testing**

- A After the pipeline has been installed, but prior to the installation of the diffuser section, the Contractor shall provide all necessary equipment and materials and shall fill the pipe to be tested with inhibited seawater or fresh water, pig it, and hydrostatically test it. Test pressure shall be applied in stages to allow for stabilization factors such as temperature change, etc.
- B The pipeline shall be initially pressurized to full test pressure and maintained by adding water for no less than 4 hours or longer. After the absorption time has elapsed, the pressure shall be reduced to 50% of test pressure and held until the temperature of the test water has stabilized. The pressure shall then be increased to the test pressure and shall be maintained until it has stabilized. The test pressure shall then be monitored with no addition of water and with no indication of leakage for a minimum of three (3) consecutive hours. The Contractor shall evaluate any possible loss of pressure attributable to change in recorded temperature of test medium or attributable to possible free air dissolving in the water.
- C The Contractor shall provide all equipment necessary for testing, including for example, a pressure recorder, calibrated with a dead weight tester and temperature recorder. Twenty-four hour recording charts shall be provided. Equipment for measuring pressure shall have an accuracy of plus or minus 0.1%. The accuracy of temperature measuring equipment shall be 0.1 degrees centigrade.
- D Filling and pigging equipment shall include a calibrated filling system with water volume measurement, 100 mesh filter screen, positive displacement fill pump, a pipeline pig with bucket, and all necessary piping, valves, pig launchers and receivers, etc.
  - 1. Pigging and Gauging. The Contractor shall run a pig through the completed pipeline during filling. The pig shall have a 6.25 mm thick aluminium gauging plate attached with a diameter that is 6 cm lesser than the final inside diameter of the lined pipeline.
  - 2. In-Place Hydrostatic Testing of Pipeline. The entire main-barrel portion of the outfall shall be hydrostatically tested after it is in place. Hydrostatic test pressure (gage) shall be 200 KPa above the maximum external hydrostatic pressure on the pipeline at the time of testing. This testing shall be made before connecting the Diffuser section.
  - 3. Pre-Testing of Pipe Strings. Pre-assembled pipe strings and the diffusers, as might be used, for example for off-bottom towing, bottom-pulling, float-and-sink, etc., shall be hydrostatically tested to the same pressures and for the same durations as described above, before they are installed. The Contractor may decide to pig pre-assembled strings as a means of cleaning, however such pigging is not a requirement if the Contractor cleans the pipe interior by other positive means.

The Contractor shall include all details of filling, pigging and hydrostatic testing, including methods, equipment and materials in the Work Plan.

- E The test will be terminated after all the data from the test have been gathered and submitted to the Engineer and written approval has been given by the Engineer. The pressure shall then be carefully released. Upon termination the outfall shall be left filled with fresh water, with all diffuser ports and valves kept closed.



**PS 2.11 Independent Inspection – Diving**

- A The Contractor shall arrange for an Independent Diving Inspector (IDI) for diving inspection and photography if, and when, instructed by the Engineer. The IDI will work directly under the Engineer's instructions and shall report directly to the Engineer.
- B The IDI shall not replace inspections required by the Contractor in connection with works under the Contract and shall be separate from any work which the Engineer may require under Dayworks using the Contractor's divers.
- C The Engineer will instruct the Contractor with regard to the scope of the diving inspection required at each stage, for which the Bill of Quantities indicates as a Provisional-Sum Item. In accordance with the Engineer's instruction specifying the details of diving inspections, the Contractor shall submit quotations collected from at least three independent diving inspection specialist firms for review and approval by the Engineer, and employ a specialist firm approved by the Engineer as a subcontractor to carry out the instructed diving inspection with the agreed price and other terms and conditions approved by the Engineer in accordance with the procedures provided for in the Conditions of Contract.
- D The Contractor shall be responsible for the performance of all work by the employed specialist subcontractor for the diving inspections.

**PS 2.12 Miscellaneous**

- A Pipeline Marker Tape  
The land-ward section of the outfall pipe shall be marked with an acid and alkali resistant polyethylene detectable warning tape with a minimum width of 300 mm and shall consist of all accessories necessary for installation at the chambers, splicing, junctions etc. The tape shall be blue in colour and clearly marked in black lettering with "CAUTION – SEWER BELOW", in English, with a maximum repeat distance of not more than 1 m. The tape shall be placed during backfilling of the pipeline trench at a depth below finished ground level indicated on the drawings.
- B The tape shall have a minimum strength of 125 kg/sq. cm in the longitudinal direction and 105 kg/sq. cm transversely. The minimum thickness of the tape shall be not less than 0.575 mm comprising of polyethylene sealing layer of 0.1 mm, aluminium foil of 0.075 mm and base layer of polyethylene 0.4 mm. The metallic conductor(s) shall be either aluminium foil having a width of not less than 50 mm and a thickness of not less than 0.075 mm or stainless steel wires. The aluminium foil shall be not less than 99.5% pure. The foil/wires shall be totally enclosed within the polyethylene laminate such that the edges of the foil are totally protected against corrosive attack. The aluminium foil/wires shall be detectable from the ground surface using a buried cable locator. The manufacturer of the tape shall provide methods for joining and terminating the tape to enable a low resistance connection to be made to the foil/wires. Electrical connection points shall be made at each chamber on the pipeline.
- C Connections to Existing Pipelines  
The ocean outfall shall be connected to the pipeline from the wastewater treatment plant at the point of IP 29 on the contract Drawing.

**Section 03300****PS 3.01 Concrete for Outfall**

- A Unless otherwise specified all cast-in-place concrete including structural concrete, screeds, mass concrete and benching shall be Class 3 (40 MPa). All blinding shall be Class 5 (15 MPa).
- B The Contractor shall submit to the Engineer, for approval, a mix design for the concrete for use as the pipe bedding and trench backfill for the submarine pipeline, where necessary. The Contractor shall also submit a method statement for manufacturing, delivering and placing the concrete.
- C Concrete production
- 1 Workmanship shall follow the practice set out (a) in this part of the Specification, (b) in other parts of the Specification and (c) in BS 8110 - in that order of precedence.
  - 2 The Contractor shall design his mixes using the approved aggregates and he shall determine the proportions which will give the required densities and strengths. Concrete shall comply with the requirements for marine works to BS 6349.
  - 3 In calculating submerged weight the Contractor shall take account of pipeline diameter, water absorption, concrete density, seawater density and density of coating and lining, each of which shall be established, together with the likely range of variations, from tests and measurements made for this outfall.
  - 4 The proportions of the materials will be as selected by the Contractor to produce a weight-coat that will provide the requirements of submerged weight and strength required for the coated pipe.
  - 5 All mix designs shall be submitted to the Engineer for approval before the commencement of coating. All concrete mixes shall be designed to minimise drying shrinkage, and the water/cement ratio shall not exceed 0.45.
- D Batching and mixing:
- 1 The Contractor's method for batching and the equipment to be used for this purpose shall be subject to the approval of the Engineer prior to the commencement of any weight-coating operation. Any equipment that tends to separate the ingredients shall not be used.
  - 2 Continuous mixing where all feeds are accurately controlled and percentages of the mix are calibrated by weight may be permitted at the Engineer's discretion.
  - 3 The strength of the concrete shall be determined from hardened and cured concrete cube samples of the concrete mix.
  - 4 The compressive strength shall be the equivalent of a cube-crushing strength of a minimum of 22N/mm<sup>2</sup> at 7 days and minimum of 40N/mm<sup>2</sup> at 28 days.

END OF PART II OF PARTICULAR SPECIFICATIONS

## **Appendix 1 to Particular Specifications Part II**

### **Environmental Management Plan for The Ocean Outfall of POMSSUP**

#### **1 Introduction**

Joyce Bay is a tidal flat or inner lagoon. The existing Kila Kila direct sewage discharge point in Joyce Bay has been causing the highest pollution load in the coastal marine waters of Port Moresby. The outfall is short and water is stagnant due to the shallow bottom of the Bay. Significant deterioration of water quality is observed showing a high degree of contamination by high fecal coliform concentration. This area is shallow in depth; hence there is no sufficient dilution and “flushing effect” of the untreated sewage discharged onshore.

The Papuan Lagoon is an enclosed water body with depths ranging from 5 to 15m at the western part and 20 to 30m at the eastern part. The lagoon is surrounded by barrier reefs and islands. The discharge point of the marine outfall with a length of about 900m (at sea) will extend up to a depth of 26m offshore of Joyce Bay where a higher dilution rate is expected. The sea floor (beyond 890m from shoreline) is characterized by mainly silts and pockets of sand. Biotic component is not known beyond the distance from 800 to 900m (EDA RANU, UPNG 2006).

The construction activities relative to the laying of the outfall pipes will have short term impact to sea grass beds and corals. The activities will have a localized short term impact on sea grass habitats, especially the zone located from 420 to 570m from the shoreline (EDA RANU, UPNG 2006). The pipeline will pass through this seabed area that will be disturbed when the seabed will be excavated in order to level the seabed or dug trenches for pipe installation. Studies indicate that the rate of recovery and re-growth of damaged areas of sea grass beds can be within months or to a year.

The rhizome structure of the sea grasses which provides a mat of vegetation throughout the substrate and allows rapid re-colonization of cleared areas. Also, organisms lodged within the bodies of water might be disturbed and results in migration to other places with additional pollution from the construction site.

#### **2 High Levels of Turbidity**

Agitation of the sea floor where some zones are basically composed of silts and other organic matters will result in increase turbidity. High levels of suspended sediments reduces light penetration and hinders growth of organisms (refer also to impact on the Aquatic Flora and Fauna). Although right now heavy siltation/sedimentation occurs at the inner part of Joyce Bay due to organic pollution and other induced sources, the major impact will be on the coral reefs dotting the outer part of the intertidal zone.

#### **3 Coral Reef Removal**

The marine survey estimated that 240 coral boulders should be removed from the pipeline corridor and later transplanted elsewhere to save the coral lives during the construction period. This is a total area of 6,000 square metres that will be disturbed directly requiring removals from the 30m wide pipeline corridor. Table APP-1 illustrated where the coral will be removed. The zones are explained in the contract drawings for the ocean outfall.

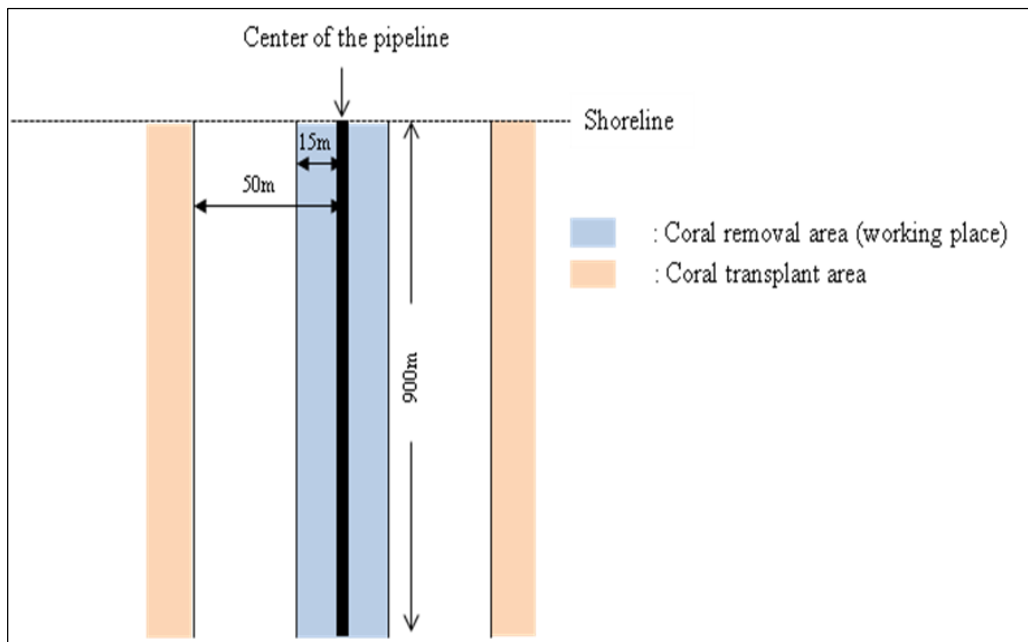
240 boulder corals from 50 to 750m from the shoreline along the 30m corridor on the proposed route of pipeline must be transplanted to nearby areas based on the result of study. The proposed route of the pipeline will pass through these coral reefs before it reaches a drop of about 30m at 720m from the shoreline thereby avoiding impact to coral communities at this point.

**Table APP-1: Estimated Coral Removal from Pipeline Corridor**

Zones covered	Coral Count	Total Boulder Corals
<b>Zones B – C</b> Approx. 6,000 sq. meters of coral area. Depths -1.11 to -1.58 m	10 coral boulders per box (10m x 10 m) x 30 along the western alignment of pipeline.	140
	5 coral boulders per box (10m x 10 m) x 30 along the eastern alignment of pipeline.	70
<b>Zones E – F</b> Coverage along the pipeline route. Depths -1.58 to - 2.78m	Coral counts along 100 m line.	30
<b>Total</b>		<b>240</b>

Source: JICA Study Team

An area of likely influence was determined to set the limits of coverage of impacts to the marine life. Any impacts are likely to be confined to the immediate vicinity of the pipeline route, about 15m on each side. Considering the size of the pipe (dia.700mm), the high precision of pipe laying and the needed work space, the area of influence would be no more than a 30m corridor.



**Figure APP-1 Area of Coral Removal and Transplant**

A topographic sea bed survey shall be undertaken by the Contractor to identify gentle terrain of the alignment of the outfall pipe in order to avoid suspended segments of the pipe and trenching/excavation. As much as possible, the path must avoid large coral reefs.

Parallel to this is a coral inventory survey and identifying the location area/s where the removed corals will be transplanted. In transplanting the corals, follow the coral transplant

plant prepared by Specialist. The Contractor must limit the working area to the designated 30m corridor to ensure that surrounding coral formations will not be disturbed.

Coral removals will be done by digging trenches for the pipeline to dislodge the boulders and lifted out for transplanting elsewhere. For the areas not trenched, this will require digging around the rock base to be dislodged and removed.

Coral transplantation will involve digging up shallow depressions at the new location. It is suggested that replanting occurs only inside the pipeline corridor so as to minimize silt plumes and deposits over a wider area.

Removing corals and transplanting will result in plumes of silt along the corridor and sedimentation. In both instances, silt fence will be necessary to reduce such impacts on the marine environment. Constant daily monitoring during construction will be necessary to ensure silt dispersals and dispositions into other areas are minimized.

#### 4 Management Measures to be Undertaken:

##### (1) Silt Fence/Protector

After the removal of corals within a width of 30m (15m for each side of the pipe) along the pipeline route, the pipe shall then be laid. However, in areas where trench dredging shall occur, excavation machine with crusher rock equipment shall be selected. The works shall be carried out for a short period so as to limit the time during which turbidity may be generated.

In order to mitigate siltation/ sedimentation to protect the coral reef from silt during the laying of pipes, silt fence or frame type Silt Protector shall be provided. This will limit the area to be influenced by silt plume. Sediments will be confined within the silt fence. The spoils may either be deposited or released into deep open sea, where they can settle harmlessly into the seabed.

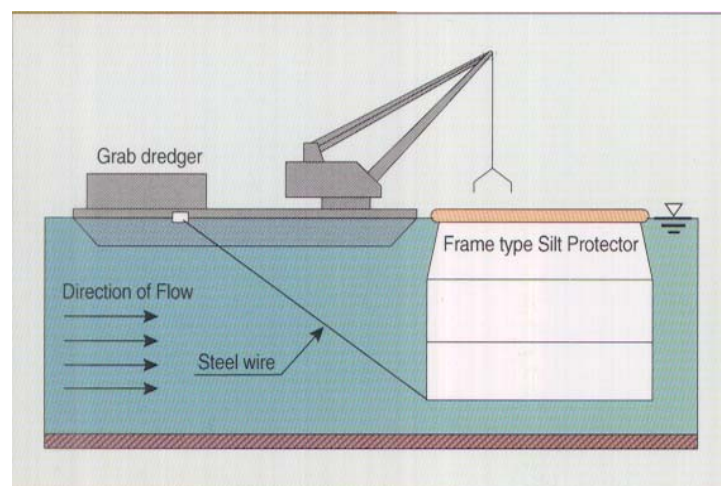


Figure APP-2 Silt Protector/Fence (Source: JICA Study Team)

##### (2) Introduction of Industrial Oil and Additives

The use of machines and equipment for the installation of marine outfall structure will also impact on the quality of seawater. Introduction of drilling fluids and additives may affect the marine water quality during the drilling/trenching works.

Drilling fluid selection shall consider water-based additives to reducing toxicity to fish, algae and zooplankton. Oil-based drilling additives should never be used.

##### (3) Construction

The Contractor shall minimize the extent of disturbance by strictly observing the boundaries of the influence area and also minimize the duration of disturbance. Laying of the pipeline along the design path as determined in the marine route survey must be followed. The Contractor shall observe best practice for operating vessels in proximity to the area of influence.

With reference to water quality – high levels of turbidity impact, the Contractor will install silt protector/frame to prevent dieback of corals and other marine organisms as shown Figure APP-1.

During the construction phase, the Contractor shall conduct ambient water quality monitoring at ocean outfall construction site. Results of the analysis will be submitted to the Engineer for control. Validation to confirm the results will be undertaken by the Client/EDA RANU as the need arises. Monitoring methods (Items, frequency, number of water sample); monitoring items, frequency, method and implementer are shown in Table 4.

**Table APP-2: Water Quality Parameters for Ocean Outfall during Construction**

Item	Unit	Frequency	Method	Implementer
Transparency/ turbidity	-	Everyday	Visible Inspection	Contractor  (self monitoring)
SS (Suspended Solid)	mg/l	Weekly	Mass Balance method, Dried 105~110 °C	Contractor  IPBC / EDA RANU
Oil/Grease	mg/l	Everyday	n-Hexane extractable material method	Contractor  IPBC / EDA RANU

(Source: JICA Study Team)

Locations of ambient water sampling points; monitoring of ambient water quality during construction shall be carried out in at least four sampling stations at the path of the ocean outfall construction sites.

#### (4) Coral Reef Monitoring

During the construction phase, transplanted coral and coral reefs along the pipe route will be monitored both by the Contractor and IPBC/EDA RANU. The parameters (Items, frequency, number of water sample); monitoring items, frequency, method and implementer are shown in Table 6.

**Table APP-3: Monitoring Parameters for Coral Reefs during Ocean Outfall Construction (Source: JICA Study Team)**

Item	Objective	Procedure	Frequency	Period	Implementer
Recovery rate of transplanted coral reef	Rate of Recovery / Success of transplant	Visual inspection	Once a month for the first three months, every three months for next nine months, thereafter every six months	Three years from transplant	Contractor/IPBC-EDA RANU
Recovery rate of corals along the pipe route	The effect of ocean outfall construction works	Visual inspection by quadrat method	Two times in a year	During construction and one year after construction	Contractor/IPBC-EDA RANU

**PART III**

**PILOT PROJECT**



## Particular Specifications Part - III

### Pilot Project

#### 1. General

##### PS 1.01 Scope of Part – III of Particular Specifications

- A. This Part – III of the Particular Specifications relates to the works for the Pilot Project (as defined hereunder) which the Contractor shall carry out and complete as part of the Works for the Port Moresby Sewerage System Upgrading Project (hereinafter referred to as the “POMSSUP” or “the Project”).
- B. This Part – III shall be read in conjunction with the Standard Specifications, and the provisions of the Standard Specifications shall be applied as appropriate, except any provisions contradicting those in this Part III of the Particular Specifications that shall take precedence.

##### PS1.02 Description of the Works

- A. The Pilot Project is to demonstrate the provision of water supply and sewerage services to a block of selected 20 houses built over the sea along the coast at Hanuababa Village. Location of the Pilot Project is shown in the Drawings, Volume IV of the Bidding Documents. The 20 houses exist on 2 jetties, each accommodating 10 houses.
- B. Scope of the works to be carried out and completed by the Contractor for the Pilot Project (hereinafter referred to as the “Pilot Project Works”), shall include, but not be limited to, the followings:
  - (1) Installation of water service pipes up to each tap such as a toilet, kitchen, bath and laundry, and installation of a water meter in each house, and installation of a bulk meter at a connection point from the existing water distribution pipeline
  - (2) Installation of a water distribution pipe connecting water service pipes in each house to the existing water distribution pipe.
  - (3) Supply and installation of flash toilet basin and wastewater collection facilities in each house.
  - (4) Installation of sewage and wastewater collection pipes, house connections in each house. A sewer collects wastewater through house connections and conveys it by gravity flow to the planned trunk sewer.
  - (5) Installation of a sewer pipe to connect the house connection installed in each house to connect the trunk sewer pipeline that will be constructed under the POMSSUP.
  - (6) Construction of adequate support facilities for the sewer pipe, house connection, water distribution pipe and water service pipe to be installed under/on the jetty under the Pilot Project.
  - (7) Installation of manholes and other associated works for connecting the sewer pipe to the trunk sewer pipeline, as well as those for connecting the water distribution pipe to the existing water distribution pipe.

##### PS1.03 Definition of Pipelines to be installed in the Pilot Project

Pipelines to be installed in the Pilot Project Works are defined as follows:

1. Sewer Pipelines (Sewer Pipes):
  - A gravity flow pipeline to be installed along each jetty to connect the house

connection to the trunk sewer pipeline to be constructed under POMSSUP (refer to Item (5) above)

2. House Connection (Sewage and Wastewater Pipes):  
Sewage and wastewater collection (gravity flow) pipes to be installed for house connection in each house (refer to Item (4) above.)
3. Water Distribution Pipelines (Water Distribution Pipes):  
A water supply pipe to be installed along each jetty to connect Water Service Pipes (defined hereunder) in each house to the existing water distribution pipeline.
4. Water Service Pipelines (Water Service Pipes):  
Water service pipes up to each tap such as a toilet, kitchen, bath and laundry in each house.

**PS1.04 Contractor's responsibility and obligation**

- A. The Contractor shall carry out, perform and complete the Pilot Project Works broadly described in PS1.02 B, including design as specified herein, in accordance with the drawings for the Pilot Project (Drawing No. PP-001 to PP-009) given in Volume IV of the Bidding Documents and this Part III of the Particular Specifications. The Contractor shall attend to any works specified in this Part – III of the Particular Specifications with applicable standards of safety commensurate with safe working practise.
- B. The Contractor shall be responsible to execute the Pilot Project Works, in satisfying and complying with all requirements set out herein, but also those set out in Division 1 [General Requirements] and Division II [Site Work] of the Standard Specifications as applicable.
- C. Any data and information on the site are provided only for information and guidance. The Employer does not guarantee accuracy and correctness of such provided site data and information. The Contractor shall be responsible to carry out investigation of the site to satisfy by himself and include any risk or contingency in his tender price. The Contractor shall not entertain any extra costs incurred in account of any unforeseeable causes over the rates/prices quoted and agreed at the tender stage.
- D. The Contractor shall confirm and shall be responsible for confirmation of all existing services on the site before commencement of construction.
- E. The Contractor shall organize a meeting with the residents targeted for the Pilot Project and landowner/administrator of the Pilot Project Area, (e.g., Motu-Koita Assembly) in presence of the representatives of the Employer and Engineer in order to brief outline of the works and seek their cooperation prior to the commencement of the construction work.
- F. Elevation of the jetties and houses for the Pilot Project Works may change since the owners or residents of these jetties and/or houses often do repair works. The Contractor shall carry out a topographic survey to confirm the levels prior to the construction/installation of level of supports, and shall adjust the design to meet the actual conditions at his responsibility and his own costs.
- G. The Contractor shall submit shop drawings, technical data and/or samples for the works or products to be furnished for the Pilot Project. For all submittals required under this Part III of the Particular Specifications, the Contractor shall follow the requirements and procedures set out in Section 01300 of the Standard Specifications, unless otherwise specified herein.

- H. Prior to the construction, the Contractor shall engage a geotechnical consultant to conduct geotechnical survey and investigation of the site for investigating the soil parameter/conditions to be used for proper design of sub-structure and footing of the pipeline support. The geotechnical investigation shall be conducted at least 2 points for one jetty. The Contractor shall design sub-structure/footings of support based on the geotechnical survey results, and submit it to the Engineer for his approval prior to the commencement of the construction; provided that the Contractor shall not entertain any extra costs over the rates/prices quoted and agreed at the tender stage.

**PS1.05 Civil Works**

- A. The Sewer Pipelines shall be fitted with suspension along each jetty. The suspended Sewer Pipeline shall be supported by RC column at 2,000 mm spacing. The Contractor shall provide a work/construction method for the support structure to the Engineer for approval prior to construction. The Contractor shall submit to Engineer for his approval the data on dynamic force such as wave force or impact by a motor boat(s) before structural calculation, and then, based on the dynamic force data approved by the Engineer, carry out the structural calculation of the Sewer Pipelines, RC column and RC foundation, and shall submit these calculation results to the Engineer for approval. In pipe support, concrete cover to reinforcing bar shall be 100 mm.
- B. For pipe bedding, connection, fire cover installation details etc., the works shall conform to the PNG Water Board/EDA RANU standards.
- C. Where piping is subjected to vehicle loading concrete encasement shall be used.
- D. All metal surface and concrete surface included in footing portion shall be painted by vinyl ester resin or equivalent, with 1 mm thickness after hardening. Tar epoxy resin should not be used. The Contractor shall submit a performance verification and painting procedure manual to the Engineer for his review, and shall carry out the painting work in accordance with the manual.
- E. All Water Service Pipes shall be connected to a kitchen, toilet, bath and laundry located within each house hence of 20 target houses for the Pilot Project as shown on Drawing PP03. Any adjustments to these connections shall be made on site for satisfaction of the relevant house owner/resident.
- F. The Sewer Pipes shall be located away from the Water Distribution Pipes to keep the drinking water safe for residents, and shall be put identification marks in order to distinguish the Sewer Pipes with the Water Distribution Pipes.
- G. At the 1<sup>st</sup> jetty, sewer length approximately 22 m shall be underwater at the time of High Tide Level (H.T.L.). The possible countermeasures are to raise the elevation of the houses, jetties and/or the height of a toilet position more than about 0.25 m from current position. The Contractor shall propose the countermeasures after topographic survey for the Engineer's approval, provided that such costs shall be included in his tender price.

**PS1.06 Installation of Flash-toilet Basin and Fitting of Water Service Pipes and House Collections**

- A. The Contractor shall remove an existing toilet basin, and furnish and install a new flash-toilet basin for use in each house. The location of the new flash-toilet basin shall be adjusted at site to the satisfaction of the house owner/resident.
- B. The flash-toilet basin to be furnished shall be a complete set of flash-type toilet in a

standard type and model commonly used in mid-class houses in PNG. The Contractor shall procure these toilet basins in the local markets in PNG with 5-years supplier's guarantee, and provide such a supplier's guarantee to the relevant house owner/resident.

- C. The Contractor shall dispose the removed old toilet basin or leave it according to the interest of the relevant house owner/resident.
- D. The Contractor shall install horizontally a water meter for domestic (15 mm diameter, i.e. vane wheel jet type water meter in accordance with ISO 4064) in each house as shown in the Drawing, for which the location shall be adjusted for maintenance and meter reading at site to the satisfaction of the relevant house owner/resident. In addition the Contractor shall install a bulk water meter as indicated in the Drawing, for which the location shall be adjusted by the Contractor to meet the actual conditions. The water meters to be installed in the houses and the bulk water meter (50 mm diameter, i.e. vane wheel jet type water meter in accordance with ISO 4064) to be installed outside the houses shall be certified by EDA RANU.
- E. A water meter case (meter body) shall be painted by vinyl ester resin or equivalent.
- F. A bulk meter shall be set in a precast concrete box with a cover.
- G. The Contractor shall use a HDPE ferrule with saddle or tee fitting (90 degree junction) for water service pipe at a tapping point of the water distribution pipe.
- H. The Water Service Pipe and Sewage and Wastewater Pipes (House Connection) shall be fitted to the installed toilet basin and existing kitchen, bath and laundry facilities to meet the satisfaction of the relevant house owner/resident. The Water Service Pipe shall be fixed by a clamp on a jetty/house at 1 - 2 m spacing.
- I. The Contractor shall disconnect an existing water service pipe from each house, and dispose the removed old water service pipe or leave it according to the interest of the relevant house owner/resident.
- J. When these works are completed, testing shall be conducted with witness of the relevant house owner/resident. The installed water meters shall be read jointly with the representative of EDA RANU, the administer of the Village and the relevant house owner/resident

## **2. Pipes and Fittings**

### **PS 2.01 Pipes and Fittings - General**

- A. All water pipes and appurtenant materials shall be suitable for carrying potable water and sewage at temperatures up to 40°C. All pipes to be buried and appurtenant materials shall be suitable for immersion in corrosive seawater and groundwater.
- B. Acceptable materials for pipes and appurtenances are as follows:
  - 1 Sewer Pipelines (Gravity Flow):
    - High Density Polyethylene (HDPE) pipe with HDPE fittings, Black HDPE pipe with carbon black  
Nominal Diameter 200 mm (Internal Diameter 150 mm) :

- a) High Density Polyethylene (HDPE) pipe with HDPE fittings in class as stated in the BOQ.
  - b) Class 20 (Nominal working head : 200 m at 20 °C), SDR9, PN20
- Polyvinyl Chloride (uPVC) pipe  
uPVC pipe with uPVC fittings in accordance with PNGS 1039 Class SH minimum shall be used for 150 mm nominal diameter.
- 2 House Connection (Gravity Flow):
- High Density Polyethylene (HDPE) pipe with HDPE fittings, Black HDPE pipe with carbon black  
Nominal Diameter 125 mm (Internal Diameter 100 mm):
    - a) HDPE pressure pipe with HDPE fittings
    - b) Class 16 (Nominal working head: 160 m at 20 °C), SDR11, PN16
- 3 Water Distribution Pipelines:
- High Density Polyethylene (HDPE) pipe with HDPE fittings, Black HDPE pipe with carbon black  
- Class 20 (Nominal working head: 200 m at 20 °C.), SDR9, PN20
- 4 Water Service Pipeline:
- a) Galvanized Steel pipe: Nominal diameter 25mm
  - b) Polyethylene pipe: Nominal diameter 32mm

C. The working pressure shall be taken as 16 bar and 20 bar for HDPE pipelines. The test pressure shall be one and half times of the working pressure.

D. Test Certificates

Each consignment of pipes, pipe specials, fittings and valves delivered to the site shall be accompanied with a witness testing and inspection certificate from a third party inspection and testing agency approved by the Engineer. The Engineer or his representative reserves the right to inspect the pipes, specials, fittings and valves to be supplied for the Pilot Project Work at the place of manufacture and to witness the manufacture and tests.

E. All pipes for the Water Distribution Pipelines and Water Service Pipelines, including their protective coatings and joint materials that may come into contact with potable water shall not constitute a toxic hazard, shall not support microbial growth, shall not cause taste or odour, cloudiness or discolouration of the water, and shall be approved by a recognized certifying authority as being suitable for use in potable water supply schemes.

F. Transportation of Pipes and Fittings

Vehicles transporting pipes shall not allow pipes to overhang. Large pipes shall be placed on cradles and loads adequately secured during transit. Pipes shall be handled in accordance with the manufacturer's recommendations.

## **PS 2.02 HDPE Pipes and Fittings for HDPE Pipelines**

- A. HDPE (High Density Polyethylene) pipe and fittings to be used for the Water Distribution Pipeline and Sewer Pipeline shall conform to ISO 4427, Pipe Grade PE 100 with SDR 9 which is rated for PN 20 at 20 °C, and HDPE pipe and fittings for the House Connections

shall conform to ISO 4427, Pipe Grade PE 100 with SDR 11 which is rated for PN 16 at 20 °C.

- B. The nominal outside diameters of the HDPE pipe and fittings shall be as follows

Internal Diameter (mm)	Nominal Outside Diameter (mm)	Class
50	63	SDR9, PN20
100	125	SDR11, PN16
150	200	SDR9, PN20

- C. All jointing for HDPE pipe and fittings shall be by fully automatic butt fusion welding, electrofusion welding, or by mechanical restrained joints.
- D. Jointing of PE pipes to metal pipes shall use special restrained transition fittings manufactured specifically for that purpose. Fabricated fittings will not be permitted. The system shall be restrained completely, except the parts where HDPE pipes are connected to unrestrained pipe systems. The restrained transition fittings shall be in accordance with PS 3.03 C. hereof
- E. Fittings and bends shall be manufactured from PE 100 polymer that is compatible to the pipe material. Pipe coils may be required for pipes at an internal diameter of 100 mm or less.
- F. Specific Requirements for PE Pipes
1. Requirements for Pipe Sizes  
PE pipes are manufactured with extruding to control outer diameter, and the pipe sizes are determined on the basis of metric system. Allowable tolerances shall accord to ISO 11922-1, and outer roundness of the pipes shall be within the values for Grade N given in Table 2 of ISO 11922-1.
  2. Performance Requirements at 20°C and 80°C  
All batches of HDPE pipes shall be subjected to a single 100 h 20 °C pressure test. In addition, one randomly selected pipe shall be tested for 165 h 80°C pressure test using notched pipe. The 100 h test is as at 12.4 MPa, the 1000 h test at 5 MPa pipe hoop stress. All pipes must pass this test. The notched pipe test requires the pipe to have four (equally spaced around the circumferences), axial notches machined into the pipe wall to a minimum depth of 19% of the pipe wall thickness. Such notches simulate abused pipes that can bear site conditions and higher ambient temperatures. The test procedures shall be in accordance with ISO 1167.
  3. Tensile Properties of PE Pipe  
Tensile samples taken from the wall of PE 100 pipes shall exhibit a minimum failure strain of at least 500%. At a crosshead speed of 50 mm/minute, the tensile strength at yield shall be greater than 23.1 MPa for PE 100 pipes. Tests shall be undertaken at 20 °C using a sample shape defined in ASTM D638, and shall be made with each production run of pipe.
  4. Offset Butt Joint Performance  
For all pipe diameters one butt fusion joint shall be prepared with the two pipe axes parallel but offset by 20% of the pipe wall thickness. Jointing shall be undertaken using the butt fusion jointing parameters recommended by the manufacturer. The welded pipe shall be tested at a pipe hoop stress of 4 MPa at 80°C, and the lifetime shall be equal to or greater than 500 hours for black pipe. This test is a type test.

- G. All fittings shall be manufactured by injection moulding. Fabricated HDPE fittings will not be permitted.

#### H. Electrofusion Fittings

1. All fittings shall be packed in such a way to allow instant use on site without additional cleaning.
2. The heating coils contained in each individual fitting and saddle shall be so designed that only one complete process cycle is necessary to fully electrofuse the fitting to the adjoining pipe or pipes. Heating coils shall not be exposed and shall be fully imbedded into the body of the fitting for protection purposes during assembly.
3. An individual data carrier card in compliance with ISO standards containing a magnetic strip and an appropriate barcode or barcodes for data transfer purposes shall be supplied with each fitting. All fittings shall have moulded-in identification and product information.
4. Process voltage of all fittings must not exceed 40 volts. Insulated contacts for the terminal pins shall be provided. A limited path style fusion indicator acting for each fusion zone as visual recognition of completed fusion cycle shall be incorporated into the body of the fitting. The design of the indicators shall prevent the escape of fusion melt.
5. All internal or externally threaded transition adaptors in the outside sizes up to and including 50 mm shall be designed with an integral polyethylene collar from PE 100 and shall not rely on rubber or synthetic seals. Threaded adapter bodies may be from brass or stainless steel and shall be of modular type and shall not be moulded into an electrofusion fitting socket.

#### I. Electrofusion Saddles

1. All saddles up to at least mains size outside diameter 200 mm shall be designed with two separate halves having a single hinge type attachment and shall be correctly processed without specialised external spring-loaded tooling.
2. The top half of the saddle shall be equipped with an outlet which can accept various other system components such as tapping tees, adapters, valve tees, caps, stop-off attachments, and the like that are simultaneously fused together with the saddle to mains joint in one operation.
3. Each branch outlet shall be equipped with an integral clamping device.
4. All pipe saddle sizes from above outside diameter 63 x 40 mm shall allow a 360° rotation of the branch outlet.
5. Safe tapping into mains must be possible under the defined allowable maximum water pressure according to the respective pipe series and ambient temperature.
6. The tapping saddle cutter shall be designed to seal-off the central passage in the uppermost position and the cutter design must fully contain the cut-out coupon. The saddle shall be capable of permanently seal-off the top of the saddle with an electrofused cap in the mains sizes from outside diameter 63 mm and above.

#### J. Requirements for Electrofusion Control Units

The Electrofusion Control Units in manufacturing electrofusion fittings and electrofusion saddles shall be required to meet the following conditions:

1. The control units shall operate with magnetic card and/or barcode data transfer method transmitted via a reader pen or a scanner.
2. The initial power supply to enable the control unit to function correctly for all fitting and saddle sizes up to outside diameter 200 mm shall not exceed 4 kVA.
3. The unit shall be designed with an automatic compensator so that it can fully operate within input tolerances of between 180V and 264 V, respectively 45 and 65 Hz. The units shall operate with a stabilised fusion voltage. The range of fusion voltage shall be between 8 and 42 volts.

4. A galvanic separation shall exist between the primary and secondary circuits by means of a high frequency transformer.
5. The unit liquid crystal display shall show information in English.
6. The display shall be backlit, be easily readable and give relevant information including:
  - a. recognition of fitting type, dimension and manufacturer
  - b. resistance of connected fitting
  - c. a check-system prior to commencement of fusion process
  - d. actual running and final fusion time in seconds
  - e. primary voltage and frequency
  - f. ambient temperature
  - g. individual fusion number and unit number
  - h. mode of data transfer
  - i. appropriate cooling time.
7. A temperature sensor shall be provided. The operating range of ambient temperatures shall be at least +50°C.
8. The unit shall be capable of processing various manufacturers' products.
9. A lightweight transport box with internal document pocket shall be provided. The complete control unit shall be fully contained and the weight including all primary and secondary cables shall not exceed 15 kg.
10. An external memory bank shall be able to record at least 300 fusion records and be easily accessible and exchangeable. The supplier shall provide a full range of system software and data transmission accessories as applicable for data processing. The ability to download fusion records from all memory systems via an RS 232 interface shall be provided. A back-up internal reserve memory with override shall be provided. Peripheral information such as operator and job number shall be able to be coded-in for fusion record purposes.
11. A blocking system to prevent unauthorised use shall be incorporated into the design.
12. The protection class of the unit shall be at least IP 65. All control units shall fulfil the Electro-Magnetic Compatibility regulations in accordance with the latest Australian standards.

### **3. Execution of Pipework**

#### **PS3.01 Inspection of Pipeline Materials**

- A. No HDPE pipe and fitting shall be ordered until all tests and Engineer's approvals have been obtained.
- B. After delivery to the site and before incorporation into the pipeline, each item of pipes and fittings shall be brushed out and carefully examined for soundness. Damaged items which, in the opinion of the Engineer, cannot be satisfactorily repaired at the site shall be rejected and removed from the site. If under line tests, the Engineer considers that an unacceptable proportion of the pipes within a test length has failed, the Contractor shall be required to test hydraulically to the works test pressure each pipe and joint before pipe laying. In this event, test results shall be submitted to and approved by the Engineer before any further pipes are laid.

#### **PS3.02 Flotation of Pipework**

The Contractor shall be solely responsible for ensuring that flotation of pipework does not occur during construction.



**PS3.03 Jointing of PE Pipes**

- A. The Contractor shall employ only manufacturer's certified staff to perform all of the following jointing techniques to create PE pressure pipe systems. An approved subcontractor may be used only with the Engineer's approval. The original certificate of each certified staff shall have an individual registration number and shall be produced for the Engineer's inspection. The certificate shall have been issued not more than two years prior to commencing the work and shall remain valid for the duration that each staff is undertaking welding. If in the opinion of the Engineer any certified staff is not strictly following the manufacturer's instructions and procedures, the Engineer has the right to force the Contractor to immediately remove the certified staff from the site and replace with another approved certified staff.
- B. The manufacturer shall provide accurate and easy-to-understand assembly instructions in English which can be used at any subsequent time for reference purposes.
- C. Transition fittings manufactured specifically for that purpose shall be used to join PE pipes to metal pipes. Restrained flange adaptors for DI/HDPE pipe shall be used for joining HDPE pipe to DI pipe adjacent to valve chamber. Flanges shall be drilled to class designation PN 10 in accordance with ISO 2531. The restrained flange adaptor for DI/HDPE shall incorporate a gripping mechanism suitable to resist pipe pull-out of the HDPE pipe to the performance requirements of WIS 4-24-01 and ISO 14236.2 and the Contractor shall provide a warranty from the manufacturer to this effect. The flange adaptor must be supplied fully pre-assembled, not requiring disassembly prior to installation. The flange material of the exposed pipes, house connections and water service pipes shall be SUS444/316 or equivalent for corrosion-proof such as antirust. All metal surface and concrete surface included in footing portion shall be painted by vinyl ester resin or equivalent.
- D. The Contractor shall take all measures to prevent contamination of the pipe ends to be joined during the heating and fusion process. Fusion welding shall not be conducted on site under conditions where the wind causes sand to blow onto the joint to be joined.

**PS3.03 Pipe to Pipe Butt Fusion Jointing**

- A. The Contractor shall adhere to the following guidelines in respect of butt fusion jointing HDPE pressure pipes:
  - 1. All butt fusion welding shall be in accordance with the latest edition of DVS 2207 1 "Welding of Thermoplastics – Heated Tool Welding of Pipes, Pipeline Components and Sheets made from HDPE". The Contractor shall make available a complete copy of this document on the site.
  - 2. Pipes of the same outside diameter but either different wall thickness or different classes of resins shall not be joined by butt fusion.
  - 3. PE pipes made from very high molecular weight resins shall not be used.
  - 4. The Contractor shall use automatic butt fusion machines as specified herein.
- B. Butt fusion machines and equipment to be used for the butt fusion jointing shall meet the following requirements:
  - 1. Butt fusion machines and equipment shall comply with the requirements of the latest edition of DVS 2208-1. The Contractor shall make available a complete copy of this document on the site.
  - 2. The equipment shall employ data storage and data retrieval to record the conditions used for butt fusion jointing.
  - 3. Any butt fusion machine and equipment that do not fully comply with this specification and DVS 2208-1 shall be indelibly marked as "in non-compliance" and

shall be immediately removed from the site to substitute for an acceptable machine and equipment.

#### **PS3.04 Pipe Laying**

- A. HDPE pipe material expands and contracts when the temperature changes. HDPE pipe expands by approximately 0.2 mm per meter for every degree increase in temperature. Although the HDPE pipe is fixed by a clamp to avoid floating, the pipe shall not be fixed to horizontal direction because the pipe expands and contracts.
- B. Material of clamp and hooks/guide brackets for the Sewer Pipes, House Connection and Water Distribution Pipe shall be stainless steel SUS444/316 or equivalent. The Contractor shall obtain the Engineer's approval before installation of pipes. All metal surface shall be painted by vinyl ester resin or equivalent.
- C. The Water Distribution Pipe shall be fixed by a clamp on a jetty. Hooks/guide brackets for the Water Distribution Pipes and House Connections shall be fitted with an interval being 10 times of the pipe diameter. Thus the fitting interval of hooks/guide brackets for the Water Distribution Pipe (HDPE pipe,  $\phi$ 50 mm, inside dia.) should be about 500 mm, and that for the House Connection (HDPE pipe,  $\phi$ 100 mm, inside dia.) should be about 1000 mm.
- D. For the Water Service Pipes, a galvanized steel pipe shall be used for outside the houses, and a polyethylene pipe shall be used for inside houses. The galvanized steel pipe shall be hot dip galvanizing or to be painted by vinyl ester resin or equivalent, with a corrosion-proof tape.
- E. The jetties and houses are unstable and tremble. To meet these conditions, a flexible joint shall be installed for the House Connection and Water Service Pipe in order to prevent any damage on jointing parts. The flexible joint shall be rubber type with flange which meets the standards of SUS444 or SUS316 or equivalent, or ISO PN10 and allowable eccentricity by lateral vibration being at least 100 mm. The Contractor shall propose appropriate flexible joint for the Engineer's approval, provided that the Contractor shall be worked out within his tender price.
- F. Two cleanouts shall be installed in the Sewer Pipe for each jetty where the exposed pipe is located above High Tide Level (H.T.L), instead of manholes. One shall be installed at the beginning of the Sewer Pipe, the starting point of the Sewer Pipe, and the other shall be in the middle of the portion of the Sewer Pipe where the pipe is located above H.T.L

#### **PS3.05 Connection to Existing Manhole and Existing Water Distribution Pipeline**

- A. The Sewer Pipe shall be connected to the trunk sewer pipeline by gravity flow from the Pilot Project Area. The gradient of the pipe is 1 in 100 (1%) for HDPE ND 200 mm and the 1 in 40 (2.5%) for the House Connection. Minimum earth cover is 600 mm for not subject to traffic.
- B. The Contractor shall confirm and decide the manhole positions where the Sewer Pipe is to be connected to the trunk sewer pipeline, together with the Engineer, the Employer/EDA RANU and landowner/administrator ( i.e. , Motu-Koita Assembly) of the Pilot Project Site.
- C. The Water Distribution Pipeline shall be connected to the existing water distribution pipeline. The Contractor shall confirm and decide the connection point from the existing water distribution pipe, together with the Engineer and the Employer / EDA RANU.

**PS3.06 Final Test and Inspection**

- A. Upon completion of the installation of the Water Distribution Pipelines and Sewer Pipelines, prior to hydraulic testing, the Contractor shall demonstrate and prove that the line is clear of debris and obstructions.
- B. The Contractor shall conduct hydraulic testing on the installed Water Distribution Pipelines and Sewer Pipelines in accordance with the test procedure approved in advance by the Engineer.
- C. After testing the mains, the Contractor shall flush out the main with clean water and then disinfect the pipeline. The Contractor shall allow in his tender for the arrangement of a large volume of water required for hydraulic testing, flush-out and disinfection of the pipelines at his responsibility and costs.
- D. The Contractor shall comply with the final inspection procedures set out in the Standard Specifications and other parts of the Contract.

**END OF PART - III OF PARTICULAR SPECIFICATIONS**

**PART IV**

**PROCUREMENT**

## Particular Specifications Part – IV

### 1. General

#### PS1.01 Contractor's responsibility under Part – IV

- A. This Part – IV relates to the supply and delivery of vehicles to be used by the Employer for operation and maintenance of the sewerage systems as defined herein (hereinafter referred to as the “Supply of Vehicles”).
- B. The Supply of Vehicles is a part of the Contractor's works to be carried out and completed under the Contract. The Contractor shall be responsible to complete the Supply of Vehicles in accordance with the provisions and requirements set out in this Part – IV of the Particular Specifications and also other Conditions of Contract.
- C. In accordance with the definition stipulated in Sub-clause 1.1.5.5 of the General Conditions of Contract, the vehicles to be supplied by the Contractor shall be deemed as a part of the Plant to be completed under the Contract, and therefore Sub-clause 4.16 and other clauses of the General Conditions shall be applied to the Supply of Vehicles.

### 2. Vehicles to be Supplied

#### PS2.01 Details of Vehicles

- A. The vehicles to be supplied by the Contractor shall be as follows:
  - (1) High-Velocity Jet Truck (Water-Jetting Sewer Clear): 1
  - (2) Water Tank Truck: 1
  - (3) Vacuum Truck 2
  - (4) Dump Truck: 2
  - (5) Car with Television Inspection 1
- B. The specifications of these vehicles are set out in Appendix to Part IV.
- C. The following supplies and submittals shall be included for each vehicle:
  - a. User's manual and handbook (English version)
  - b. Maintenance manual for special equipment (English version)
  - c. Common repair tools
  - d. Spare parts

#### PS2.02 Arrangement for Manufacturer's Warranty and Services

- A. The Contractor shall provide the Employer with a manufacturer's warranty for each supplied vehicle giving a non-conditional guarantee on the performance of the vehicle for two (2) years after delivery besides the Contractor's defect liability under the Contract.
- B. The Contractor shall arrange maintenance services for each supplied vehicle for at least five years after delivery, including maintenance services in free of charge during the warranty period.

### 3. Delivery, Test and Inspection

#### PS3.01 Delivery

- A. The Contractor shall deliver all the vehicles to the Site, and store at the designated place in the custody and full responsibility of the Contractor until handed over to the Employer. The Contractor shall discuss and agree with the Employer and Engineer before shipment with regard to the place to be stored after delivery and the date of handing over to the Employer.
- B. The Contractor shall take a complete package of insurance for each vehicle covering full risk up to the handing-over to the Employer, and shall indemnify and hold the Employer harmless against and from all damages, losses and expenses (including legal fees and expenses) resulting from the transport of these vehicles to be supplied, and shall negotiate and pay all claims arising from their transport.
- C. The Contractor shall notify to the Engineer in writing the date of arrival at a destination port for each vehicle in seven (7) days advance, and shall submit the following documents to the Engineer prior to its arrival:
  - a. A copy of Bill of Lading
  - b. A copy of sea way bill and/or airway bill
  - c. A copy of insurance policy
  - d. A Manufacturer's and/or Supplier's warranty certificate
  - e. An pre-shipment inspection certificate issued by a nominated inspection agency
  - f. A Supplier's factory shipping details
- D. The Contractor shall make all necessary documentation and arrangements for custom clearance, including application for exemption of import duties and surcharges for the imported vehicles on behalf of and in the name of the IPBC/EDA RANU, at the Contractor's responsibility and his own costs.

### **PS3.02 Inspection, Test and Training**

#### **A. Pre-shipment**

For all vehicles to be supplied, the Contractor shall arrange inspection at the manufacturer's or supplier's shop for each vehicle by an authorized third party inspector at the Contractor's cost prior to shipment, and submit a certificate of these inspections to the Engineer as specified in PS3.01 C. above.

The Contractor shall inform the Employer of each pre-shipment inspection with fourteen (14) days advance notice, and shall accept witness by the representatives of the Employer and Engineer, one person each for every inspection, for which the travelling and accommodation expenses for them shall be borne and paid by the Contractor. The Contractor shall allow for these expenses in his tender price.

#### **B. Inspection and Performance Test at Site**

When each vehicle is delivered at the Site, the Contractor shall arrange the inspection of the delivered vehicle by the representatives of the Employer/Engineer and the representative of the supplier at the site, and then arrange to demonstrate the performance of the delivered vehicle to the satisfaction of IPBC/EDA RANU.

The Employer reserves the right to reject the delivered vehicles, if any damage and/or defect are identified during the site inspection and/or performance test. The Contractor shall be responsible to bring out such a rejected vehicle(s) and replace with another new vehicle at his cost.

**C. Training**

The Contractor shall conduct training to the drivers/operators and maintenance forces of EDA RANU to guide them on the safety driving, operation of equipment, and maintenance of these delivered vehicles and equipment prior to handing over them to the Employer. Such training shall be in English for at least two (2) days.

**END OF PARTICULAR SPECIFICATIONS PART – IV**

**APPENDIX TO PART – IV OF PARTICULAR SPECIFICATIONS****Specifications of Vehicles To Be Supplied****1. High-Velocity Jet Truck (Water-Jetting Sewer Clear)**

Number of Vehicles: 1

General: The water tank is mounted on a truck chassis and equipped with the high-pressure water pump, hose reel and power transmission. Cleaning operation of drainpipe or ditch can be done by the levers and handles outside the cab. Minimum seating capacity is 2 persons.

Reference dimension: 7,000mm x 2,500mm x 3,000mm

Reference Gross Vehicle Weight: 11,000kg

Water tank: All stainless steel welded, elliptical sectioned cylindrical type

Reference dimension (inside): 3,000mm x 2,200mm x 1,200mm

Number of equipment: 1 set

Number of Manhole: 1 set

Number of level gauge: 1 each

Equipment:

1) High-pressure water pump

Reference type-plunger pump

Reference theoretical maximum capacity- 206 liters per minute

Reference Maximum Pressure- 20 MPa

2) Main hose reel

Reference rotating type-hydraulic type

Reference rolling capacity of hose-120m

Accessories-slide arm, hose guide

3) Sub hose reel

Rotating type-manual

Reference Rolling capacity of hose-40m

Reference tire size: 8.25R-20-14PR

Tank capacity: 4,000L

Country of Origin: Complete built-up unit from Japan

To be supplied: Accessories and Spare parts

Accessories:

1. High-pressure rubber hose for main hose reel-2 each

2. High-pressure rubber hose main hose reel-2 each

3. High-pressure rubber hose for sub hose reel-3 each

4. High-pressure spray gun-1 each

5. Nozzle-3 each

6. Hose guide-1 set

7. Hose guide holder-1 each

8. Working lamp-1 each

9. Spare tire carrier-1 each

10. Tool box-1 each



11. Tool for hose connection-1 set
12. Maintenance tool of high-pressure water pump-1 set
13. Operation and Maintenance Manual Booklet-1 set

Spare parts:

1. BRG, Unit for driving bearings and the body -2 sets
2. BRG, Unit for driving bearings and the body -2 sets
3. BRG, Unit for driving bearings and the body -4 sets
4. V Belt-6 sets
5. Gasket-3 sets
6. Corn Valve-1 set
7. Compression Spring-1 set
8. Spring Plate-1 set
9. Discharge Valve, spring-1 set
10. Base Ring-3sets
11. Screw Ground- 2sets
12. Wiper ring (O-ring)
13. Gasket for connecting valve and pipe -1 set
14. Gasket for connecting valve and pipe -1 set
15. Oil Seal-1 set
16. O-ring-1 set
17. Gasket for connecting valve and pipe -1 set
18. Gasket for connecting valve and pipe -1 set

Note) 1, 2 and 3 are different type of parts each other.

13, 14, 17 and 18 are different type of gasket each other.

## 2. Water Tank Truck

Number of Vehicles: 2

General: The water tank is mounted on the truck chassis and equipped with a volute pump. Loading goods can be loaded from the storage into the tank either by pumping or gravity, and it can be unloaded from the truck either by pumping or gravity. Water can be transported to the destination. Minimum seating capacity is 2 persons.

Tank: All steel construction, elliptical sectioned cylindrical tank.  
Reference dimension-6,500mm x 2,200mm x 2,300mm

Reference Gross vehicle weight: 8,000kg

Tank: All steel construction, elliptical sectioned cylindrical tank  
Reference dimension-3,800mm x 1,700mm x 900mm

Tank capacity: 4,000L

Equipment:

1) Pump

Reference Type- volute pump

Reference capacity-550 Liters per minute

2) Piping and cock

Reference diameter of piping and cocks-63mm

Number of 2-way cock-2 each

Number of 4-way cock-1 each

Material of cocks-Cast iron

Material of piping-Mild steel

Tank attachment:

Hose box-2 each

Tool box-1 each

Country of Origin: Complete built-up unit from Japan

To be supplied: Accessories and Spare parts

Accessories:

1. Suction and delivery hose-1 each
2. Hose wrench-2 each
3. Suction basket strainer-1 each
4. Maintenance tool of high-pressure water pump-1 set
5. Operation and Maintenance Manual Booklet-1 set

Spare parts:

1. O-ring for the pump-1 set
2. O-ring for the pump-1 set
3. Bearing-1 set
4. Oil seal-1 set
5. Packing-1 set
6. Journal-2 sets
7. Gasket for connecting between pipe and a valve, 2.5 B-5 sets
8. Gasket for connecting between the pump and a pipe, 2.5 B - 2 sets
9. Pin for handle of the four-way valve, dia. 6mm-1 set
10. Spring for handle of the four-way valve-1 set
11. Ball for handle of the four-way valve-1 set
12. O-ring for the four-way valve - 2 sets
13. O-ring for the four-way valve-1 set
14. O-ring for the four-way valve- 2 sets
15. Pin for handle of the two-way valve, dia. 5mm-1 set
16. Spring for handle of the two-way valve -1 set
17. Ball for handle of the two-way valve -1 set
18. O-ring for handle of the two-way valve -1 set
19. Packing for handle of the two-way valve -2 sets
20. Pin for handle of the two-way valve, dia. 1mm -1 set
21. Snap ring-1 set
22. O-ring for the two-way valve -2 sets
23. Float-1 set
24. Pipe-1 set
25. O-ring for the level gauge-1 set
26. Hose band-1 set
27. Hose-1 set
28. Spring for the manhole-1 set
29. Stopper-1 set
30. Packing for the manhole-1 set
31. Air vent-1 set
32. Packing-1 set
33. Gasket for the manhole-1 set
34. Basket-1 set
35. Wrench-1 set

Note) 1 and 2 are different type of parts each other.

11, 12 and 13 are different type of parts each other.

18 and 25 are different type of parts each other.

### 3. Vacuum Truck

Number of Vehicles: 2

General: Vacuum tank body and such device as vacuum pump, discharging dump mechanism and power transmission are mounted on a truck chassis. Minimum seating capacity is 2 persons.

Vacuum Tank:

Type-Cylindrical steel

Reference inner dimension-1,500mm x 5,000mm

Equipment:

1) Vacuum Pump

Reference discharge- 5,800 liters per minute

Reference Revolution- 700 r.p.m

Reference maximum degree of vacuum- -96kPa

2) Dump Mechanism: Double Acting Hydraulic Cylinder

Reference Dump angle- 50 degrees

Hydraulic pump- model gear type

Reference tire size: 10R-20-16PR

Tank capacity: 8,000L

Painting: Anti-corrosive painting

Country of Origin: Complete built-up unit from Japan/ UK/ Western Europe/ USA

To be supplied: Accessories and Spare parts

Accessories:

1. 3 inch suction and discharging vinyl chloride hose (6m)-2 each

2. 3 inch suction pipe (1.5m)-1 each

3. Maintenance tool of high-pressure water pump-1 set

4. Operation and Maintenance Manual Booklet-1 set

Spare parts:

1. Tail gate, seal packing-1set

2. Oil pump, seal kit-1set

3. Dump cylinder, seal kit-1set

4. Gate cylinder, seal kit-2 sets

5. Suction and discharge valve-2 sets

6. V belt-6 sets

7. Seal Kit-1 set

8. Timing gear-1 set

9. Hosing oil seal-4 sets

10. Packing for discharge port-1 set

11. Suction hose (10m)-1 set

12. Universal joint-1 set

#### **4. Dump Truck**

Number of Vehicles: 2

General: This dump truck is specially designed for carrying sand and gravel. In this project treated sludge is carried by the truck. It is consist of steel vessel, tipping mechanism and chassis. All dumping operations can be done in the cab. Minimum seating capacity is 2 persons.

Reference dimension: 8,000mm x 2,500mm x 3,000mm

Reference Gross vehicle weight: 25,000kg

Dump vessel:

Reference dump vessel inside dimension: 4,800mm x 2,300mm x 900mm

Reference tire size: 10R-20-16PR

Tank capacity: 10 cubic meters

Warning system and Essential Accessories

Country of Origin: Complete built-up unit from Japan

Accessories:

1. Manufacture's standard tool for maintenance
2. One copy of Operation and Maintenance Manual Booklet

#### **5. Car with Television Inspection**

Number of Vehicles: 1

General: The television inspection system is mounted in a rear body of the van and equipped with the monitor, cameras and recording system. Inspection for sewer can be done by the camera and the result of the inspection can be recorded by the recorder. Minimum seating capacity is 3 persons.

Reference Engine capacity: 2,700cc

Drive System: 4-wheel drive

Reference dimension: 4,700mm x 1,700mm x 2,300mm

Reference Wheels and tires: 195 80R15 (front), 105/107L LT (rear)

Inspection equipment:

Cable length-300m: 1 set

Camera head-applicable diameter 150mm to 250mm, 250mm to 350mm and 350mm to 600mm its accessories: 1 set

Diameter conversion unit and its accessories- for diameter 250mm to 350mm and 350mm to 600mm: 1 set

Electrical Cable drum with controller: 1 set

Remote controller for cable drum: 1 set

Controller: 1 set

Character generator for recording the motion picture: 1 set

Cable Guide unit: 1 set

Cable Guide unit (surface roller): 1 set

Cable Guide unit (side roller): 1 set

Cable guide for connecting the camera: 1 set  
Monitor- Liquid Crystal Display its accessories: 2 set  
Recorder- HDD+DVD recorder its accessories: 1 set  
Cable guiding devices: Cable guide, side roller and surface roller its accessories: 1 set  
Power Generator: 2.8 kVA: 1 set

Warning system and Essential Accessories

Country of Origin: Complete built-up unit from Japan

To be supplied: Accessories and Spare parts

Accessories:

1. Vehicle Antitheft system -1 set
2. Maintenance tool of high-pressure water pump-1 set
3. Operation and Maintenance Manual Booklet-1 set

Spare parts:

1. Wheels for camera head guide, dia. 150mm-18 sets
2. Wheels for camera head guide, dia. 200mm-4 sets
3. Conversion shaft for dia. 200 mm-1set
4. Cover for a camera-1 sets

**END OF APPNEDIX TO PARTICULAR SPECIFICATIONS PART – IV.**

**PART V**

**SOCIAL DEVELOPMENT  
PROGRAMME**

## Appendix A to Particular Specification Part V

### The Proposed Social and Environmental Education Training Program for the Pilot Area of the Water Village in Hanuabada

#### 1 Aim

To raise the level of awareness and concern of the participants about health and the total environment and its associated problems by providing knowledge, motivation and commitment to work individually and collectively towards the solutions of the current problems and the prevention of new ones.

#### 2 Target Audience

One member (woman or man) per participating household for a total of 20 household members

#### 3 Over-all Process/Design

The 20 households will be divided into two groups with each FGD participated in by 10 households. Participatory learning activities will be applied in the four modules with each module to be conducted in one day. These modules are organized into: hygiene promotion; sanitation and systems' sustainability; health; and environmental management. Each module contains a series of educational information for specific subject. Examples include personal hygiene, prevailing water-borne disease transmission routes, protecting and conserving marine water resources, and attitudes, behavior and norms towards payment for improved services and eventual improvement of lifestyle. Other than the formal education goals, focus will also be on the social life such as cooperation and mutual understanding and the linking and application of learning activities to the daily life of the participants.

During the FGDs, variety of mediums will be used: group discussions, demonstrations, role plays, stories, pictures and flip charts.

#### 4 Training Modules

There will be four (4) modules that will be developed:

- Training Module 1: *Hygiene Practices and Education & Promotion*

##### Objectives

- To raise the level of knowledge awareness of the participants of good hygiene habits or practices to cover personal, domestic and environmental cleanliness.
- To appreciate the importance of everyone practicing good hand washing and communicate effectively to others the value of hand washing at critical times.
- To know the risks involve if personal hygiene is not maintained.

##### Expected Results

- Improved hygiene behaviors including hand washing that impact on health outcomes such as reductions in diarrhea, parasitic infections, morbidity and mortality.
- Effective and replicable hygiene education strategies that promote behavior change and creating culturally acceptable and sustainable changes that benefit the health and well-being of the community.

- Training Module 2: *Human Wastewater Disposal Practices & Management and Facility Management (proper use of toilets, promotion of tariff for improvement of services (O&M fee)*

#### Objectives

- i. To gain understanding of the characteristics, conditions, trends, issues and challenges of the water supply and sanitation sector including the role and responsibility of the community in water and sanitation development.
- ii. To adopt and promote desired environmental sanitation practices (excreta disposal, and liquid waste management).
- iii. To promote proper use of toilet facilities, the importance of paying tariff for the maintenance of the system and ownership given to them.

#### Expected Results

- i. Awareness of the issues and challenges on the human waste water disposal and the roles and responsibilities of each of the members of the community.
  - ii. Understanding on the proper use and maintenance of the toilet facilities.
  - iii. Willingness to pay for an improved service such as water and sewerage services.
- Training Module 3: *Water-borne Diseases including Cholera Prevention, Control and Management*

#### Objectives

- i. To understand the source of infection, transmission (common routes), symptoms, prevention processes and treatments of water and sanitation related diseases including cholera.
- ii. To understand the possible sources of contamination between the source and the mouth, about fecal-oral disease transmission, and the concept of germs.
- iii. To communicate effectively to others about preventing water and sanitation related diseases and preventing and curing dehydration.
- iv. To know the social and economic negative effects of contacting water and sanitation related diseases.

#### Expected Results

- i. Knowledge and practices to reduce infections and deaths from water and sanitation related diseases.
  - ii. Effective communication to others about water and sanitation related diseases.
  - iii. Knowledge on the social and economic consequences of water and sanitation related diseases.
- Training Module 4: *Solid Waste Management, Water Pollution/Water Quality Management and Its Impact to Health and Environment*

#### Objectives

- i. To encourage active participation in community activities for environmental protection and conservation specifically on water quality management.
- ii. To identify negative implications of careless disposal practices and to develop the idea of waste as a resource.
- iii. To inform the participants on their responsibility to address water quality issues and adapts best practices on water quality management.
- iv. To increase accurate in-depth knowledge of the opportunities for better quality of life in relation to health and economic benefits of maintaining clean water bodies.

#### Expected Results

- i. Environmental awareness and action towards a better environment.



- ii. Keeping the surroundings clean and reusing what is not thrown away.
- iii. Adapt best practices on water quality management.

Can outline environmental factors that result in water pollution and their health and economic impacts.

## Appendix B to Particular Specification Part V

### The Proposed Detailed Implementation Plan for the HIV and AIDS Prevention Program for Construction Workers and Off-Site Communities

#### 1 Aim

To help contain the spread of HIV and AIDS in the workplace and surrounding communities to mitigate the social and economic impact of the epidemic.

To improve the knowledge base and practices for the effective implementation of HIV and AIDS prevention interventions in IPBC/EDA RANU projects.

In the implementation of the Plan, the Contractor shall conform to PNGs' laws and regulations applicable to HIV/AIDS and requirements specified in EDA RANUs' Workplace Policy.

#### 2 Target Audience

All construction workers, both skilled and unskilled, of the Project and the surrounding communities of the construction sites of the Kila kila STP<sup>1</sup>

#### 3 Over-all Process/Design

A series of training sessions is designed for a length of 4 days and will be attended by about 40 to 50 participants. Each session (one module per session) will be carried out and will be completed within one-day. For construction workers, frequency can be four training sessions to be conducted once a week. For the communities, a 2-day session in a month is appropriate to give more time for the local communities to attend to their economic activities.

The course conveys teaching messages mainly through interactive practical work by participants. Hand-on learning focuses on fictitious situations based mainly on real life conditions and challenges. The activities of the training modules involve self-awareness, handling interpersonal relationships, coping with emotions and stress, critical and creative thinking, decision making, problem solving, communication, and empathy.

The training modules have activities that focus on the following: i) to correct misconceptions; ii) to influence high-risk behavior related to condom use and alcohol consumption; and iii) to build skills to help reduce risk taking behavior.

#### 4 Training Modules

There will be four (4) modules that will be developed:

- Training Module 1: *Basic Information on Reproductive Health and Information on HIV/AIDS and STI*

##### Objectives

- i. To increase participants' understanding when talking about reproductive organs, sexual behavior, and how that behavior is related to spread of the virus

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<sup>1</sup> During this stage, the number of construction workers has not yet been estimated.

- ii. To provide information on HIV/AIDS/STI and services available in their area

#### Activities

##### ○ Activity 1 – *Our Body*

This activity prepares participants to feel more comfortable talking about sexual activities by helping them find familiar terms for sexual organs, terms they can use throughout the training sessions. It provides information on male and female reproductive organs. This will help participants get a better understanding when talking about sexual behavior and how it is related to the spread of the virus.

##### ○ Activity 2 – *Transmission of HIV*

Introduces the HIV and AIDS issues. This is to gauge how much the participants already know about HIV and AIDS and understanding of high-risk behavior for contracting HIV such as the reduction of the number of concurrent sexual partners and delay on the sexual debut of young people.

##### ○ Activity 3 – *Persons who are HIV Positive and Sexually Transmitted Infection Identification*

This set of activities provides information that anyone can be infected with HIV, and that it depends on their behavior, not on age, gender, or profession. It provides understanding that they cannot self-diagnose sexually transmitted infections (STIs) and that self-treating STIs may cause drug resistance.

##### ○ Activity 4 – *Risk Assessment*

This activity seeks understanding of the body's orifices and bodily fluids related to HIV infection. It also provides opportunities to practice the HIV risk assessment. It educates on the mechanism of HIV and the human body's immune system.

##### ○ Activity 5 – *The Use of Condoms and Where to Find Condoms, Places providing HIV Testing and STI Check-ups in the Community*

Reviews information about condoms and HIV and AIDS, and assesses participants' attitudes. Participants identify where to find condoms and places providing HIV testing and STI checkups in their communities.

##### ○ Activity 6 – *Consequences of HIV Infection*

This activity presents an opportunity to learn about the consequences of HIV infection, especially the cost of medicine, which results in having less money to support the family.

- Training Module 2: *HIV/AIDS and Attitudes*

#### Objectives

- i. To have participants examine pros and cons of attitudes contributing to using or not using condoms.
- ii. To inform participants about the effect of alcohol on condom use.

#### Activities

##### ○ Activity 1 – *Reasons for Using or Not Using Condom*

This activity encourages participants to look at the positive and negative effects of attitudes toward condom use

##### ○ Activity 2 – *Effects of Alcohol*

This activity informs the participants about the effects of alcohol and how this increases the risk of HIV infection, especially when they decide to have sex and are unable to use a condom correctly.

- Training Module 3: *Communication and Dealing with Relationships to Reduce Risky Behaviors*

#### Objective

- i. To build skills of critical and creative thinking, problem solving, decision making, and communication that will help contribute to the reduction of risky behavior.

#### Activities

- Activity 1 – *Logical Thinking, Problem Solving and Decision Making Formula*

This activity trains participants to practice their logical thinking skills and analyze the cause and effect of their actions. It will help participants learn about problem solving and decision making and the opportunity to practice the skills.

- Activity 2 – *Assessing Levels of Closeness and Risk*

This activity seeks to provide the participants with learning on how to assess appropriate levels of intimacy with the opposite sex as well as on how to assess their high-risk behavior, especially their risk of HIV infection.

- Activity 3 – *Types of Communication*

This activity increases participants' understanding of differences between three types of communication—aggressive, passive, and assertive and prepares participants to practice communication skills for negotiation or refusal.

- Training Module 4: *Living with People with HIV*

#### Objective

- i. To promote acceptance of people living with HIV/AIDS.

#### Activities

- Activity 1 – *I am HIV Positive*

This activity raises participants' awareness about tolerance for persons living with HIV (PLHIV) and to help them realize how it feels to be discriminated against.

- Activity 2 – *Basic Health Care for Persons Living with HIV*

This activity provides an understanding of basic health care for PLHIV.

- Activity 3 – *Needed Actions to Support PLHIV*

This activity encourages participants to think of actions and/or contributions they can make to provide PLHIV with support.

#### Expected Results

- i. Environmental awareness and action towards a better environment.
- ii. Keeping the surroundings clean and reusing what is not thrown away.
- iii. Adapt best practices on water quality management.

Can outline environmental factors that result in water pollution and their health and economic impacts.

## **Particular Specification Part - V**

### **Social and Environmental Consideration Programmes**

#### **1. General**

##### **PS 1.01 Scope of Part-V of Particular Specifications**

- A. This Part-V of the particular Specifications relates to the works for the Social and Environmental Consideration Programmes which the Contractor shall carry out as a part of the Works for the Port Moresby Sewerage System Upgrading Project (hereinafter referred to as the “POMSSUP” or “the Project”).

##### **PS 1.02 Descriptions of the Works**

- A. The Contractor shall prepare and implement the Social and Environmental Consideration Programmes aiming to maximize the benefits that can be derived from the Pilot Project in the near-shore village inhabitants and also preventing HIV/ AIDS from spreading, which comprise the following two programmes:
1. Social and Environmental Education and Dissemination Programme for the 20 households of the Pilot Project area in Hanuabada water village.
  2. HIV/AIDS Preventive Promotion Programme for the construction workers and neighbouring communities.
- B. Scope of the works to be carried out and completed by the Contractor shall include, but not be limited to, the followings:
1. Social and Environmental Education and Dissemination Programme
    - (1) Preparation of the Social and Environmental Education and Dissemination Programme
    - (2) Preparation of Information, Education and Dissemination Materials for the Pilot Area
    - (3) Implementation of the Social and Environmental Education and Dissemination Programme for the 20 households of the Pilot Project area
    - (4) Implementation of the Public Information Programme
    - (5) Monitoring and Evaluation
  2. HIV/AIDS Preventive Promotion Programme
    - (1) Preparation of a HIV/AIDS Preventive Promotion Programme
    - (2) Implementation of the HIV/AIDS Preventive Promotion Programme for the construction workers and neighbouring communities
    - (3) Distribution of Condoms around the workplace
    - (4) Monitoring and Evaluation

## 2. Implementation

### PS02.01 Implementation of the Social and Environmental Education and Dissemination Programme

- A. The Contractor shall develop and prepare an education and dissemination programme for the 20 households of the Pilot Project area in Hanuabada to promote awareness on the proper health and hygiene practices, responsibility of maintaining the systems through efficient use of water, proper use of toilets/sewers, understanding of tariff for improvement of services, water-borne diseases, environmental management and so on. The Contractor shall pay attention to highlighting how to control and manage to prevent Cholera from spreading, taking an instant of an epidemic that occurred just recently.
- B. The Contractor shall develop four (4) modules for the education and dissemination programme. Refer to Appendix A to Part V for details of each module
- Module 1: *Hygiene Practices and Education & Promotion*
  - Module 2: *Human Wastewater Disposal Practices & Management and Facility Management (proper use of toilets, promotion of tariff for improvement of services (O&M fee))*
  - Module 3: *Water-borne Diseases including Cholera Prevention, Control and Management*
  - Module 4: *Solid Waste Management, Water Pollution/Water Quality Management and Its Impact to Health and Environment*
- C. Target Audience  
One person per each of the targeted 20 households in the Pilot Project Area.
- D. Overall Approach:  
The Contractor shall take general approach in this programme adopting education and dissemination to stakeholders through focus group discussions (FGDs), with the 20 households divided into two groups with each FGD participated in by 10 households.
- E. Venue:  
The Contractor shall arrange the venue for these activities and submit the proposal to the Engineer/Employer/EDA RANU for approval
- F. Period of FGD: 4 days in total
- G. Instructor  
The Contractor shall employ one lecturer and two assistants for two FGDs in each module. The Contractor shall submit the proposal to the Engineer/Employer/EDA RANU.
- H. Monitoring and Evaluation of the Programme

A monitoring and evaluation framework shall be developed by the Contractor.

#### **PS02.02 Implementation of the Public Information Programme**

- A. The Contractor shall conduct a Public Information Programme composed of Information, Education and Communication (IEC) Campaign through IEC materials for all the inhabitants of Hanuabada water village.
- B. The Contractor shall prepare the leaflets as IEC materials to provide general information on how to prevent further deterioration of marine waters and other water quality management techniques/practices such as the provision of a sewerage system. The material should highlight on ensuring clean water for public health and sustainable environment to increase exposure on the benefits derived from better water quality management. The specification of the leaflets shall be as follows:
- (1) 1,200 copies
  - (2) Paper dimension A5 (215mm x 148mm) coloured paper
  - (3) Back to back printing: 1 panel each side
- C. Target Audience  
All inhabitants of the Hanuabada water village. The Contractor shall arrange a plan for grouping the target audience and submit it to the Engineer/Employer/EDA RANU for approval.
- D. Overall Approach  
The Public Information Programme through IEC materials shall be implemented for all inhabitants of the Hanuabada water village.
- E. Venue  
The Contractor shall arrange the venue for these activities and submit the proposal to the Engineer/Employer/EDA RANU for approval.
- F. Period of Programme Implementation  
The Contractor shall develop the schedule of the programme implementation and submit it to the Engineer/Employer/EDA RANU for approval
- G. Instructor  
The Contractor shall employ one lecturer for the programme. The Contractor shall submit the proposal to the Engineer/Employer/EDA RANU.
- H. Monitoring and Evaluation of the Program  
A monitoring and evaluation framework shall be developed by the Contractor.

**PS3.01 Development of HIV/AIDS Preventive Promotion Programme**

- A. The Contractor shall develop HIV/AIDS Preventive Promotion Programme for the construction workers and neighbouring communities of the construction sites of the Kila Kila STP to prevent HIV and AIDS from spreading in the workplace and to mitigate the social and economic impact of the epidemic. The Contractor shall arrange periodic meetings on this programme.
- B. The Contractor shall formulate a regulation limiting the day for taking alcohol in the construction camp in consideration that alcohol affects the manner of workers, and include it in their training and workplace policy.
- C. The Contractor shall develop four (4) modules as follows. Refer to Appendix-B for details.
- Module 1: *Basic Information on Reproductive Health and Information on HIV/AIDS and STI*
  - Module 2: *HIV/AIDS and Attitudes*
  - Module 3: *Communication and Dealing with Relationships to Reduce Risky Behaviors*
  - Module 4: *Living with People with HIV*
- D. Target Audience
- (1) All construction workers, both skilled and unskilled, of the Project
  - (2) The surrounding communities of the Kila Kila STP construction sites
- E. Overall Approach
- The Contractor shall arrange periodical training sessions designed for 40 to 50 participants a day.
- F. Venue
- The Contractor shall arrange the venue for these activities and submit the proposal to the Engineer/Employer/EDA RANU for approval.
- G. Period of Programme Implementation
- The Contractor shall develop the schedule of the programme implementation and submit it to the Engineer/Employer/EDA RANU for approval
- H. Instructor
- The Contractor shall employ one lecturer and two assistants. The Contractor shall submit the proposal to the Engineer/the Client/EDA RANU.
- I. Monitoring and Evaluation of the Program
- A monitoring and evaluation framework shall be developed by the Contractor.



**PS3.02 Distribution of Condoms**

The Contractor shall prepare the action plan for HIV/AIDS prevention, such as making condoms available for workers, making accessible to condoms around the workplace and encouraging availability in shops of the surrounding communities to meet the following requirements:

**A. Target Groups**

- (1) All construction workers, both skilled and unskilled, of the Project
- (2) The surrounding communities of the Kila Kila STP construction site

**B. Overall Approach**

The Contractor shall distribute condom free of charge at targeted distribution points around the workplace and shops in nearby communities in cooperation with BAHA. This activity must be supported by the education and dissemination seminars in Module 1 and 2 that address stigma, myths and misinformation around condom use.

**C. Distribution points**

The Contractor shall develop the plan of distribution points such as the number of points, places, refill intervals etc. and submit it to the Engineer/Employer/EDA RANU for approval.

**D. Time Table**

During the period of construction of the Project (2013~2015)

**END OF PARTICULAR SPECIFICATIONS PART – V**