Tina River Hydropower Development Project P-1 Construction Environmental and Social Management Plan (CESMP)

TINA RIVER HYDROPOWER LIMITED | FEBRUARY 2023



# Tina River Hydropower Development Project

# P-1 Construction Environmental and Social Management Plan (CESMP) February 2023

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# ACRONYMS

ADB	Asian Development Bank			
ADWG	Australian Drinking Water Guidelines			
AIFFP	Australian Infrastructure Financing Facility for the Pacific			
ANZECC	Australian and New Zealand Environment and Conservation Council			
BOOT	Build, Own, Operate and Transfer			
BSC	Benefit Share Community			
CBSP	Community Benefit Share Program			
CCTV	Closed-circuit television			
CESMP	Construction Environment and Social Management Plan			
CHDVMP	Community Health and Disease Vector Management Plan			
CLO	Community Liaison Officer			
COVID-19	Coronavirus disease (caused by novel coronavirus SARS-CoV-2)			
DIA	Direct Impact Area			
dbh	Diameter at breast height			
E&S	Environmental and Social			
EDCF	Economic Development Cooperation Fund			
EHS	Environmental Health and Safety			
EPC	Engineering, Procurement and Construction			
ESIA	Environmental and Social Impact Assessment			
ESMP	Environment and Social Management Plan			
ESS	Environmental and Social Safeguards			
FAO	Food and Agriculture Organization			
GAP	Gender Action Plan			
GHG	Greenhouse Gas			
GIIP	Good International Industry Practice			
GPS	Global Positioning System			
GRM	Grievance Redress Mechanism			
HEC	Hyundai Engineering Corporation Limited			
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome			
H&S	Health and Safety			
HRLMP	Human Resources and Labour Management Plan			
HSE	Health Safety and Environment			
IA	Implementation Agreement			
ID Card	Project Identification Card			
IFC	International Finance Corporation			
IFC PS	IFC Performance Standard			
IFMP	Invasive Flora Management Protocol			
IGM	Internal Grievance Mechanism			
IMP	Influx Management Plan			
JSDF	Japan Social Development Fund			
K-water	Korea Water Resources Corporation			
kV	Kilovolt			

LTA	Lenders Technical Advisor
masl	Meters above sea level
MECDM	Ministry of Environment Climate Change and Disaster Management
MHMS	Ministry of Health and Medical Services
MID	Ministry of Infrastructure and Development
MMERE	Ministry of Mines, Energy and Rural Electrification
MW	Megawatt
NCD	Non-communicable disease
NCR	Non-compliance Report
NGO	Non-Governmental Organization
NMR	Neonatal Mortality Rate
NPHL	National Public Health Laboratory
NRH	National Referral Hospital
OE	Owner's Engineer (Stantec New Zealand)
PO	Project Office
PPA	Power Purchase Agreement
PPE	Personal Protective Equipment
PS	Performance Standard (IFC)
Q/C	Quality Control
RSIPF	Royal Solomon Islands Police Force
RSIPF EOU	Royal Solomon Islands Police Force Explosives Ordinance Unit
SECP	Stakeholder Engagement and Communications Plan
SIEA	Solomon Islands Electricity Authority
SIG	Solomon Islands Government
SMGH	Security Main Guard House
SMP	Security Management Plan
SRERP	Spill Prevention and Emergency Response Plan
SPS	Safeguard Policy Statement
STD	Sexually Transmitted Disease
STI	Sexually Transmitted Infection
THL	Tina Hydropower Limited
TRHDP	Tina River Hydropower Development Project (the Project)
UNDP	United Nations Development Programme
UXO	Unexploded Ordnance
WAC	Workers Accommodation Camp
WASP	Workers Accommodation Security Plan
WCC	Workers Code of Conduct
WHO	World Health Organization

# GLOSSARY

As Low As Reasonably Practicable (ALARP)	To reduce a risk to a level which is as low as reasonably practicable involves balancing reduction in risk against the time, trouble, difficulty and cost of achieving it. This is the level, where the time, effort, difficulty and cost of further reduction measures becomes disproportionate to the additional risk reduction from the incremental efforts.
Communicable Disease	Diseases that can spread from person to person (e.g. influenza, Hepatitis A, etc.).
Complainant	An individual, group or organisation that submits a verbal or written complaint to the Project.
Employee/s	Any person(s) who is/are directly employed by the PO, THL or HEC to work on the Project and who receives, or is entitled to receive, remuneration.
Employer / Owner	Tina Hydropower Limited (THL); the Project Owner, which will take over operation of the hydropower facility once it is constructed.
EPC Contractor	The engineering, procurement and construction contractor for the TRHDP; Hyundai Engineering Corporation Limited (HEC)
Frequency	A measure of the rate of occurrence of an event expressed as the number of occurrences of an event in a given time.
Grievance / Complaint	An expression of dissatisfaction that stems from real or perceived issues, typically referring to a specific source of concern and/or seeking a specific solution.
Hazard	Materials, activities, or conditions that have a significant potential to cause harm including ill health and injury, damage to property, product or the environment.
Hazard identification	The process of recognizing that hazards exist and defining their characteristics
Likelihood	Used as qualitative description of probability or frequency
Misconduct	The deliberate unacceptable or improper behaviour by a worker.
Non-communicable	Diseases that is not transmissible directly from one person to another (e.g. cardiovascular diseases, cancer, chronic respiratory diseases, etc.).
Recruitment	The process of advertising, selecting and appointing a suitable candidate for a vacant position.
Residual risk	Residual Risk refers to the risk that remains after the identified actions have been put in place.
Risk	A term which combines the chance that a specified undesired event will occur and the severity of the consequences of the event.
Risk assessment	A careful consideration by competent people of the hazards associated with a task. RA is a technique that focuses on job tasks as a way to identify hazards so that precautions and control measures can be implemented hence eliminating or minimizing the hazards to an acceptable risk level to prevent injury, illness, property damage, negative impact to environment.
Risk assessment team	A group of competent personnel who are required to conduct a risk assessment
Sexually Transmitted Infections (STI)	Infections or diseases that are passed on during unprotected sex with an infected partner (e.g. Chlamydia, HIV/AIDS, Gonorrhea, etc.).

Stakeholder	Individuals or groups who are affected or likely to be affected by the project (project-affected parties); and may have an interest in the Project (other interested parties).
Subcontractors	All companies, persons working directly for these companies, or employed by an employment agency, that are under contract to carry out work for HEC, as part of the construction workforce.
Unsatisfactory	Where work undertaken does not meet expectations or
conduct	requirements.
Vector-borne	Vector-borne diseases are human illnesses caused by parasites,
diseases	viruses and bacteria that are transmitted by mosquitoes, sand-tlies, triatomine bugs, blackflies, ticks, tsetse flies, mites, snails and lice (e.g. malaria, yellow fever, etc.).
Workers	Individual person/s engaged in Project activities, including
	employees, subcontractors, temporary and permanent staff.
Workforce	All persons engaged in Project activities, including both employees and contractors.

# 1. INTRODUCTION

## 1.1. Background

The Tina River Hydropower Development Project (TRHDP) (the Project) is the first large utilityscale renewable energy project to be developed in the Solomon Islands. The Project is located on central Guadalcanal and will support the development of renewable energy to supply electricity for Honiara. The Project consists of four components:

- A 15-megawatt (MW) hydropower facility.
- 21.5 milometers (km) of access roads.
- 44 km of 66 kilovolt (kV) transmission line<sup>1</sup>, consisting of two parallel lines of 22 km long.
- Technical assistance to the Solomon Island Government to implement the scheme.

The Project is managed by a dedicated government Project Office sitting within the national Ministry of Mines, Energy and Rural Electrification (MMERE). The project is financed by the Solomon Island Government (SIG), plus six different financiers known as the concessional finance partners (CFPs).

Tina Hydropower Limited (THL) is the project developer established by Korea Water Resources Corporation (K-Water) and Hyundai Engineering Company (HEC). THL will Build, Own, Operate and Transfer (BOOT) the Project under an Implementation Agreement (IA) and a Power Purchase Agreement (PPA) with the SIG. The BOOT concession is for a 30-year period, following commissioning. HEC is the engineering, procurement, and construction (EPC) contractor responsible for design and construction of the hydropower scheme, excluding the transmission line. This component will be built by Solomon Power.

Construction activities will take place on land acquired for the Project in 2014, known as the Core Land, and along the public Black Post Road. The Tina Core Land Company (TCLC) is a joint venture between customary landowners and the government and hold rights to the Core Area, including the access road from the power station to the dam site. This land will be leased to THL for the duration of the BOOT concession.

Approval to commence construction of the Lot 1 access road (the upgrade of Black Post Road) was granted on 14 June 2021 by the CFPs. Construction of Lots 2 and 3 access roads and temporary facilities was authorised on 16 June 2022. Approval to commence Main Works has not yet been granted. The construction phase of the Project is estimated to last 54 months.

## 1.2. Aim and Scope

The updated Environmental and Social Impact Assessment (ESIA) prepared for the Project in 2019 included a list of environmental and social management plans (ESMPs) to be prepared. These included plans related to dam safety, project preparation, construction, operations, and monitoring (refer Table 1-1 and Annex P-1-I). The CFPs are required to review and approve the ESMPs related to the construction phase prior to the commencement of Main Works.

This document presents the P-1 Construction Environment and Social Management Plan (CESMP) for the construction phase of the Project. The CESMP specifies how the Project will achieve the environmental and social safeguards for the project under in-country regulations and CFP requirements. The CESMP also specifies the other ESMPs, or sub-plans, that are required to be implemented and complied with by the Project company and contractor

<sup>&</sup>lt;sup>1</sup> The transmission line will briefly be described as an Associated Facility. The E&S safeguards requirements for the Transmission Line are the responsibility of Solomon Power and will be covered in separate documentation.

during the construction phase. It provides an overview of how these plans interact and serves to reduce repetition and overall risks associated with the Project during construction.

The CESMP and sub-plans cover all aspects of the hydropower facility and access roads to be constructed by the EPC contractor. HEC, on behalf of THL, are required to implement and adhere to the plans during the construction phase. There are also elements of the CESMPs to be implemented by other project stakeholders, which are specified in each plan.

No.	Name	Owner	
Prepar	ation Phase Plans		
P-1	Construction ESMP	HEC HSE Manager	
P-2	Biodiversity Management Plan*	HEC HSE Manager	
P-3	Stakeholder Engagement and Communication Plan	THL E&S Manager	
P-4	Human Resources and Labour Management Plan	HEC Administration Manager	
P-5	Influx Management Plan	HEC Administration Manager	
P-6	Grievance Redress Mechanism	THL Governance Lead / E&S Assistant (Social)	
P-7	Security Management Plan	HEC HSE Manager	
P-8	Worker's Health and Safety Plan	HEC HSE Manager	
P-9	Workers Code of Conduct	HEC Administration Manager	
P-10	Community Health and Disease Vector Management Plan	HEC HSE Manager	
P-11	Traffic Management Plan	HEC HSE Manager	
P-12	Waste Management and Point Source Pollution Plan	HEC HSE Manager	
P-13	Hazardous Materials Management Plan	HEC HSE Manager	
P-14	Spill Prevention and Emergency Response Plan	HEC HSE Manager	
P-15	Air Quality Management and Dust Control Plan	HEC HSE Manager	
Construction Phase Plans			
C-1	Cultural Heritage Management Plan (not included here)	MMERE	
C-2	UXO Management Plan	HEC Construction and HSE Managers	
C-3	Forest Clearance Plan	HEC HSE Manager	
C-4	Post-construction Rehabilitation and Revegetation Plan	HEC HSE Manager and Rehabilitation Consultant	
C-5	Quarry Management Plan	HEC Construction and HSE Managers	
C-6	Reservoir Preparation Plan (not included here)	MMERE	
C-7	Water Supply Replacement Plan	HEC Project Control and HSE Managers	
C-8	Watercourse Crossing Management Plan	HEC HSE Manager	
C-9	Spoil and Topsoil Management Plan	HEC HSE Manager	
C-10	Drainage, Erosion and Sediment Control Plan	HEC HSE Manager	
C-11	Drill and Blast Management Plan	HEC HSE Manager	

Table 1-1: List of ESMPs relevant to the construction phase, and responsibility for implementation

No.	Name	Owner		
C-12	Stormwater Management Plan (not required)			
C-13	Noise and Vibration Management Plan	HEC HSE Manager		
C-14	Cumulative Impact Management Strategy Solomon Islands Government			
Monitoring Plans				
M-1	Suspended Sediment Monitoring Plan	HEC HSE Manager		
M-2	Water Quality Monitoring Plan	HEC HSE Manager		
M-3	Fish, Algae, and Macro-Invertebrate Monitoring Plan	HEC HSE Manager		
M-4	Social Impacts Monitoring Plan (not included here)	PO E&S Safeguards Manager & THL E&S Manager		
M-5	Flora and Fauna Monitoring Plan	HEC HSE Manager		
M-6	Construction Works Monitoring Plan	HEC HSE Manager		
M-7	Air Quality and Noise Monitoring Plan	HEC HSE Manager		

\* P-2 covering construction and operational impacts and mitigation. Offsetting covered in two separate documents: Terrestrial Offset Management Strategy (T-OMS) and Aquatic Offset Management Strategy (A-OMS).

# 2. PROJECT DESCRIPTION

The Project comprises a 15-megawatt (MW) hydropower facility and associated permanent and temporary infrastructure.

Main works includes a dam and reservoir on the Tina River, intake and tunnel delivering the water to the powerhouse 4.5 km downstream, and electrical switchyard (Figure 2-1).

Temporary facilities required for construction include a camp to accommodate workers, site office, batch and crusher plants, explosives magazine and stockpile/spoil disposal areas.

These components are described in the following sections. The construction methodology for each item is provided in Annex P-1-II.

### 2.1. Main Works

#### 2.1.1. Dam and Reservoir

The main works for the Project comprise a 72 m high Roller Compacted Concrete (RCC) dam (from foundation to dam crest) 30 km inland. Works also include a spillway, scour outlet, riparian outlet and parapet wall (refer to Figure 2-2).

The specifications for the main dam are:

- River level at dam site 122 masl
- Average river discharge at dam site 13.1 m<sup>3</sup>/s
- Minimum operating level 170 masl (outlet for environmental flow)
- Normal operating level 172 masl
- Full supply level (FSL) 175 masl
- Reservoir length 2.6 km
- Reservoir area at FSL 30 ha
- Reservoir volume active storage 1.42 million m<sup>3</sup>, dead storage 3.25 million m<sup>3</sup>
- Maximum flood level 187.5 masl
- Dam crest length 219 m
- Environmental flow minimum of 1.0 m<sup>3</sup>/s<sup>2</sup>
- Spillway width 55.0 m
- Riparian outlet diameter 0.8 m
- Scour outlet dimensions 3.0 m width, 3.0 m height and 59.3 m length

The Tina River will be diverted to facilitate the construction of the main dam. The river diversion will involve a longitudinal cofferdam, upstream cofferdam, downstream cofferdam and diversion culverts. Construction of the river diversion works will take approximately 11 months and will remain in place for 22 months while the main dam is constructed. The design flood for river diversion is 360 m<sup>3</sup>/sec (1 in 2 year return interval flood event).

Prior to reservoir inundation, it will be necessary to clear vegetation to reduce the potential for decaying organic matter to reduce the water quality within the reservoir and downstream of the powerhouse. The responsibility for this activity rests with SIG and will be addressed in C-6 Reservoir Preparation Plan (RPP).

<sup>&</sup>lt;sup>2</sup> According to the ESIA 2019, provision of a 1 m3/s environmental flow between the dam and powerhouse should maintain or improve fish and benthic invertebrate densities and total numbers for most species. A higher 3.4 m3/sec discharge overnight during reservoir filling was also recommended.



Figure 2-1 Overview of the Project construction and reservoir footprint



Figure 2-2 General Plan of Dam Site

During construction and operation, an environmental flow (eflow) of at least 1 m<sup>3</sup>/sec will be maintained downstream of the dam. During operations, this will be maintained via an eflow conduit located at RL 165 masl in the dam face. The eflow will vary from 1.32 m<sup>3</sup>/sec at full supply level, reducing to 1.16 m<sup>3</sup>/sec at minimum operating level, and 0.98 when the reservoir drops to 165 masl (Figure 2-3).

Upstream migration of fish will be maintained via a trap and haul system.

The design and operation of the eflow conduit(s) and trap and haul system is being reviewed by Stantec alongside the update of P-2 Biodiversity Management Plan. The turbine operations, including ramping up and ramping down of flows, will also be considered.



Figure 2-3: Discharge rates from the eflow conduit in the dam at different water levels

### 2.1.2. Headrace Tunnel, Power Tunnel and Penstock

There are five components of the tunnel and pipeline that delivers water from the reservoir to the powerhouse:

- Intake
- Headrace tunnel
- Surge tank
- Power tunnel
- Penstock

The intake is located at approximately 160 masl and will be 3.8 m wide and 3.8 m high. The intake includes a fish screen with a diameter of 25mm (Figure 2-4). This is consistent with the environmental flow and fish passage assessment completed in the ESIA which recommended 15-25 mm screens in front of the intake structure to prevent the ingress of large eels.

The headrace tunnel is 3,220.59 metres in length by 3.8 metres diameter, constructed by a shield tunnel boring machine which automatically drills the tunnel and places supports. A restricted orifice surge tank/shaft, diameter 7.0 m and height 47.4 m, will be located at the end of the headrace tunnel.

The power tunnel is 74 metres long and ranges from 3.0 to 3.8 metres in diameter. This will be constructed via a combination of a shield tunnel boring machine and new Austrian tunnelling method (which involves drilling and blasting). The steel penstock (diameter 3.0 m, length 153.67m) and control valve chamber will be located within the power tunnel (refer to Figure 2-5).

For both tunnelling methods, spoil material will be extracted via railway and small wagons. Trucks will then transport the spoil to the disposal site.

#### 2.1.3. Powerhouse

The powerhouse will be located 5.4 km downstream from the dam on the left bank of the Tina River. The tailrace will be at river elevation 73 masl. The powerhouse will have three vertical Francis turbine generator units, each with a capacity of 5 MW, allowing a maximum discharge of 19 m<sup>3</sup>/s and a minimum discharge of 2.4 m<sup>3</sup>/s. An environmental flow of at least 1 m<sup>3</sup>/s will be maintained between the dam and the powerhouse tailrace, a distance of 5.7 km.

The powerhouse building will be 607 m<sup>2</sup> in area (39.7m long and 15.3m wide), with two floors hosting the generator units and auxiliary equipment. There is also a control and admin building of 4.12.5 m2 for operational staff.

To the south of the powerhouse there will be a switchyard and 62.5 m<sup>2</sup> switchyard control building. The switchyard control building will include a battery room, workshop and storage.



Figure 2-4: Fish screen for the intake structure



Figure 2-5 General Plan of Powerhouse Site

## 2.2. Access Roads

Access roads to the Project include the upgrade of an existing public road (Lot 1), upgrade of an existing logging road (lot 2-1) and construction of project-specific roads (Lots 2-2, 2-3, 3-1 and 3-2).

Lot 1, Black Post Road to Managikiki village will require upgrading to accommodate the passage of construction traffic in both directions. The first 7.6 km of Black Post Road is an existing gravel public road and will provide access to the Project site on most of its current alignment (approximately 7.6 km). The remaining length follows a new alignment, by-passing Marava Village and linking back with the existing formed access to Managikiki Village.

Lot 2 is an extension to Black Post Road that passes through steep terrain from Managikiki village, until the dam site. Lot 2 lies within the Project Core boundary and will be used for project purposes only. The access road Lot 2-1 is designed to be in the same alignment with a logging road up to 2.5 km. Lot 2-2 and 2-3 constitute the access road that extends to the dam, with the entire section of the route designed as a new route for one-way heavy vehicular access. The route has been designed taking the steep topography into consideration.

Lot 3 access road begins south of Managikiki village and extends to the powerhouse site near Tina River. Lots 2-1, 2-2 and 3-1 will have concrete pavement installed at the end of construction. All other roads will be gravel except for localised steep sections that will be cement stabilised gravel or concrete pavement.

HEC will need to ensure that appropriate pavement is maintained throughout construction to permit access for heavy vehicles, as well as to prevent erosion and sediment runoff and to ensure the safety of workers and the community.

#### Table 2-1 Description of access roads

#	Section	Length (km)	Width (m)	Infrastructure*	Description
Lot 1	-	13.200	7.0	<ul> <li>39 drainage pipes totalling 463 m</li> <li>19 road signs</li> <li>1,449.5 m guardrail</li> <li>607.3 m of guard fence</li> </ul>	Dual lane public road. Upgrade of existing Black Post Road from the junction on the Kukum Highway to the terminus south of Managikiki village. Temporary surfacing: Gravel Permanent surfacing: Mostly gravel. Concrete from Sta.7+600 to Sta.7+840
Lot 2	2-1	2.500	7.0	<ul> <li>2 x drainage pipes of 24.0 metres</li> <li>4 x road signs</li> <li>390 m guardrail</li> </ul>	Dual lane, private road. Existing logging road (apart from small diversion at Managikiki village). First 2.5 km to the fork with Lot 2-2 that goes to the dam. Temporary surfacing: Gravel Permanent surfacing: Mostly cement stabilised gravel. Concrete from Sta.2+220 to Sta.0+940, and Sta.1+540 to Sta.2+500
	2-2	2.731	4.5	<ul> <li>1 x box culvert of 30 m</li> <li>3 x drainage pipes of 67.8 m</li> <li>1,167 m of guardrail</li> </ul>	Single lane, private road. Access road to main dam and reservoir. Temporary surfacing: Gravel, concrete where necessary. Permanent surfacing: Concrete
	2-3	0.456	4.5	<ul> <li>2 x drainage pipes of 18.1 m</li> <li>3 x road signs</li> <li>36 m guardrail</li> </ul>	Single lane, private road. Short section of access road to base of dam. Temporary surfacing: Gravel, concrete where necessary. Permanent surfacing: Concrete
Lot 3	3-1	1.509	4.5	<ul> <li>3 x drainage pipes of 30.6 m</li> <li>4 x road signs</li> <li>845 m guardrail</li> </ul>	Single lane, private road. Main access road to powerhouse. Initially gravel, to be sealed at the end of construction. Temporary surfacing: Gravel, concrete where necessary. Permanent surfacing: Concrete
	3-2	0.022	5.0	• 1 x drainage pipe of 6.1 m	Single lane, private road. Short access road to tunnel portal. Temporary surfacing: Gravel Permanent surfacing: Concrete

\*Subject to change given on-site conditions



Figure 2-6 Overview of access roads leading to the powerhouse and dam site

## 2.3. Temporary Facilities

Temporary facilities will be required during construction and can later be disassembled and/or disbanded and rehabilitated. The temporary facilities for the Project include:

- Workers' accommodation camp
- Site office and laboratory
- Crusher plant
- Concrete batch plant (office)
- RCC batch plant (dam)
- Explosives magazine
- Spoil disposal sites
- Material stockpiles
- Aggregate extraction sites
- Water supply bores
- Laydown areas.

#### 2.3.1. Workers Accommodation Camp

A Workers' Accommodation Camp (WAC) has already been established on a site known as Grass Hill within Malango Ward. The camp is located outside of the core boundary, west of Black Post Road, on a leased perpetual estate. This facility will house up to 214 non-local workers (expats) during the peak construction period (Figure 2-7). The following facilities are available in the WAC premises and will be used for Project purposes:

- Accommodation for workers
- Workshop for project vehicle servicing
- Warehouse for storage of equipment, materials and supplies for the installation during construction phase
- Office for Camp Management<sup>3</sup>
- Security Guard House
- Parking area for light vehicles and heavy equipment
- Water supply bore
- Fuel storage for diesel generator operations
- Hazardous chemical store
- Waste management area
- Membrane bioreactor wastewater treatment plant (WWTP).

As the WAC itself, the WWTP, and water supply bores for the construction phase were not covered the Project ESIA<sup>4</sup>, three standalone ESIAs were prepared at the request of the CFPs. The purpose of these documents were to ensure adherence to CFP safeguards and to identify and address the anticipated environmental and social impacts of these facilities. The Camp Impact Assessment is appended to **P-4 Human Resources & Labour Management Plan.** A compliance audit of this facility is pending. The Sewage Treatment Plant Impact Assessment is available as an annex to **P-12 Waste Management and Point Source Pollution Plan.** The Groundwater Impact Assessment is available as an Annex to **C-7 Water Supply Replacement Plan.** 

<sup>&</sup>lt;sup>3</sup> Stantec understands that this office will now be used as a Construction Office as well, with a smaller office maintained on site.

<sup>&</sup>lt;sup>4</sup> The ESIA was written assuming that all workers would be housed in existing accommodation in Honiara. Wastewater was to be collected and trucked to the Ranadi landfill. Water supplies were to be from Tina River.



Figure 2-7 Worker's accommodation camp

### 2.3.2. Site Office

The site office is located within Core Plan adjacent to Lot 2-1 STA 1+100 km in the Direct Impact Area. The location was chosen considering two aspects:

- **Construction and management efficiency** Considering the distance between office sites and construction sites such as the dam and powerhouse, the location is optimized for site accessibility and emergency preparedness and response.
- Environment and social impact The location was previously disturbed due to human activities such as logging and gardening. A walk-through and pre-clearance survey had been undertaken and concluded that there are no significant ecosystems near the target area. Further, given the distance and topography specification, this location can minimize the impact on surrounding communities.

The main facilities that are planned to be installed at the site office premises include (Figure 2-8):

- Office buildings for employer, contractor and subcontractors
- Concrete batch plant for concrete production
- Crusher plant for crushing rock to produce sand and aggregates
- Septic system
- Water supply bore
- Auxiliary facilities like fuel storage tank, chemical store, generator.



Figure 2-8 Office premises layout

A crusher plant will produce aggregates for concrete to be used for a wide variety of uses including RCC dam and powerhouse concrete works, concrete lining of headrace tunnel and surge tank, penstock saddles and anchor blocks, shotcrete over a large area, and foundations for infrastructure, etc. Proposed production capacity is 150 tonnes/hour. A temporary stock yard will be provided. A second crusher plant will be installed specifically for RCC aggregate. A layout is yet to be confirmed.

An excavator and a front-end loader will operate at the crusher plant, while dump trucks will transport aggregates to and from the site. Electricity supply, water supply and wastewater treatment facility will be provided.

The expected production from the conventional vibrated concrete batch plant (operating 12 hours a day) will be 936 m<sup>3</sup>/day. Treatment facilities for residual concrete and polluted water (truck mixer cleaning and aggregate recycling) will be installed. Sludge that is dehydrated and compressed and will be reused on stie or transported to a dedicated disposal area (see Section 2.3.5).

The RCC batch plant output (operating 24 hours a day) will be 1,728 m<sup>3</sup>/day. This batch plant will be located near the true left dam abutment as shown on *Figure* 2-2.

#### 2.3.3. Explosives Magazine

The explosives magazine is located on a side road near the Lot 2-2 access road. The magazine is a specialist bunded and fenced compound that has a designated security post.



The total volume of explosives required for construction is:

• Explosive (NewMITE Plus): 100,000 KGEA

- Electric detonator (HiDETO Plus): 2,100 EA
- Nonelectric detonator (HiNEL Plus MS): 36,600 EA
- Nonelectric detonator (HiNEL Plus SDD): 9,100 EA

#### 2.3.4. Spoil Disposal Sites

Approximately 1,670,226 m<sup>3</sup> of spoil material is to be generated from the Project as a result of the following activities:

- Blasting and excavation of the main dam, coffer dam and associated construction activities;
- Blasting and tunnelling associated with the headrace tunnel, power tunnel and surge tank;
- Blasting and excavation of access roads Lot 2 and 3;
- Widening of Black Post Road (Lot 1); and
- Unsuitable material from aggregate crushing and processing.

Where material is suitable quality, it will be reused on site as aggregate. However poorer quality material will need to be disposed of on site. HEC has already established one spoil disposal site outside of Core Land (Lot 0, refer Figure 2-11). This site was approved for use by SIG but was subject to a Corrective Action Plan from the CFPs as this site was not previously assessed in the ESIA 2019.

HEC currently proposes to establish six more spoil disposal areas to be used for materials produced by the excavation for the dam, excavation of the headrace tunnel and surge tank, excavation of the powerhouse and other structures, surplus soil during road works and sand. These sites are shown in Figure 2-1. The total volume disposed at sites 1-1, 1-2, and 1-3 will be 534,015 m<sup>3</sup> from road works and main dam construction. The volume at site 2 is 147, 979 m<sup>3</sup> from road work, while 577,196 m<sup>3</sup> and 411,036 m<sup>3</sup> will be disposed at sites 3 and 4 respectively from excavation of the tunnels, surge tank and powerhouse.

The location and design of each spoil disposal area is reviewed by OE. Due to steep topography, heavy rainfall during the wet season, and poor stability of spoil material, establishing and maintaining stable spoil disposal sites is a challenge. It is for this reason that some sites are yet to be approved.



Following completion of use, spoil disposal areas will be progressively revegetated.

Figure 2-11: Spoil disposal site 0, July 2022

### 2.3.5. Aggregate Supplies

The Project requires approximately 376,420 m<sup>3</sup> of aggregate for the construction phase. This is expected to be sourced as follows:

- 165,140 m<sup>3</sup> of blasted rock sourced in-situ from blasting and excavation of the dam site and access roads;
- 66,918 m<sup>3</sup> of river alluvium sourced from the Tina River within Core Land;
- 24,400 m<sup>3</sup> of river alluvium sourced from Solomon Sheet Steel (SSS).
- 142,931 m<sup>3</sup> of river alluvium sourced from other commercial suppliers, such as Vatumarasa Resource Limited (VRL) and ZYG Trading Co. Limited.

Sourcing aggregate from within Core Land is permitted under the ESIA 2019. Hard rock quarries with suitable aggregate are not available within Core Land, therefore won rock and river aggregate will be used. Additional river aggregate will be sourced from commercial suppliers. Existing suppliers will be audited prior to supplying to the project, to ensure that Project safeguard standards are being upheld. New commercial suppliers established for the purpose of supplying to the Project shall be subject to a standalone Environmental and Social Impact Assessment (ESIA) as they are considered Associated Facilities<sup>5</sup> under CFP safeguard policies. More detail on aggregate supplies and environmental and social management is provided in C-5 Quarry Management Plan.



### 2.3.6. Material Stockpiles

Stockpiles are required for the temporary storage of materials prior to use during construction or site rehabilitation. The type of stockpiles on site will include:

- Raw aggregate storage (i.e. river gravels)
- Processed aggregate
- Topsoil
- Vegetation and mulch.

Stockpiles from aggregate production and for concrete production will be located at the two batch plants: one at the site office area and one at the RCC dam. Further stockpiles will utilise the flat areas created by the spoil disposal sites discussed above. HEC has no plan to make additional stockpiling area for aggregate, but is increasing the sites of plan to increase the size of disposal site #3 and crusher plant site for aggregate stockpiling area

<sup>&</sup>lt;sup>5</sup> Associated Facilities are not funded as part of the project and whose viability and existence depend exclusively on the project and whose goods or services are essential for successful operation of the project (ADB, 2009).

Topsoil, unmerchantable vegetation and mulched material will also be temporarily stored at the spoil disposal sites. Temporary storage of felled logs is the responsibility of TCLC and will occur outside of Core Land.

### 2.3.7. Demolition and Rehabilitation of Temporary Facilities

As part of the construction phase, all areas of temporary disturbance will need to be progressively remediated, rehabilitated or restored. This will involve:

- the dismantling and removal of structures and facilities,
- removal of all construction equipment and waste materials,
- revegetation of cleared and disturbed areas including temporary access roads, spoil disposal areas, temporary erosion control structures, sites of buildings and plant, and around the dam, cofferdams, tunnel portals, pipeline and powerhouse
- identification and remediation of any contaminated sites.

**C-4 Post-construction Rehabilitation and Revegetation Plan** outlines the mitigation and management actions and monitoring required to be implemented in order to mitigate impacts from clearing and construction of the project.

It is understood that the Workers Accommodation Camp will remain and will not be rehabilitated at the end of construction. This is at the request of the community.

## 2.4. Associated Facilities

Associated facilities are activities or infrastructure that are not funded as part of the project but whose viability and existence depend exclusively on the project and whose goods or services are essential for successful operation. Funding may be provided separately by the project proponent or by third parties. Associated facility must adhere to CFP safeguard policies, even if funded separately. These facilities are likely to require significant approval processes involving completion of an ESIA.

### 2.4.1. Transmission Lines

Power generated from the Project will be transferred to the Honiara electricity system through two 22-kilometre long, parallel single-circuit 66 kilovolt transmission lines. The transmission line will originate at the Project switchyard and terminate at the existing Lungga Diesel Power Station. All pylons will be installed within the access road corridor secured for the Project.

This part of the Project will be implemented by the Solomon Islands Electricity Authority (SIEA), trading as Solomon Power. The Australian Infrastructure Financing Facility for the Pacific (AIFFP) is partnering with SEIA to fund and develop the transmission system.

The safeguards requirements for the transmission line are the responsibility of Solomon Power and will be covered in separate documentation.

### 2.4.2. Aggregate Source

As discussed in section 2.3.5, the Project is considering sourcing gravel from new sources. Any new gravel extraction sites that are established for the sole purpose of supplying the Project will be considered an Associated Facility under CFP safeguard policies.

## 2.5. Construction Methodology and Schedule

The latest construction methodology and updated schedule is included in Annex P-1-II and P-1-III, respectively.

### 2.6. Sensitive Receptors and Known Water Sources

The following figure shows the sensitive receptors close to the project area, such as villages, schools and churches. Also shown are the known community water sources that could potentially be impacted by the project.



# 3. LEGAL AND REGULATORY FRAMEWORK

The CESMP and associated sub-plans have been developed with regard to relevant legal requirements, national and international standards and guidelines. The operational practices to be implemented during this project have been designed based on relevant regulations, guidelines and standards at the time of the last version of ESIA and EIS and will be reviewed annually during the construction phase.

Should the Project change or new regulations, guidelines or standards apply, HEC will review and amend the CESMP and sub-plans as required. Any changes will be subject to review by THL and potentially require the approval of the Project Office (PO) and CFPs, in accordance with the review procedure outlined in section 7.1.

## 3.1. In-country Safeguards

The following legislation will be continually reviewed to ensure that proposed work practices comply with the legislative requirements. A summary of these documents is provided in Annex P-1-IV.

- Solomon Islands Electricity Act 1969
- Solomon Islands Environment Act 1998
- Solomon Islands Environment Regulation 2008
- Solomon Islands Environmental Health Act 1980
- Solomon Islands Environmental Health (Public Health Act 1970) Regulations
- Solomon Islands Explosive Act 1968
- Solomon Islands Fisheries Management Act 2015
- Solomon Islands Forest Resources and Timber Utilization Act 1969
- Solomon Islands Roads Act 1996
- Solomon Islands Traffic Act (Revised Edition, 2009)
- Solomon Islands Labour Act (Revised Edition 1996)
- Solomon Islands Guadalcanal Historic Places Ordinance 1985
- Solomon Islands Mines and Minerals Act 1990
- Solomon Islands National Provident Fund Act (Revised Edition, 1993)
- Solomon Islands Provincial Government Act 1997
- Solomon Islands Public Health Ordinance 1970
- Solomon Islands Protected Areas Act 2010
- Solomon Islands River Water Ordinance 1969
- Solomon Islands River Waters Act 1964
- Solomon Islands Safety at Work Act 1982
- Solomon Islands Trade Unions Act (Revised Edition 1996)
- Solomon Islands Water Authority (Catchment Areas) Regulations LN 42 1995
- Solomon Islands Water Authority Act 1992
- Solomon Islands Workmen's Compensation Act (Revised Edition 1996)
- Solomon Islands Unfair Dismissal Act (Revised Edition 1996)
- Solomon Islands Wild Birds Protection Act 1914
- Solomon Islands Wildlife Protection and Management Act 1998
- Law of Solomon Islands, Chapter 131, Traffic Act, 1996
- Law of Solomon Islands, Chapter 129, Roads Act, 1996
- Ministry of Infrastructure Development Safeguards Procedures Manual (no date)

## 3.2. International Safeguards

### 3.2.1. International Treaties, Standards and Guidelines

The following international treaties, standards and guidelines apply to the Project.

- Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal ()
- Convention for the Protection of Natural Resources and Environment of the South Pacific Region (1986)
- International Convention on Civil Liability for Oil Pollution Damage (1992)
- London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (1972)
- Stockholm Convention on Persistent Organic Pollutants (2001)
- United Nation's Code of Conduct for Law Enforcement Officials (1979)
- Waigani Convention on Hazardous & Radioactive Wastes (1995)
- World Health Organization (WHO) guidelines for drinking-water quality (2017)
- The International Association for Impact Assessment (IAIA) Guidelines on Social Impact Assessment
- Noumea Convention, Protocol for the prevention of pollution of the South Pacific region by dumping, 1986
- Pollution Protocol for Dumping (Ratified 10/9/98)
- Pollution Protocol for Emergencies (Ratified 10/9/98)

#### 3.2.2. International Labour Organization Conventions

The following Conventions have been ratified by the SIG and apply to labour employed during Project construction:

- C029 Forced Labour Convention, 1930 (No. 29) (06 Aug 1985)
- C087 Freedom of Association and Protection of the Right to Organise Convention, 1948 (No. 87) (13 Apr 2012)
- C098 Right to Organise and Collective Bargaining Convention, 1949 (No. 98) (13 Apr 2012)
- C100 Equal Remuneration Convention, 1951 (No. 100) (13 Apr 2012)
- C105 Abolition of Forced Labour Convention, 1957 (No. 105) (13 Apr 2012)
- C111 Discrimination (Employment and Occupation) Convention, 1958 (No. 111) (13 Apr 2012)
- C138 Minimum Age Convention, 1973 (No. 138) (Minimum age specified: 14 years) (22 Apr 2013)
- C182 Worst Forms of Child Labour Convention, 1999 (No. 182) (13 Apr 2012)
- C081 Labour Inspection Convention, 1947 (No. 81)
- C011 Right of Association (Agriculture) Convention, 1921 (No. 11) (06 Aug 1985)
- C012 Workmen's Compensation (Agriculture) Convention, 1921 (No. 12) (06 Aug 1985)
- C014 Weekly Rest (Industry) Convention, 1921 (No. 14) (06 Aug 1985)
- C016 Medical Examination of Young Persons (Sea) Convention, 1921 (No. 16) (06 Aug 1985)
- C019 Equality of Treatment (Accident Compensation) Convention, 1925 (No. 19) (06 Aug 1985)
- C026 Minimum Wage-Fixing Machinery Convention, 1928 (No. 26) (06 Aug 1985)
- C042 Workmen's Compensation (Occupational Diseases) Convention (Revised), 1934 (No. 42) (06 Aug 1985)
- C045 Underground Work (Women) Convention, 1935 (No. 45) (06 Aug 1985)
- C084 Right of Association (Non-Metropolitan Territories) Convention, 1947 (No. 84) (28 May 1984)
- C094 Labour Clauses (Public Contracts) Convention, 1949 (No. 94) (06 Aug 1985)
- C095 Protection of Wages Convention, 1949 (No. 95) (06 Aug 1985)
- C108 Seafarers' Identity Documents Convention, 1958 (No. 108)

### 3.2.3. Other International Guidelines and Standards

- Australian and New Zealand Environment and Conservation Council (ANZECC), Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2018)
- Australian Government, Australian Drinking Water Guidelines (ADWG) 2011 (updated October 2017)
- Economic Development Cooperation Fund (EDCF) Safeguard Policy (2016)
- FAO Code of Practice for Forest Harvesting in Asia-Pacific (1999)

### 3.3. CFPs Safeguards

### 3.3.1. World Bank Group

- The World Bank Environmental and Social Framework, World Bank, 2016
- World Bank Safeguards Policies
  - OP 4.01 Environmental Assessment
  - OP 4.03 Performance Standards for Private Activities.
  - OP 4.04 Natural Habitat
  - OP 4.11 Physical Cultural Resources
  - OP 4.12 Involuntary Resettlement
  - OP 4.36 Forests
  - o OP 4.37 Operational Policy, Safety of Dams
- IFC Performance Standards (2012)
  - PS1 Assessment and Management of Environmental and Social Risks and Impacts (2012)
  - PS2 Labour and Working Conditions
  - PS3 Resource Efficiency and Pollution Prevention
  - o PS4 Community Health, Safety, and Security, 2006
  - PS6 Biodiversity Conservation and Sustainable Management of Living Natural Resources (2012)
  - PS8 Performance Standard Cultural Heritage
- IFC/EBRD Workers' accommodation: processes and standards (2009)
- World Bank Group Environmental, Health, and Safety (EHS)Guidelines and industryspecific guidelines:
  - World Bank Group EHS General Guidelines (2007)
  - World Bank Group EHS Guidelines: Waste Management (2007)
  - World Bank Group EHS Guidelines: Construction and Decommissioning (2007)
  - World Bank Group EHS Guidelines: Environmental Wastewater and Ambient Water Quality (2007)
  - World Bank Group EHS Guidelines: Forest Harvesting Operations (2007)
  - World Bank Group Guidelines for Construction Materials Extraction (2007)
- World Bank "Managing The Risks of Adverse Impacts On Communities from Temporary Project Induced Labour Influx" Guidance Note (2016)
- Executed Power Purchase Agreement (PPA) Schedule 16, p 241 and 242

### 3.3.2. Asian Development Bank

- ADB Safeguard Policy Statement (2009)
- ADB Environment Safeguards: A Good Practice Sourcebook (Draft Working Document) (2012)
- ADB Operations Manual: Section F1: Environmental Considerations in ADB Operations (2006)

# 4. ROLES AND RESPONSIBILITIES

Having an appropriate organizational structure in place, with appropriately defined roles and responsibilities, is essential to ensuring the overall success of the Project.

## 4.1. Solomon Islands Government

The Solomon Islands Government (SIG) is developing the project for the people of the Solomon Islands.

### 4.1.1. Ministry of Finance and Treasury

The Ministry of Finance and Treasury is administering the funds for the project on behalf of the SIG and CFPs. The Ministry will apportion funds to THL for the implementation of the hydropower facility and access roads, to the Solomon Islands Electricity Authority (SIEA) for the Transmission Line, and to Ministry of Mines, Energy and Rural Electrification (MMERE) for establishment and operation of the Project Office. On behalf of SIG, the Ministry of Finance and Treasury will enter into the power purchase agreement with THL, and jointly with MMERE, enter into the implementation agreement with THL.

### 4.1.2. Solomon Power

Solomon Islands Electricity Authority (SIEA), trading as "Solomon Power" is the state-owned power utility. Solomon Power will purchase electricity from the Project through a Power Purchase Agreement. The also have responsibility for the construction and operation of the transmission line.

### 4.1.3. Ministry of Mines, Energy and Rural Electrification

MMERE oversees the mining and energy sector in the Solomon Islands, including rural electrification. The MMERE has established a Project Office (PO) to facilitate and oversee delivery of the project on behalf of SIG.

The PO is responsible for environmental and social compliance under the agreed terms of the ESIA and financing agreements. The PO have and will maintain the following environmental and social (E&S) monitoring team that will provide monitoring and oversight of environmental, social and gender-based safeguard obligations during the construction phase. The team will include, at a minimum:

- **E&S Manager:** Responsible for oversight of environmental and social issues on the Project, including ensuring that HEC and THL have obtained, maintained and complied with all applicable laws, regulations, permits, licences and consents.
- **Community Liaison Officer (CLO):** Contact point within the PO for community leaders and key contacts to obtain and receive information about the project.
- **Gender Focal Point:** Responsible for liaising on gender issues between Project Office management, THL, HEC, and other external stakeholders.

The PO will audit HEC and THL E&S performance on a regular basis, including monthly site visits to check compliance with all requirements, guidelines, procedures, timetables and other specifications set out in the CESMPs.

To assist with project implementation, SIG has engaged Norconsult as the Lender's Technical Advisor (LTA) to work through the PO. The main role of the LTA will be to identify and mitigate project risks on behalf of SIG during the implementation of the Project and to assist SIG to fulfil the obligations and requirements under the concessional finance agreements and onlending agreement with THL. The LTA will also act as the independent Environmental and Social Monitoring Agent (E&S Agent) as described in the concessional finance agreements. This will encompass monitoring of SIG and THL's compliance with the applicable environmental and social standards. The LTA will also monitor the environmental and social performance of SIEA's transmission line.

### 4.1.4. Ministry of Forestry and Research

The Ministry of Forestry and Research has a regulatory and support function associated with the Project. The Ministry has granted an exemption under the Forest Resources and Timber Utilisation Act (1970), allowing the Project to clear vegetation within Core Land associated with the construction phase of the Project.

The Ministry also has a regulatory function associated with the Tina River catchment and protection of the reservoir from sedimentation. The Ministry is working alongside MMERE and MEDCM to limit destructive land uses upstream of the Project. This includes reviewing all Timber Harvesting Licences and protection of forests at elevations above 400 masl as per the Forests Act (1996).

### 4.1.5. Ministry of Environment, Climate Change and Disaster Management

The Ministry of Environment, Climate Change and Disaster Management (MECDM) is the approving authority for the Development Consent to allow the project to proceed. The Project prepared an Environmental Impact Statement (aka. ESIA 2019) under the Environment Act of 1998.

The Ministry also has a regulatory function associated with the Tina River catchment and protection of the reservoir from sedimentation. The Ministry is working alongside MMERE and the Ministry of Forestry to limit destructive land uses upstream of the Project. This includes reviewing Development Consent applications for activities in the upper catchment.

#### 4.1.6. Solomon Islands Police Force

The Royal Solomon Islands Police Force have a role in the Project, and the CESMPs in particular, under the P-2 Biodiversity Management Plan, P-7 Security Management Plan and the C-2 UXO Management Plan.

The RSIPF works alongside the Project to ensure that the 50-metre-wide Lot 1 corridor remains clear, and has an enforcement role should illegal activities occur within Core Land or the upper catchment, such as trespassing, construction of structures, or illegal logging. During pre-clearance unexploded ordinance (UXO) surveys and in the case of chance finds, the Royal Solomon Islands Police Force Explosives Ordinance Unit (RSIPF EOU) assists with the clearance and transport of UXOs off-site. The EOU Explosives Ordinance Disposal Technician provides sign-off to allow the site to reopen and issues ALARP certification to confirm that the risk of UXO contamination within the survey area has been reduced to As Low As Reasonably Practicable. More information on UXO clearance process is provided in C-2 UXO Management Plan.

### 4.1.7. Tina Core Land Company

The Tina Core Land Company (TCLC) is a holding company established between the Solomon Island Government (50% ownership) and the five tribes who have customary land ownership in the Project area (50% ownership). TCLC is leasing the Core Land to THL via a 34-year lease agreement. The money generated from this agreement will be directed to the five tribes in a unique funding model where all rightful landowners, including women and children, will receive a nominated monthly payment directly into their account. The Project will be accompanied by a Community Benefit Share Fund anticipated to provide non-cash development benefits to the host community, such as social services, education, training, and improved community facilities.

The details of the lease are set out in the Lease Agreement signed between TCLC and THL. The lease permits THL to construct, operate and maintain the hydropower Project within Core Land. The lease also permits customary landowners to have pedestrian access within Core Land to carry out traditional livelihood activities of fishing, hunting and collection of nonwood forest products. It does not permit other activities such as felling of trees, conduct of agriculture, use of vehicles, or construction of houses or other structures. Entry to project sites and facilities is prohibited for health, safety and security reasons. Entry into Core Land by people outside of the five tribes is also not permitted.

## 4.2. THL

Tina Hydropower Limited (THL) is a joint venture between K-Water and HEC. THL is the Project developer that will Build, Own, Operate and Transfer (BOOT) the Project under an Implementation Agreement with SIG.

The THL E&S Manager has a team that assists with implementation and monitoring of environment, health and safety, and social matters. The THL E&S Assistant (Social) is the main contact point for day-to-day implementation of P-6 Grievance Redress Mechanism, with oversight from the THL Governance Lead in the early stages of construction. They are responsible for maintaining the Project Grievance Register and drafting and issuing formal written communications (acknowledgement, rejection, and agreed resolutions, and closing out) to complainants.

The organisational structure for THL is provided in Figure 4-1 (correct as of February 2023).

The key safeguard roles of the THL team are provided in Table 4-1.

### 4.3. HEC

HEC is the lead contractor responsible for the construction of the Project. The management team for HEC is shown in Figure 4-2. HEC's on-site personnel are organised in eight teams:

- 1. Design Team
- 2. Project Control Team
- 3. Tunnel Team
- 4. Dam & Powerhouse Team
- 5. Mechanical and Electrical Team
- 6. Quality Control Team
- 7. Health Safety and Environmental Team
- 8. Administration Team

The Health, Safety and Environmental Team is divided into three groups: Health & Safety, Environmental & Social, and Training. The HSE Manager is directly responsible for coordinating the three teams with the support of supervisors as shown in Figure 4-3.

A general description of the key roles of the Health, Safety and Environmental Team and their responsibilities are provided in Table 4-2. HEC is committed to providing the necessary human resources to ensure that the organisational structure can implement the CESMP and sub-plans and achieve compliance with all relevant standards. The minimum qualifications required for the key positions of the Project are detailed in Schedule 13 of the EPC Contract.



Figure 4-1 THL Organisational Chart

#### Table 4-1: Key safeguard roles and responsibilities of THL

Position	Responsibilities
THL E&S Manager	<ul> <li>Coordinate any stakeholder engagement activities, seeking assistance from PO and HEC where needed.</li> <li>Maintain the Project Stakeholder Engagement Database (as per P-3 Stakeholder Engagement and Communication Plan (SECP))</li> <li>Ensure implementation of ESMS as per ISO 14001 requirements, E&amp;S Standards and Good International Industry Practice, including reviewing HEC on-site activities and reporting to the HEC Manager on performance of ESMS including recommendation for improvements.</li> <li>Oversee Emergency preparedness of the Project.</li> <li>Supervise environmental and social consultants supporting the project.</li> <li>Liaise with Government agencies on issues related to licensing, approvals, project permitting requirements and coordinating for joint inspections.</li> <li>Take lead role in investigating incidents and grievances of critical nature and develop action plans.</li> <li>Resolve E&amp;S issues in case of non-compliance, and where needed, prepare a time-bound corrective action plan with specific follow-up procedures</li> <li>Participate in site inspections with HEC and subcontractors during construction.</li> <li>Prepare monthly E&amp;S performance reports.</li> <li>Audit HEC compliance with the CESMP and sub-plans.</li> </ul>
THL Governance Lead	<ul> <li>Provide internal THL oversight over GRM processes and social safeguards implementation, including Human Resources and labour practices and Community Benefit Share Pilot-related activities.</li> <li>Responsible for initial evaluation of grievances as they are received and decision on whether or not a grievance can be rejected without further investigation in accordance with P-6 Grievance Redress Mechanism.</li> <li>Responsible for critical objective evaluation of the effectiveness of GRM implementation, including conducting quarterly reviews.</li> <li>If GRM implementation is not adequate, the Governance Lead may approach the PO, THL and HEC managers to discuss measures required to improve performance.</li> </ul>
THL E&S Assistants	<ul> <li>The THL E&amp;S Assistant (Social) is the main contact point for day-to-day implementation of the GRM (with oversight from the THL Governance Lead). They are responsible for maintaining the Project Grievance Register and drafting and issuing formal written communications to complainants (acknowledgement, rejection, and agreed resolutions, and closing out).</li> <li>The THL E&amp;S Assistants (EH&amp;S) provide additional support to the THL E&amp;S Manager in terms of inspections, compliance, monitoring and reporting.</li> </ul>
Community Liaison Officer (CLO) and Community Liaison Assistant (CLA)	THL will have at least one CLO who are full time employees of the Project. They will provide a consistent contact point for local community leaders and key contacts and coordinate stakeholder engagement activities in affected communities. CLOs may also work with Community Liaison Assistants (CLAs) - people living in communities who provide assistance to implement engagement activities and serve as a contact point. CLAs receive an allowance for time spent assisting with the Project but generally don't work full time.


Figure 4-2: HEC site management (as of February 2023)



Figure 4-3 HEC health, safety and environment team structure (as of February 2023)

Table 4-2: Key safeguard roles and responsibilities of HEC

Position	Responsibilities
HEC Project Manager	Ensure adequate resources are provided to successfully implement this CESMP.
	<ul> <li>Ensure all HEC managers and subcontractors understand and fulfil their CESMP responsibilities.</li> </ul>
	<ul> <li>Ensure that the mitigation activities are sufficiently resourced with competent and trained personnel to comply with the requirements of the CESMP.</li> </ul>
HEC Construction Manager*	<ul> <li>Ensure that the HEC HQ Design Team integrates E&amp;S mitigation measures into the final project design.</li> <li>Participate in site inspections in relation to E&amp;S site measures as detailed in the CESMP.</li> <li>Review and approve detailed site plans and method statements incorporating E&amp;S measures.</li> <li>Ensure that all personnel involved in construction activities, including subcontractors and vendors, are adequately trained and informed on the requirements of the CESMP.</li> <li>Review and approve HSE reports.</li> </ul>
	<ul> <li>Audit subcontractor performance.</li> </ul>
HEC HSE Manager	<ul> <li>Maintain this CESMP.</li> <li>Ensure that all personnel including subcontractors and vendors are adequately trained and informed on the requirements of this CESMP.</li> <li>Lead site inspections with the HEC Construction Manager to plan and confirm the detailed design of E&amp;S site measures.</li> <li>Prepare detailed site plans integrating E&amp;S measures into final design drawings and method statements and submit these to the HEC Construction Manager.</li> <li>Lead weekly site inspections with subcontractors and THL during construction.</li> <li>Prepare weekly and incident HSE Performance Reports.</li> <li>Audit subcontractor E&amp;S performance.</li> </ul>
HEC E&S Team Manager	<ul> <li>Implement environmental and social safeguards under in-country regulations (local law) and requirements of the CFPs.</li> </ul>
HEC E&S Team Supervisor	<ul> <li>Undertake field inspections and environmental and social monitoring as stated in ESMPs, where allocated to this role), reporting any issues directly to the HEC HSE Manager on a daily basis.</li> <li>Contribute to weekly and incident HSE reports prepared by the HEC HSE Manager.</li> <li>Ensure the HEC E&amp;S team conducts all monitoring and reporting as set out in the ESMPs.</li> <li>Provide support to HEC HSE Manager in updating this CESMP as necessary.</li> <li>Implements all aspects of the Stakeholder Engagement Programme (detailed in Section 6 of the SECP) that are allocated to HEC.</li> <li>Ensure that E&amp;S team conduct internal grievance monitoring and reporting as required.</li> <li>Assist with the management of HEC's Community Liaison Officers.</li> </ul>

Position	Responsibilities
	<ul> <li>Serve as the key contact to coordinate investigation and resolution of grievances allocated to HEC (by the THL Governance Lead) (as per P-6 Grievance Redress Mechanism).</li> </ul>
HEC E&S Team Environmental Staff (2 x Biodiversity Field Officers + 1 x E&S Officer) Social Staff (3x Community Liaison Officers (CLOs)*	<ul> <li>Manage the monitoring plans and ensure they can identify potential degradation of environmental conditions.</li> <li>Collaborate with the other teams to develop and implement corrective and preventative action in the existing management plans to address any non-conformances and deficiencies.</li> <li>Advise the Project HSE Manager of any required actions to improve working and living conditions in the field.</li> <li>Conduct social monitoring and audits as required.</li> <li>Report on social issues and progress with implementing the various requirements in line with the applicable standard.</li> <li>Ensure implementation of P-3 Stakeholder Engagement and Communication Plan and P-6 Grievance Redress Mechanism.</li> <li>Closely coordinate with THL and PO to conduct information disclosure, public consultation and stakeholder engagement.</li> </ul>
HEC Training Supervisor (supported by the HEC Training Team)	<ul> <li>Conduct internal glevance monitoring and reporting as required.</li> <li>Ensure that HEC employees and subcontractors receive mandatory training required for the Project.</li> <li>Oversee the development and delivery of all training courses, including the development of an HSE training matrix, plan, programs, etc.</li> <li>Keep all training records accurately and securely, and distribute to THL, PO, OE, LTA or other auditors upon request.</li> <li>Conduct regular audits to ensure compliance with training matrix and plan.</li> </ul>
HEC H&S Supervisor	<ul> <li>Ensure a safe and healthy workplace for employees including enforcement of safe work practices and procedures.</li> <li>Correct unsafe or unhealthy workplace conditions or hazards within their authority and ability to do so.</li> <li>Conduct accident investigations and ensure all occupationally injured employees report incidents immediately.</li> <li>Encourage workers to regularly report on observed hazards/opportunities for improvement (e.g. make it a topic in daily toolbox).</li> </ul>
HEC H&S Emergency Supervisor (designated by HEC HSE Manager)	<ul> <li>Manage the Emergency Response Procedure and collaborate in the maintenance of the P-14 Spill Prevention and Emergency Response Plan.</li> <li>Coordinate and respond to emergencies in compliance with the relevant management plan.</li> <li>Be involved in incident investigation teams as necessary.</li> <li>Schedule and coordinate drill and emergency evacuations.</li> <li>Provide the necessary measures to manage emergencies, including emergency response facilities and resources.</li> <li>Monitor and review the operational conditions of the emergency facilities.</li> </ul>
HEC H&S Supervisor	<ul> <li>Ensure the day-to-day implementation of P-8 Workers Health and Safety Plan.</li> <li>Ensure that Project accurately reports HSE performance, identifies and implements corrective actions.</li> <li>Inspects the worksite and reports and corrects unsafe acts and conditions.</li> </ul>

Position	Responsibilities
HEC H&S Officer	<ul> <li>Provide support to the HEC HSE Team, primarily the HEC H&amp;S Supervisor in implementing health and safety policies and procedures.</li> </ul>
HEC Camp Manager	<ul> <li>Responsible for day-to-day operations of the workers' accommodation camp.</li> <li>Manage the camp as per the camp rules.</li> <li>Receive emergency calls and maintain an emergency log book.</li> <li>Strictly enforce Zero Tolerance for socialising with local community members and use of alcohol/drugs.</li> <li>Monitor and inspect for implementation of mitigation and control measures.</li> <li>Liaise with the Camp Security Manager regarding implementation and compliance with security procedures across the Project site.</li> <li>Liaise with the HEC Administration Manager and HR Manager to arrange for accommodation and transport of employees, as required.</li> </ul>
Security Manager	<ul> <li>Prepare and submit security aspects for the monthly HEC HSE report.</li> <li>Conduct spontaneous checks of security patrols, surveillance (within the Project DIA, and Infrastructure Area including workers' camp).</li> <li>Maintain keys and locks to all buildings, entrances and exits.</li> <li>Fulfils the tasks assigned to the Security Manager in P-14 Spill Prevention and Emergency Response Plan.</li> <li>Liaise with local Police (Royal Solomon Islands Police Force) when required.</li> <li>Arrange and supervise rehearsals for a Rapid Response Team to prepare for any future emergency responses.</li> <li>Responsible for reporting on security matters during weekly Project meetings with HEC and THL management.</li> <li>Other responsibilities as per P-7 Security Management Plan.</li> </ul>

\*HEC Construction Manager and 1 x CLO position currently vacant.

#### 4.4. Subcontractors

HEC will hire subcontractors to conduct specified project tasks. Each subcontractor will be responsible for the execution of the CESMP and sub-plans as applicable to their role in the project and they are responsible for coordinating with HEC on the execution of the CESMPs as well. It will be a requirement for the subcontractor to demonstrate to HEC as part of the tendering process the way their role in the plan will be implemented. These actions will then become a contractual commitment between the subcontractor and HEC.

The selection and management of subcontractors will be conducted according to HEC's internal corporate HSE Standard for Management of Subcontractors (HEC-AH-H04-H02), and Schedule 24 of EPC contract. HEC will hire subcontractors that are reputable and legitimate enterprises licensed by the relevant government regulatory agencies. Where international firms do not hold local licenses, they are able to operate under the licenses acquired by HEC.

#### 4.5. Owner's Engineer

Stantec New Zealand is Owner's Engineer (OE) to THL. The role of OE is as an independent representative for the project owner that provides project management and quality assurance support during all stages of Project design, construction and operation.

The role of the OE in relation to the CESMPs is to:

- Review the CESMP and sub-plans for compliance with the E&S Standards and Good International Industry Practice.
- Review and provide advice to THL on design drawings, method statements, site plans and construction procedures.
- Audit project delivery and check HEC day to day activities are in accordance with the detailed project design, method statements, management plans, and detailed site plans.
- Undertake regular site supervision and report any E&S non-compliances to the HEC HSE Manager, THL E&S Manager and OE Environmental & Social Safeguards (ESS) Lead.
- Audit HEC performance with respect to the requirements of the EPC Contract, and health, safety, environmental and social obligations (including but not limited to the E&S Standards, and Schedule 7 of the EPC Contract). Auditing will include a site visit every six months from commencement of construction, for the duration of the construction phase, by the OE ESS Lead at minimum.

#### 4.6. Concessional Finance Partners

The CFPs will be responsible for reviewing the Draft CESMP and sub-plans to ensure compliance with the required environmental and social standards as set out in Schedule 16 of the PPA. CFPs will also review the monthly THL reports and quarterly LTA reports, as well as incident investigation reports. The Management of Change process will be followed for any changes to the documents. CFPs will also review and comment on quarterly reports issued by PO. CFPs may also undertake ad hoc site visits.

#### 4.7. Coordination of Environment and Social Entities

External communication is defined as a communication between HEC and external parties such as THL, OE, PO, CFPs, relevant authorities of SIG, and other stakeholders on health and safety, social and environmental issues. The co-ordination of each entity is shown in Figure 4-4.



Figure 4-4 Indicative Environmental and Social Safeguards Organisational Chart

### 5. INDUCTION AND TRAINING

The HSE Manager and HEC Training Supervisor are responsible for implementing the training activities required in each ESMP. All employees and subcontractors will receive general induction training that will cover a large range of issues, as outlined below. The induction training may be split over several days or weeks to improve comprehension. This training will be developed and imparted in multiple languages to ensure that it is well received and understood.

When technical training is required to implement plan-specific mitigation measures the Training Supervisor will coordinate with other HEC or subcontractor technical experts.

Refresher training of all courses is required to be completed on an annual basis.

Daily toolbox sessions onsite will be conducted by HEC and subcontractors as a means of communicating E&S management requirements. HEC will ensure 'mock drills' are carried out regularly to check the efficacy of training.

Training records shall be kept and reported in quarterly E&S reports. This shall include the dates and attendees of all completed training and drills.

#### 5.1. List of Training Courses

A training course outline is presented in Table 5-1. The table includes both environmental and social safeguards training and health and safety training.

Tonia	Included in	Person	Allenderer	Target Audience		
торіс	Induction	Responsible	Amendance	Workers	Visitors	Community
General site induction	Yes	HSE Manager	All new personnel and visitors upon entry to Core Land or WAC	~	√	~
Safety Induction & Heat Stress	Yes	HSE Manager and Training Supervisor	All New Personnel at the induction presentation	~		
Defensive Driving	Yes	HSE Manager and Training Supervisor	Driver and Equipment Operator at the induction presentation	~		
Emergency Response	Yes	HSE Manager and Training Supervisor	All Personnel at the induction presentation	~	~	~
Flagman training / No zone area	Yes	HSE Manager and Training Supervisor	Foreman / Operator / Flagman at the induction presentation	~		
Hand &Finger Injury Prevention	Yes	HSE Manager and Training Supervisor	Selected Personnel at the induction presentation	V		
Special Training (technical, etc.)	No	HSE Manager and Training Supervisor	As required to be provided to identified personnel.	~		

Table 5-1 List of training courses provided

Tonio	Included in Constant	Person	A Handana a	Target Audience		
Торіс	Induction	Responsible	Aπendance	Workers	Visitors	Community
Biodiversity Values and Implementation Training (Wildlife Interaction)	No	HSE Manager and Training Supervisor / HSE staff with knowledge on Terrestrial and Aquatic environments	All New Personnel at the special training session by subject matter expert	V	V	✓
Workers Code of Conduct	Yes	HSE Manager and Training Supervisor	All New Personnel at the induction presentation	~	✓	
Engaging with Communities Procedure	Yes	HSE Manager and Training Supervisor	All New Personnel at the special training session by subject matter expert	✓		
Cultural Awareness	Yes	HEC CLO with Training Supervisor	All New foreign Personnel at the special training session by subject matter expert	✓		
Emergency Evacuation	Yes	HSE Manager and Training Supervisor	All New Personnel at the induction presentation	✓		✓
Gender Awareness (including gender equality, sexual harassment, abuse and exploitation)	Yes	Training supervisor with support of NGO / PO Gender Focal Point	All New Personnel at the special training session by subject matter expert, followed by annual refresher training by the HEC Training Supervisor	V		~
Sexual Health Awareness (including STDs, HIV, AIDS)	No	Training supervisor with support of NGO / SI Parenthood Association / Ministry of Health / Red Cross	All New Personnel at the special training session by subject matter expert, followed by annual refresher training by the HEC Training Supervisor	¥		~
Financial Planning	No	Training supervisor with support of NGO	All New Personnel at the special training session by subject matter expert, followed by annual refresher training by the HEC Training Supervisor Also delivered in communities (by CLOs).	~		~

Topio	Included in	Person	Target Audience			
торіс	Induction	Responsible	Allendunce	Workers	Visitors	Community
Domestic violence	No	Training supervisor with support of NGO, prepared and delivered by Women Division (MWYCFA), or Family Violence Office (RSIPF) or Experts (World Vision), or Expert (Oxfam)	All New Personnel at the special training session by subject matter expert, followed by annual refresher training by the HEC Training Supervisor Also delivered in communities (with CLOs).	¥		~
Healthy eating	No	Training supervisor with support of Ministry of Health	All New Personnel at the special training session by subject matter expert, followed by annual refresher training by the HEC Training Supervisor	V		¥
Non- communicable diseases	No	Training supervisor with support of NGO / Solomon Islands Parenthood Association / Ministry of Health	All New Personnel at the special training session by subject matter expert, followed by annual refresher training by the HEC Training Supervisor	V		~
Fire Prevention and Protection	Yes	HSE Manager and Training Supervisor	All New Personnel at the induction presentation.	V		
First Aid Safety	Yes	HSE Manager and Training Supervisor	All New Personnel at the special training session by subject matter expert.	¥		
Working at Height	Yes	HSE Manager and Training Supervisor	Selected Personnel at the induction presentation.	√		
PPE	Yes	HSE Manager and Training Supervisor	Selected Personnel at the induction presentation.	~		
Electrical Safety	Yes	HSE Manager and Training Supervisor	Selected Personnel at the induction presentation.	~		
Manual Lifting	Yes	HSE Manager and Training Supervisor	Selected Personnel at the induction presentation.	√		
Drug and Alcohol Awareness	No	HSE Manager and Training Supervisor	All new personnel at the induction presentation.	√		✓
Laundry Safety	No	HSE Manager and Training Supervisor	All New Personnel at the induction presentation.	~		

Torio	Included in	Person	A Handana a		Target Audie	nce
торіс	Induction	Responsible	Affendance	Workers	Visitors	Community
Lifting and rigging	Yes	HSE Manager and Training Supervisor	Selected Personnel at the induction presentation.	~		
LPG Gas Cylinder and kitchen safety	Yes	HSE Manager and Training Supervisor	Selected Personnel at the induction presentation.	~		
Working on Roads / Traffic Awareness	Yes	HEC HSE Manager and HEC Training Supervisor	Selected Personnel at the induction presentation.	~		
Working in Rivers	Yes (but also needs specialized module)	HSE Training Supervisor	Selected Personnel at the induction presentation.	V		
Working in Tunnels	No	HSE Manager and Training Supervisor	Selected Personnel at the induction presentation	V		
Drilling and Blasting	No	HEC Training Supervisor	All workers involved in drilling or blasting, and HSE Team.	~		
Other Mosquito Borne Disease (e.g. Malaria, Dengue and Zika)	Yes	HEC Training Supervisor and Project Doctor	All workers at initial general induction, and every six months.	~		~
UXO Safety	Yes	HEC Training Supervisor	All new personnel at the induction presentation.	~		
Security Rules	Yes	HEC Training Supervisor	All new personnel at the induction presentation.	~		
Waste and hazardous substance management	Yes	HEC Training Supervisor	All new personnel at the induction presentation.	~		
Work permit System	Yes	HEC Training Supervisor	All new personnel at the induction presentation.	~		
Knowledge of HEC organisation and structures	No	HEC Training Supervisor	All new personnel at the induction presentation.	~		
Labour regulations	No	HEC Training Supervisor	All new personnel at the induction presentation.	~		
Communication Skills (security/safety communications)	No	Security Manager	All security and H&S personnel.	V		
Report Writing	No	HEC Training Supervisor	All personnel responsible for administration, documentation and reporting.	~		
Use of Security and safety equipment	No	Security Manager HEC HSE Manager	All security and H&S personnel.	~		

Topio	Included in	Person Attendance Responsible	Allondenoo	Target Audience		
Торіс	Induction		Allendance	Workers	Visitors	Community
Basic Reaction Skills	No	Security Manager HEC HSE Manager	All security and H&S personnel.	¥		
Conflict Management	No	HEC Training Supervisor	All new personnel at the induction presentation. All senior staff in management roles, or community-facing (e.g. CLOs) – comprehensive module.	V		
Human Rights legislations	No	HEC Training Supervisor	All new personnel at the induction presentation.	$\checkmark$		
Security guards Code of Conduct.	No	Security Manager and HEC HSE Manager	All security personnel.	¥		
COVID 19 Community and Stakeholders training	No	HEC and THL personnel who have completed MHMS Community Mobilisation module (#47 below)	All employees, and delivered in Project- affected communities with CLOs in attendance.	V		~
COVID-19 Community and Stakeholder Training – Community Mobilisation component	No	MHMS	Employees from THL and HEC who will be delivering COVID-19 community and stakeholder training and using MHMS's Community Mobilisation Toolkit (e.g. HEC Training Supervisor, HEC HSE Manager, THL E&S Manager).	¥		~
Forest Clearance Protocol, and Wildlife Shepherding and Injured Wildlife Protocol	No	Training Supervisor with support from E&S Supervisor	All Personnel	~		~
Drainage and Erosion Control Measures for Access road, Tunneling spoil, working in river)	No	Training Supervisor with support from E&S Supervisor	All Personnel	×		
Hazardous Material Handling, and MSDS	No	Training Supervisor with support from E&S Supervisor	All Personnel	~	~	
Spill prevention and Response Protocol	No	Training Supervisor with support from E&S Supervisor	All Personnel	~		~

Tonia	Included in	Included in Person		Target Audience		
торіс	Induction	Responsible	Aπendance	Workers	Visitors	Community
Air Quality and Dust Control Measures	No	Training Supervisor with support from E&S Supervisor	All Personnel	~	~	
Noise management and control measures	No	Training Supervisor with support from E&S Supervisor	All Personnel	¥	V	
Solid waste management and waste segregation hierarchy	No	Training Supervisor with support from E&S Supervisor	All Personnel	~	~	
Grievance Redress Mechanism	No	Training Supervisor with support from E&S Supervisor	All Personnel	~		~
Fire Prevention and Protection (Firefighting Drill )	No	HSE Manager Training Supervisor	All Personnel	~		
Hot Work Safety Training (Welding, cutting, & grinding)	No	HSE Manager Training Supervisor	All Personnel	¥		
Heavy Equipment Prestart check and Operating procedures	No	HSE Manager Training Supervisor	Heavy Equipment Operators and Light Vehicle Drivers	¥		
Dump Truck loading and unloading safety procedures	No	HSE Manager Training Supervisor	Heavy Equipment Operators and Light Vehicle Drivers	~		
Hazard Hunting (Unsafe Acts/Unsafe Conditions)	Yes	HSE Manager Training Supervisor	All Personnel	~	~	

### 6. MONITORING AND REPORTING

The following procedures shall be followed to ensure effective implementation of the CESMPs and sub-plans throughout the construction phase. Where possible, monitoring and auditing of CESMP compliance shall complement existing checks and balances in place for technical aspects, quality assurance and quality control.

#### 6.1. Public Disclosure of CESMPs

#### 6.1.1. Draft CESMPs

As part of the consultation and disclosure process of the CESMPs, the draft CESMPs for were disclosed by the PO on the Project website on 17 November 2022. The disclosure was socialized via social media on the Tina River Hydro Project Facebook page, and a community consultation event was held on 23 November 2022 at Managiki Village. The CESMPs were also accessible from the HEC and THL offices.

The main purpose of this consultation was:

- To disclose the updated ESMPs for the construction of the main works to Project Affected Communities.
- Provide information on Project, construction schedule, as well as the management, monitoring, and mitigation measures that guide these construction activities.
- To provide an opportunity for community members to present their views and feedback regarding the updated ESMPs.
- For HEC and THL to receive community feedback through face-to-face consultation which will contribute to the review, improvement, finalization, and approval of the ESMPs.

The presentation and results of the consultation are provided in Annex P-1-VII and feedback received is summarized below.

Community	Comments and issues raised	HEC response	Related ESMPs
Managikiki	Time and again Managikiki is requesting HEC to provide Transport for students traveling to school and Community people going to town and Clinic	Background: The request to provide transportation to the community after HEC enacted the "No passengers in Tray policy" and restricted the public from using HEC vehicles. Transporting students to school, and community members to the town is not within the remit of HEC. This measure was not foreseen in the ESIA. It's not a feasible option as there are a number of communities that may further demand HEC to transport community members.	P11 Traffic Management Plan
Managikiki	The Managikiki community requested HEC to connect the water supply from the Office site Borehole to their communities.	HEC has provided water tanks to Managikiki. There is a provision for water supply from the office borehole through a tanker truck. However, CBSP may consider piping from the Office site to Managikiki, as the this is not under HEC scope of Works.	C7 Water Supply Replacement Plan

#### Table 6-1: Feedback received from the community on draft CESMPs

Community	Comments and issues raised	HEC response	Related ESMPs
Managikiki Antioch	The Managikiki community would like to have some options for providing catering services for HEC Construction Team onsite. Thus, the community requests HEC to meet the costs.	The Contractor had initiated this from 20th September to 23rd September with 15 communities by holding a community consultation for the procurement of fruits and vegetables for the WAC kitchen from communities, especially women. The plan is under discussion.	P4 Human Resources and Labour Management Plan
Managikiki	Since Solomon Island is likely experiencing Earthquakes, how safe is the Dam Construction against the Natural disaster or Power of Nature?	The design of the Hydropower Facility has taken into consideration the geological, meteorological, and flood risks. The designs are reviewed by engineering experts to check that these risks are rightly mitigated and addressed. Additionally, there exists a Dam Safety Advisory Panel that ensures the safety of the dam.	P13 Spill Prevention & Emergency Response Plan
Kaimomosa	My community and other Malango Communities may have an impact due the Disposal 2 & 3 sites activities which causes their streams to water turbidity. He requested HEC to do monitoring on these two sites and give feedback to his communities	After the receipt of NTC 30 from the Owners Engineer, HEC has been monitoring the impacts from August 2022 at the confluence of Disposal 2, Disposal 3 and Disposal 5. Monitoring of discharges from Disposal Sites 2 and 3 is already covered in the recent version of ESMP.	M1 Suspended Sediment Monitoring Plan

#### 6.1.2. Approved CESMPs

Following finalization and approval, the final ESMPs will be made available in English on the Project website by the PO and will be socialized to Project Affected Peoples. HEC is required to maintain a copy of the current CESMP and sub-plans at its construction site office(s). The documents shall be made available in English and Korean as a minimum.

#### 6.2. Monitoring and Audits

#### 6.2.1. HSE Targets and Key Performance Indicators

The various subplans include targets and key performance indicators (KPIs) to be met for the project.

THL and HEC are to establish an agreed set of KPIs in order to monitor performance for achieving HSE objectives and targets. The HEC HSE Manager will develop project-specific targets based on the agreed CESMPs, corporate ESMS requirements and stakeholder expectations prior to commencement of Main Works. Typical KPI would include:

- leading indicators such as training, inspections, audits, hazard observations, personnel qualifications and emergency drills.
- trailing indicators such as health and safety incidents, lost time injury rate, NCRs and grievances.
- performance against project targets set for HSE monitoring.

The OE and PO will review and approve the proposed KPIs prior to commencement of Main Works. Performance against the KPIs shall be reported in the HEC quarterly environmental and social monitoring reports.

Where HSE targets and KPIs are not being met, HEC shall investigate and put in place corrective actions where required. If targets and KPIs continue to be missed, a more comprehensive investigation shall be conducted, involving THL, OE and PO, to help to resolve the issue. Where necessary, construction activities and/or CESMP mitigation, monitoring and targets may need to be amended through the CESMP review procedure.

#### 6.2.2. HEC Site Management

HEC is responsible for ensuring compliance with the CESMPs by its own workers, subcontractors, as well as casual workers and site visitors.

Regular HSE meetings, site visits and inspections will be carried out by HEC to determine if activities comply with legal and other requirements and the requirements of the CESMP and sub-plans. Opportunities for improvement may also be identified.

In general, these inspections will be carried out in accordance with the HEC Management Standard HSE Inspection Procedure (HEC-AH-H04-H10)<sup>6</sup> and IR-005 HEC EHS Monitoring -General ESMP Controls spreadsheet.<sup>7</sup> The HEC HSE Supervisor(s) will be responsible for daily HSE inspections of areas as assigned by the HSE Manager. They will complete the Daily HSE Inspection Report which will be submitted to the HEC HSE Manager.

The HEC HSE Manager will lead weekly site inspections, conducted with the THL E&S team, OE and relevant subcontractors. The Weekly HSE Inspection Report will be completed, identifying who attended the inspection, date and time of inspection, locations, observations, any corrective actions that are required, and the responsible person and due date for each corrective action.

As far as reasonably practicable, immediate measures will be taken to remove all unsafe behaviour and unsafe conditions. Where corrective action has been required and identified, a responsible person and due date will be assigned. Once the required action is implemented, evidence will be added to the inspection report. The HEC HSE Manager will maintain a HSE Inspection Follow-up Log.

On a fortnightly basis, HEC, THL and OE will hold a joint onsite monitoring and inspection meeting. Project implementation against the CESMP and sub-plans will be observed and discussed, alongside other technical aspects of the Project. Non-compliances and related corrective actions will be followed up. Details of the non-compliance process and reporting are provided in section 6.3.4.

#### 6.2.3. Owner's Engineer

Stantec, as the OE, provides Project supervision across the fields of management, engineering and safeguards. The company ensures that the Project adheres to its specifications, quality assurance and quality control procedures, as well as lender requirements.

The OE Site Engineer provides day to day support to THL and oversight of HEC and its subcontractors. The OE Site Engineer will undertake regular site inspections and supervision and report any E&S non-compliance to the HEC HSE Manager, THL E&S Manager and the OE Environmental & Social Safeguards Lead. This role also includes participation in site inspections and bi-weekly meetings.

The OE Environmental and Social Safeguards Lead is responsible for preparing and reviewing safeguards documentation and for providing on-site audits on a six-monthly basis. The OE Environmental and Social Safeguards Lead will conduct a site audit every six months from commencement of construction, for the duration of the construction phase. The audit may involve a social safeguards specialist and/or health and safety specialist if required.

The OE is required to notify relevant HEC site staff about upcoming audit events via written notice. This provides a mechanism to communicate the schedule, activities and objectives of the audit. The Six-monthly audits will examine HEC performance with respect to the requirements of the EPC Contract, and health, safety, environmental and social obligations (including but not limited to the ESIA 2019, CESMP and sub-plans, and Schedule 7 of the EPC Contract). OE will prepare a concise audit report for review by THL.

<sup>&</sup>lt;sup>6</sup> Included as an annex to P-8 Workers Health and Safety Plan (Annex P-8-III).

<sup>&</sup>lt;sup>7</sup> Included as Annex P-1-VI.

#### 6.2.4. THL Audits

On a quarterly basis, the THL E&S Manager will audit HEC's safeguard practices and the effectiveness of mitigation measures implemented to ensure compliance to the contractual obligations, and good international industry practice. It is the responsibility of HEC to provide available documentation, information and data requested. The results of the audit and any associated corrective actions will be provided to HEC for action.

#### 6.2.5. HEC Corporate Audits

The HEC headquarters will conduct regular audits on the HEC onsite team. The auditing will follow the procedure described in the HSE Audit Procedure (HEC-AH-H04-H13)<sup>8</sup>. The internal audit will be conducted twice a year and carried out by three members from HEC HSE Team. Non-conformances or observations identified during audits will be subject to the provisions of corrective action and will be implemented for closure.

#### 6.2.6. PO Monitoring and Audits

The Project Office have dedicated safeguards personnel based in Honiara who will conduct ongoing monitoring of the ESIA and ESMPs throughout the construction period. The PO Environmental and Social Monitoring team will conduct joint site visits with THL and HEC on a monthly basis and when necessary.

The PO Environmental and Social Monitoring Agent (LTA) will conduct quarterly audits. The audit will ensure that any corrective measures proposed by a concessional finance party, or the PO and/or LTA, have been implemented.

#### 6.2.7. Concessional Finance Parties

Representatives of the CFPs will participate in regular Technical Safeguards Missions to the Project site. These missions would typically be programmed over a week and involve a kick-off meeting with all relevant stakeholders, followed by various other meetings as needed to gain understanding of Project progress and challenges. Visits to the construction sites are an important component of the CFP missions. A wrap-up meeting with all stakeholders will conclude each mission.

Should non-compliances with CFP safeguard policies be identified, a Safeguards Action Plan shall be prepared, for resolution by THL.

#### 6.3. Non-Conformance Management

#### 6.3.1. Environmental and Social Risk Management

HEC shall maintain and Environmental and Social Risk Register for the Project. This shall systematically identify the risk to people and the environment which may arise from Project activities during construction. For moderate and high risk activities, HEC shall carry out risk assessments to identify, avoid, minimise and mitigate identified hazards which may affect people, assets, and the environment (where such risks are not already addressed in the CESMP and sub-plans).

Work Method Statements will be developed to ensure the appropriate safeguards are identified for the safe execution of tasks that may pose a health and safety risk. The final revision of the Work Method Statement will include task risk assessment and will be included in Permit to Work (PTW) package. Task risk assessments (sometimes called Job Hazard Analysis) will be prepared for all critical tasks as outlined in P-8 Workers Health and Safety Plan. The HEC HSE Manager will be responsible for maintaining the risk assessment register and current revision of all completed risk assessments in accordance with HEC-AH-H04-H03 Risk Assessment Procedure.

The work permit specifies the conditions and procedures for safe execution of the work and allows the work to be carried out under controlled risk conditions. HEC will use two types of

<sup>&</sup>lt;sup>8</sup> Included as an annex to P-8 Workers Health and Safety Plan.

permits: Hot Work Permit and Cold Work Permit. Responsibilities, approvals, etc. are addressed in the corporate HEC document '[HEC-AHH04-H04] Permit to Work Procedure'.

HEC will establish a communication system among managers, supervisory personnel, workers, and Subcontractors. The following Site meetings will be held:

- HSE Committee Meeting (Monthly);
- Risk Review Meeting (Bi-Monthly);
- Weekly HSE Meeting (Weekly);
- Mass Toolbox Meeting (Weekly);
- Toolbox Meeting (Daily).

HEC will perform HSE inspections of all working areas. The following HSE inspections shall be conducted:

- Monthly HSE Inspection (HSE Committee);
- Weekly HSE Inspection (HSE Staff);
- Daily HSE Inspection (HSE Supervisor & Work Supervisor / Foreman).

#### 6.3.2. Environmental, Health and Safety Incidents

Environmental, health and safety incidents shall be recorded and managed in the Incident/Near Miss Register administered by the HSE Team.

HEC will keep written records of all injuries/occupational illnesses & disabilities, fatalities, incidental property damage, environmental incidents and near misses. These records will identify all persons and property involved and will summarize all corrective action taken. The HEC will follow requirements of the HSE document '[HEC-AH-H04-H14] Incident Investigation and Reporting'.<sup>9</sup>. A near miss is an incident which resulted in no injury, illness, damage to environment or harm to reputation so its severity rating is zero. However, the level of investigation effort will be based on its potential severity.

Once a medium or high severity incident, or high potential near miss report has been closed out, the HEC HSE Manager will prepare a one-page summary which will be posted on notice boards, discussed at the toolbox meeting and discussed at the regular HSE meeting. This will help to identify any process or procedural changes that may be needed to prevent the incident from recurring.

Where actual or potential non-compliances are found, a Field Observation Report (FOR) C, B, A or Non-Conformity Reports (NCR) shall be raised, as per the procedure outlined below.

#### 6.3.3. Social Incidents and Grievances

Social issues and incidents affecting workers and the community shall be recorded under the Grievance Register maintained by the THL Governance Lead.<sup>10</sup>

A Grievance Redress Mechanism (GRM P-6) has been developed for the Project. GRMs can bring significant value to a large project, because they provide valuable insights into the effectiveness of mitigation measures and management approaches applied 'on the ground' at all levels, similar to a monitoring programme.

The GRM will be implemented to ensure Project related grievances can be identified, documented, resolved and monitored. Implementation of the GRM will be led by THL (with initial assistance from the PO during early construction stages), but all employees of the Project have a responsibility to ensure that all grievances received are taken seriously and reported, and the GRM procedure is strictly followed.

THL, HEC and the PO will inform communities about the GRM through a variety of channels including verbal (phone, in person), written (by post, via drop box, or email), and online (via the Tina Hydro website maintained by the PO). The Project will publicly disclose information about the outcomes from implementation of the GRM, including the volume and nature of

<sup>&</sup>lt;sup>9</sup> Included as an annex to P-8 Workers Health and Safety Plan.

<sup>&</sup>lt;sup>10</sup> Refer P-6 Grievance Redress Mechanism.

complaints, and performance against response time targets—as well as key conclusions from the monitoring and evaluation process described in P-6.

Where actual or potential non-compliances are found, a Field Observation Report (FOR) C, B, A or Non-Conformity Reports (NCR) shall be raised, as per the procedure outlined below.

#### 6.3.4. Non-Conformance Process

The non-conformance process covers construction and project quality, health and safety, and environmental and social safeguards. Non-compliance is where there is failure to implement required health, safety, environmental and social measures, and/or meet objectives and targets as well as failure to apply required mitigation measures. THL, HEC and OE may issue corrective action requests as Field Observation Reports (FORs) or Non-Conformity Reports (NCRs) to HEC for any non-compliance related to the construction work. HEC will formally respond within the timeframe specified in the FOR or NCR. This process is defined by the Employer's Requirements.

The non-compliances identified are subject to different processes depending on the severity of the situation. All FORs and NCRs will be subject to formal reporting. HEC has a limited time, depending on the severity of the non-compliance detected, to implement corrective measures. Corrective actions may include changes to work instructions, further staff training, replacing worn pieces of equipment, updating mitigation measure, etc. The status of all identified non-compliances should be reviewed by HEC's HSE Manager and the THL E&S Manager and form part of construction meeting agendas. The HSE Manager will maintain the HSE Inspection Action Tracking Register (NCR Register) and monitor the status (close-out).

It is the responsibility of HEC and subcontractor to immediately initiate corrective actions and, once completed, provide details of the actions undertaken on the noncompliance/corrective action report, sign it and submit to THL within an appropriate timeframe. A standard form for recording FORs and NCRs is attached in Annex P1-1-V.

If the result is acceptable to THL or OE, the FOR or NCR will be closed.

The four levels of non-compliance are described in Table 6-2 below.

#### Table 6-2: Field Observation Record and Non-Compliance Record levels

Level	Description
FOR C (minor)	FOR C is for a minor issue, where an improvement could be made. It is similar to a 'continuous improvement opportunity'. There may be minimal effect on the Project or the structural integrity of the constructions concerned and may include minor issues with the HSE requirements. HEC will correct the observed situation within one month. The corrective actions by HEC can be performed without having the consent of THL or OE on the methods to be applied.
FOR B (moderate)	<ul> <li>FOR B is for a moderate issue that would have a significant effect on the Project. It may impact the structural integrity but does not represent a serious immediate risk for health or environment. HEC is expected to correct the situation within one week. The corrective actions by HEC can be performed without having the consent of THL or OE on the methods to be applied. THL or OE may request a root cause analysis of the problem observed and may further request HEC to take further actions to prevent the re-occurrence of the non- conformity of concern. A FOR B which is not closed by the appropriate corrective action by HEC within two weeks will be raised to NCR level.</li> <li>Examples of non-compliance include:</li> <li>Inappropriate storage of non-hazardous waste.</li> <li>Inappropriate storage of Hazardous Materials (oil, fuel), but without immediate danger for the environment.</li> <li>No training courses, emergency drills in appropriate time frame.</li> <li>Inappropriate management/cleaning of sedimentation pond or storm water drainage network.</li> <li>Lack of road signs or any required sign boards such as hazardous material storage area, explosive magazine, etc.</li> <li>Dust and air pollution generated from inappropriate operations/ machines.</li> <li>Excessive speed or noise detected in sensitive areas.</li> </ul>
	<ul> <li>Inappropriate maintenance of vehicles/engines that possibly cause oil leakage on the ground.</li> <li>Minor leakages from fuel tanks.</li> <li>Any non-implementation following proposed mitigation measures without immediate danger or damage to human and environment.</li> </ul>
FOR A (major)	<ul> <li>FOR A is for a major issue that has serious impacts on structural integrity. It also covers issues that may result in damages for health or environment or represent a high potential risk for health or the environment. Immediate remedial action is required and the works may not proceed without the FOR A being closed. HEC will correct the situation within three working days and obtain the consent of THL or OE for the methods and materials that are proposed for the corrective action. A root cause analysis of the problem observed will be undertaken and HEC will take further actions to prevent the re-occurrence of the non-conformity of concern. The outcome of all FOR A incidents will be reported to CFPs by PO when the FOR A is closed or if it is raised to NCR level. A FOR A which is not closed by the appropriate corrective action by HEC within one week shall be raised to NCR level. Examples of non-compliance include:</li> <li>Inappropriate storage of Hazardous Materials (oil, fuel), with potential threat for the environment.</li> <li>Significant leakages from fuel tanks or from garages areas.</li> <li>Inappropriate soil management and spoil dumping beyond specific areas.</li> <li>Inappropriate restoration or rehabilitation of areas after construction activities completion (borrow areas, temporary camps, stockyards, etc).</li> <li>Lack of environmental quality monitoring (air, water, noise) in regular time frame.</li> <li>Unauthorised hunting, cooking, fishing, collecting of fauna and flora by employee.</li> </ul>
	Any non-implementation tollowing proposed mitigation measures that may cause danger or damage to human and environment if no resolution in a timely manner.
(critical)	<ul> <li>NCK is used for an issue that represents a high risk with major consequences to Project requirements, health or the environment. The highest management levels within HEC and THL/OE, as well as PO and CFPs will be informed immediately (within 24 hours). HEC has two days to apply the corrective action to bring the situation under control. If the situation requires, THL or OE can order the suspension of works on the concerned worksite until the closing of the NCR. Examples of non-compliance include:</li> <li>Any FOR Non- Compliance left uncorrected after due date.</li> <li>Any accidental spill in excess of containment volume of fuel or any other liquid product registered as Hazardous Material.</li> </ul>

Level	Description
	<ul> <li>Accidental spill in a sensitive area (within 30 m of a water body).</li> <li>Deliberate discharge of used oil or other hazardous waste in river stream.</li> <li>Concrete waste (liquid) discharged directly to natural water bodies.</li> <li>Trapping or killing of protected or endangered animal species during clearing activities or by HEC and subcontractors' employee personally.</li> <li>Dangerous behaviour on public roads (excessive speed, dangerous load, alcohol) that cause extreme damage to property and life.</li> <li>Effluent (not compliance to applicable standard) discharged directly to natural water bodies.</li> <li>Test results of environmental quality monitoring (potable water, drinking water, effluent from camps, ambient air and noise) are not compliance to applicable standard, without appropriate corrective actions.</li> <li>Caused serious danger to human and environment.</li> </ul>

#### 6.4. Reporting

#### 6.4.1. HEC Monthly Project Reports

HEC is required to submit monthly project reports to THL. This document provides an overview of construction works completed within the month, a review of environmental and social safeguard implementation, any health, safety or security incidents, engineering designs, and an updated on the Project schedule. The report also documents the monthly monitoring results undertaken under the various ESMPs.

#### 6.4.2. HEC Quarterly Environmental and Social Safeguards Reports

HEC also prepares comprehensive Quarterly Environmental and Social Safeguards Reports for THL. This provides a detailed account of CESMP and safeguards implementation in the previous quarter.

As stated in the construction contract, the quarterly report is to be prepared by HEC as follows:

- 1) The Contractor shall provide a report to the Employer on a quarterly basis, which sets out the following information:
  - a) a summary of the Project's and the Contractor's compliance (or non-compliance, as the case may be) with all the Environmental and Social Standards and the Safeguard Documents giving details of:
    - *i)* any areas of actual or potential breach or non-compliance;
    - *ii) measures taken in furtherance of the Safeguard Documents;*
    - iii) conditions, if any, which interfere or threaten to interfere with the smooth implementation of the Safeguard Documents so as to be available in a form and substance acceptable to the Employer before the implementation of the relevant activities; and
    - *iv)* remedial measures taken or required to be taken to address such conditions;
  - b) a summary of compliance with the requirements of Clause 6 [Staff and Labour], identifying any areas of actual or potential breach or non-compliance; and
  - c) the implementation of any recommendations of the Dam Safety Advisory Panel, ("Safeguard Report").
- 2) If any unanticipated environmental and/or social risks and impacts arise during construction, implementation or operation of the Project that were not considered in the Safeguard Documents or the Environmental and Social Standards, the Contractor shall:
  - a) promptly (and in any event within five (5) Business Days of the Contractor becoming aware of any such risks or impacts) inform the Employer of the occurrence of such risks or impacts, with a detailed description of the event and proposed corrective action plan; and
  - b) thereafter, promptly (and in any event within four (4) weeks of request by the Employer) update the Safeguard Documents to account for such emerging risks and impacts (in form and substance satisfactory to the Employer).
- 3) The Contractor shall report any actual or potential breach of the measures set forth in the Safeguard Documents promptly after becoming aware of such breach.

4) The Contractor shall, where requested by the Employer, disclose relevant information from the Safeguard Reports to affected persons.

The quarterly environmental and social safeguards report shall include performance against the targets and KPIs identified in section 6.2.1.

#### 6.4.3. PO Reporting

The PO prepares quarterly and semi-annual (six-monthly) reports to the CFPs. The requirements for these reports are covered in the Financing Agreements under PPA.

#### 6.4.4. Report Disclosure

HEC is required to communicate and report directly to THL. In turn, THL will communicate with the relevant stakeholders.

Copies of the Quarterly Environmental and Social Safeguards Reports prepared by HEC will be made available on the Tina Hydro website (<u>https://www.tina-hydro.com/project-documents/</u>) within one month of review and approval by THL/OE. PO will be responsible for the upload. Where necessary, sensitive personal or financial information can be redacted in the version displayed online.

In addition, all reports prepared for the Project will be maintained on the project site (Document Space) for the entire BOOT concession period.

### 7. CESMP REVIEW AND UPDATES

#### 7.1. Management of Change Process

The 2019 ESIA and the 2023 CESMPs have been prepared based on current knowledge of the design and proposed construction method for the Project. It is possible that changes to the Project may lead to unanticipated impacts and risks that were not envisaged during the ESIA or CESMP process completed to date. This requires a Management of Change Process.

The Management of Change process is applied when activities occur that may increase the extent or severity of environmental or social impacts. This may include but is not limited to:

- Engineering/design changes
- Route/location changes
- Construction methodology changes
- Requirements for additional land, physical or economic displacement
- New associated facilities required for construction
- Clearance of vegetation and habitats outside of predicted boundaries
- Applicable legislation changes related to environmental and social issues
- New environmental/social data, such as repeated non-compliances
- Stakeholders influence on the project

HEC shall be responsible for communicating any such changes to Project stakeholders before they occur, or as soon as they become known. THL and PO shall be responsible for the coordination and assessment of any deviation from the Project impacts covered in the existing ESIA and CESMPs, to ensure that environmental and social issues are adequately addressed as per project safeguard requirements. If new or unintended environmental or social issues are identified, additional safeguard requirements shall be implemented.

Additional safeguard requirements may include but are not limited to:

- Additional environmental or social mitigation, management and/or monitoring, requiring updates to CESMP(s)
- Completion of an environmental and social safeguard audit<sup>11</sup>
- Preparation of a standalone Environmental and Social Impact Assessment or ESIA addendum<sup>12</sup>
- Permits or other requirements under in-country law
- Additional stakeholder engagement.

THL and PO shall be responsible for assessing and determining the additional requirements to be completed. HEC shall be responsible for the completion of any additional reporting or studies, as well as mitigation and monitoring, at its own cost. The review and approval of documents prepared shall be completed by OE and PO, to ensure that the environmental considerations have been fully addressed and environmental and social assessment studies, public consultation, permitting processes are completed as necessary and necessary revisions are performed in the CESMP and sub-plans.

Communication of any changes shall follow the process identified for CESMP updates in section 7.2 and Table 7-1 below.

<sup>&</sup>lt;sup>11</sup> Often triggered for existing facilities to ensure compliance with Project safeguard requirements.

<sup>&</sup>lt;sup>12</sup> Often triggered for changes in Project scale or extent, such as works outside of Core Land or new impacts.

#### 7.2. Review of CESMP and Sub-Plans

The CESMP and sub-plans will be reviewed on a regular basis to ensure that they continue to be fit for purpose during the Project's construction phase and meet the commitment for continual improvement.

A review will be undertaken by the HEC HSE Manager every 12 months, or sooner if there is a change to the project (refer 7.1) or if there is a major incident of non-compliance to which the CESMP relates. The following will be reviewed and assessed, and a view taken to whether the CESMP needs to be updated to reflect the findings and ensure continued compliance with the objectives and goals of the management plans:

- Current objectives, targets, and management plans.
- Internal and external audit reports.
- Non-compliances to the CESMP by the subcontractors and the status and effectiveness of corrective actions.
- Status of performance regarding objectives and targets.
- Improvement proposals or suggestions.
- Review of the effectiveness of mitigation measures and whether they continue to reflect best practice.

Following the review of the CESMP by HEC, a Management Review meeting will be conducted to discuss the opportunities for improvement as identified above. The Management Review will be led by the HEC HSE Manager with inputs from THL, OE, and PO. The meetings can be scheduled to coincide with the Mission(s) of the LTA Independent E&S Monitoring team and/or CFPs.

The expected outputs of the Management Review will be, but not be limited to:

- Minutes of the Management Review meeting.
- Revision of policies, objectives, targets and plans where improvements are deemed necessary.
- Identification of requirements for improvement of management system, planning and implementation.
- Suggestions and proposed actions, if any.
- A revised CESMP and/or revised sub-plans as determined by the review.

Table 7-1 below defines three categories of potential changes to the CESMP and the review and approval process associated with each category.

Category	Update Description	Action Required	Responsibility	
Category 1 (least significant)	Changes that are expected to: Result in similar or improved HSSE performance and are unlikely to result in any increase in environmental or social impacts above those described in the ESIA	HEC will notify THL of the proposed change and provide the rationale and justification for the change. THL will notify OE, and OE will review and clear the proposed change prior to implementation.	HEC HSE Manager	
Category 2	Changes that have the potential to, or are reasonably likely to: Result in, decreased HSSE performance, but are unlikely to result in any increase in environmental / social impacts above those described in the ESIA;	HEC will notify THL of the proposed change and provide the rationale and justification for the change. THL will provide change(s) to OE for review, and to seek further advice. Once OE feedback is received, THL will notify PO. PO will review and approve the change before implementation. CFPs to be notified via monthly and quarterly reports.	HEC HSE Manager	

#### Table 7-1: Project CESMP Update Process

Category	Update Description	Action Required	Responsibility
Category 3 (most significant)	<ul> <li>Changes which have the potential to, or are reasonably likely to:</li> <li>Result in decreased HSSE performance</li> <li>Result in an increase in HSSE impacts above those disclosed in the ESIA</li> <li>Result in new impacts not disclosed in the ESIA</li> <li>Require the acquisition of rights to use additional lands</li> <li>Require additional permits/approvals from the government.</li> </ul>	HEC will notify THL of the proposed change and provide the rationale and justification for the change. THL will provide change(s) to OE for review, and to seek further advice. Once OE feedback is received, THL will notify PO and provide PO with an opportunity to review. PO will then notify CFPs within one week of the receipt of the request for a CESMP change (from THL). This category of change requires PO and Lender approval before implementation.	HEC HSE Manager

LIST OF ANNEXES

ANNEX P-1-I – FULL LIST OF CESMPS FROM ESIA 2019

ANNEX P-1-II – CONSTRUCTION METHODOLOGY

ANNEX P-1-III – CONSTRUCTION SCHEDULE

ANNEX P-1-IV – SUMMARY OF LAWS AND REGULATIONS OF THE SOLOMON ISLANDS

ANNEX P-1-V – FIELD OBSERVATION RECORD / NON-CONFORMITY REPORT

ANNEX P-1-VI – IR-005 HEC EHS MONITORING - GENERAL ESMP CONTROLS SPREADSHEET

ANNEX P-1-VII – ESMP DISCLOSURE FOR MAIN WORKS, COMMUNITY CONSULTATION REPORT

## ANNEX P-1-I FULL LIST OF CESMPS FROM ESIA 2019

Code	Ref	Title
DAM SA	AFETY PLANS	
DS-1	-	Construction and Quality Assurance Plan
DS-2	-	Instrumention Plan
DS-3	-	Operation and Maintenance Plan
DS-4	-	Emergency Preparedness Plan
PREPAR	ATION PHASE P	LANS*
P-1	CESMP	Construction ESMP Framework (CESMP)
P-2	BMP	Biodiversity Management Plan (BMP)
P-3	SECP	Stakeholder Engagement and Communications Plan (SECP)
P-4	HRLMP	Human Resources and Labour Management Plan (HRLMP)
P-5	IMP	Influx Management Plan (IMP)
P-6	GRM	Grievance Redress Mechanism (GRM)
P-7	SMP	Security Management Plan (SMP)
P-8	WHSP	Worker's Health and Safety Plan (WHSP)
P-9	WCC	Workers Code of Conduct (WCC)
P-10	CHDVMP	Community Health and Disease Vector Management Plan (CHDVMP)
P-11	тмр	Traffic Management Plan (TMP)
P-12	WMPSPP	Waste Management and Point Source Pollution Plan (WMPSPP)
P-13	НММР	Hazardous Materials Management Plan (HMMP)
P-14	SPERP	Spill Prevention and Emergency Response Plan (SPERP)
P-15	AQMDCP	Air Quality Management and Dust Control Plan (AQMDCP)
CONSTR	RUCTION PHASE	PLANS*
C-1	СНМР	Cultural Heritage Management Plan (CHMP)
C-2	UXO	UXO Management Plan
C-3	FCP	Forest Clearance Plan (FCP)
C-4	PCRRP	Post-construction Rehabilitation and Revegetation Plan (PCRRP)
C-5	QMP	Quarry Management Plan (QMP)
C-6	RPP	Reservoir Preparation Plan (RPP)
C-7	WSRP	Water Supply Replacement Plan (WSRP)
C-8	WCMP	Watercourse Crossing Management Plan (WCMP)
C-9	STMP	Spoil and Topsoil Management Plan (STMP)
C-10	DESCP	Drainage, Erosion and Sediment Control Plan (DESCP)
C-11	DBMP	Drill and Blast Management Plan (DBMP)
<del>C-12</del>	<del>SMP</del>	Stormwater Management Plan (SMP)
C-13	NVMP	Noise and Vibration Management Plan (NVMP)
C-14	CIMS	Cumulative Impact Management Strategy
C-15	RDMP	River Diversion Management Plan
OPERAT	TION PHASE PLA	NS
0-1	OESMP	Suspended Sediment Monitoring Plan (SSMP)
0-2	-	Water Quality Monitoring Plan (WQMP)
PREPAR	ATION PHASE P	LANS*
M-1	SSMP	Suspended Sediment Monitoring Plan (SSMP)
M-2	WQMP	Water Quality Monitoring Plan (WQMP)
M-3	FAMMP	Fish, Algae, and Macro-invertebrate Monitoring Plan (FAMMP)
M-4	SIMP	Social Impact Monitoring Plan
M-5	FFMP	Flora and Fauna Monitoring Plan (FFMP)
M-6	CWMP	Construction Works Monitoring Plan (CWMP)
M-7	AQNMP	Air Quality and Noise Monitoring Plan (AQNMP)

Other D	ocuments	
1	CIA	Camp Impact Assessment
2	GIA	Groundwater Impact Assesment
3	STP IA	Sewage Treatment Plant Impact Assessment

\*Required for the construction phase

# ANNEX P-1-II CONSTRUCTION METHODOLOGY

	PROJECT : Tina River Hydropower Development Project (TRHDP)									
CONSTRUCTION METHOD STATEMENTS (CONSTRUCTION PLAN)										
DOCU	DOCUMENT No : E-GE-PMGD-R0-09300-C									
EPC CO	NTRACTOR	: HYUNDAI ENGINEER	ING C	CO., L'	TD. (ł	HEC)				
		ISSUE STA	TUS							
<u>C</u>	<u>15-DEC-2021</u>	ISSUED FOR INFORMATION	<u>W.C.</u> JANG	Famp	<u>J.H.</u> YANG	Nis	<u>T.H.</u> <u>KIM</u>	ala	<u>J.M.</u> <u>KIM</u>	
В	30-JUN-2021	ISSUED FOR INFORMATION	W.C. JANG	Fang	J.H. YANG	Nis	T.H. KIM	afri	J.M. KIM	
А	11-DEC-2020	ISSUED FOR INFORMATION	W.C. JANG	Fame	J.H. YANG	No	T.H. KIM	aler	J.K. LEE	zleik
REV. No.	DATE	DESCRIPTION	PREP.	ARED	CHEC	CKED	REVII	EWED	APPR	OVED

# CONSTRUCTION METHOD STATEMENTS (CONSTRUCTION PLAN)

### <u>15-DEC</u>-2021



Tina Hydropower Limited



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# **1. Project Summary**

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- 1.2 Primary Terms of the Contract
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- 1.4 Project Layout & Major Structure Specifications
# 1. Project Summary

# 1.1. Generals

## 1.1.1. Outline of the Work

PROJECT	TINA HYDROPOWER PLANT PROJECT
LOCATION	Area along the Tina river located 19km southeast of Honiara, capital city, in Solomon Islands
AMOUNT	USD 165.25 million (Main 140.25 + Access Road 25)
PERIOD	2019. 12.12 (Planned). ~ 2025. 01. 20 (62 months)
PROJECT COMPANY	SPC_TINA HYDROPOWER LIMITED (THL)
COOPERATION STRUCTURE	EPC Sole-sourcing (BOOT : K-Water + Hyundai Engineering)
SCALE	<ol> <li>Access Road : L = 20.64km, W = 4.5~7.0m</li> <li>Dam : RCC Type, H = 71.3m, L = 234.3m</li> <li>Power House : 15MW (5MW x 3Units)</li> <li>Penstock : D = 3.0m, L = 181m</li> <li>Headrace Tunnel : D = 3.8m, L = 3,292m</li> </ol>

### <Figure 1.1-1> Outline of the Work

# **1.2. Primary Terms of the Contract**

BOND		PAYMENT TERMS		
BID BOND	- N/A (Private Contract)	ADVANCES RECEIVED	- 15% of Contract Amount	
PERFORMANCE BOND	<ul> <li>- 15% of Contract Amount</li> <li>- 54months of Warranty</li> <li>Period</li> </ul>	ADVANCE PAYMENT BOND	- 15% of Contract Amount	
WARRANTY BOND	<ul> <li>- 10% of Completion Money</li> <li>- Warranty Period : 24months for Civil Work</li> <li>36months for Mechanical /Electrical Work</li> </ul>	PAYMENT	- Payment Method : Quarterly Progress	
RETENTION PAYMENT BOND	- N/A RETENTION MONEY		- N/A	
LIQUIDATED DAMAGES - 15% of Contract Amount				
TAXES AND THE PUBLIC UTILITIES' CHARGE	- Corporate Tax : Tax Free - Tariff and Commodity Tax : Tax Free			

### <Figure 1.2-1> Primary Terms of the Contract

# 1.3. Status of the Work



<Figure 1.3-1> Status of the Work

### 1.4. Project Layout & Major Structure Specifications

The Main dam planned in the Project was in the form of RCC (Roller Compacted Concrete) at the length of 234.0m and height of 71.3 m with non-gated spillway at the center. The dam site is located at mid-downstream of the Tina River mainstream which is about 11.7 km upstream from Njalimbisu river junction. The powerhouse was planned as a surface type with three units of Francis Turbines will be installed in the future. It is located at about 3.5 km downstream from the dam along the Tina River.

The major components of facility layout planned in the Project are as shown below.



### <Figure 1.4-1> Project Layout

The main contents and major structure specifications of the basic design for the Project are summarized in the following table.

Item		Specification	Remarks	
Site	Name of River		Tina	
Sile	Ca	tchment Area	125 km <sup>2</sup>	Dam site
	Des	sign Discharge	360 m³/s	2-year
	Leveltudia el	Туре	Earth Fill	
	Cofferdam	Crest EL.	U/S: EL.127.0 m, D/S: EL.126.0 m	
	Concradin	Crest Width	3.0 m	
		Туре	RCC	
		Crest EL.	EL.134.5 m	
	Opstream Cofferdam	H/L	13.0 m / 69.8 m	
		Gradient	1:0.5	
Diversion		Grouting Method	Permeation Grouting & RCC	
		Туре	Earth Fill	
	Downstream	Crest EL.	EL.127.5 m	
	Cofferdam	H/L	7.2~9.5 m / 42.2 m	
		Gradient	1:1.8	
		Location	Left Bank	
	Diversion	Туре	Reinforced Concrete	Cast in place
	Culverts	Size	B4.4 m×H4.4 m×2row	
		Length	464 m (232m×2 row)	

### <Table 1.4-1> Major Structure Specifications

Item		Specification	Remarks	
		Dam Type	RCC	
		F.S.L.	EL.175.0 m	Weir Crest EL.
	Flood	PMF	5,008 m³/s	Safety Check Flood
	discharge	10,000-yr.	3,290 m³/s	Spillway Design Flood
		PMF	EL.187.2 m	M.F.L
	Flood level	10,000-yr.	EL.184.4 m	Spillway Design Flood Level
Main	Main dam	Crest EL.	EL.186.5 m	
Dam	Main dam	Parapet Wall Crown	EL.187.5 m	
		Crest width	7.0 m ~10.0 m	
		Height	71.3 m	
		Length	234.3 m	
	Hori	zontal Bending	Straight	
	Clone gradient	Upstream	Ver. / R87.861 / 1:0.2	
	Slope gradient	Downstream	<u>1:0.2 / R48.979 / 1:0.7</u>	
	0	verflow width	55 m	
		Chute	Stepped chute (39m at flip bucket)	
Spillway	Chu	teway Gradient	1V:0.7H	
-17	Energy Dissipator	Туре	Flip Bucket with splitter	
		Bucket Radius	11.0 m	
	Bioopator	Lip EL.	EL.136.0 m	
	Des	sign discharge	135 m³/s	
	Des	ign water level	EL.170.0 m	M.O.L
		Size	B3.0 m×H3.0 m	
		Length	Approx. 59.3 m	
	Bottom El	Inlet	EL.150.0 m	
Scour	DOUUIII EL.	Outlet (lip)	EL.134.5 m	
Oullet	Ene	ergy Dissipator	Separate Flip Bucket	
		Gate Type	Roller Gate	
	Lifting Devic	e Type for Scour Outlet	Hydraulic Cylinder + HPU	
	S	stoplog Type	Slide Gate	
	Lifting Devic	e Type for Scour Outlet Stoplog	Electric Hoist	
	Des	sign discharge	1.0 m³/s, 3.4 m³/s	
	Ins	talled location	Near Scour Outlet	
Rinarian		Size	<u>D0.70 m / D0.35 m / D0.60 m</u>	
Outlet		Inlet EL.	EL.159.1 m	
		Outlet EL.	EL.15 <u>2.5</u> m	
	G	ate Facilities	Isolation Valve, Fixed Cone Valve, Electric Gate Valve	

Item		Specification	Remarks	
		Length	3,220.59m	
	Headrace	Cross Section	D3.8 m	TBM(Circular)
	Turinor	Slope	0.455%	
	_	Length	TBM: 40.0 m / NATM 33.5 m	
	Power Tunnel	Cross Section	TBM: D 3.80 m / NATM D3.00~3.80 m	
	Turinor	Slope	Level	
	+ :	Length	12.3 m	
	lailrace Outlet	Cross Section	W20.9 m×H4.5 m	
	oulot	Slope	33.33%	
		Cross Section	D3.0 m	
		Total Length	1 <u>53.67</u> m	
Power Waterway		Upstream tunnel liners	D3.0 m x <u>L25.5</u> m	
matorinay		Inclined exposed part	D3.0 m x L11 <u>9.3</u> m	
		Isolation valve part (exposed)	D2.55 m x L <u>8.87</u> m	
		Trifurcation part	D3.0 m ~ D1.65 m x L <u>8.0</u> m	
	Penstock	Downstream buried penstock	D1.65 m ~ D 1.2 m x L28 <u>.08</u> m	
		Used steel material	SM 400 B (rolled steels for welded structure)	
		Maximum Design Load	13.28 kg/cm <sup>2</sup>	
		Ring girder	Slide bearing type 3 sets	
		Expansion Joint	Sleeve coupling type 3 sets	
		Anchor Block	2 sets	
		Size	W3.8 m×H3.8 m	
	Ga	te Bottom EL.	EL.161.5 m	
	Tra	ashrack Size	W6.3 m×H5.9 m	
	Inlet	Tunnel Length	19.75 m	
Intako		Gate Type	Roller Gate	
IIIdke	Lifting Devic	e Type for Intake Gate	Hydraulic cylinder + HPU	
	S	toplog Type	Slide Gate	
	Lifting Device	Type for Intake Stoplog	Electric Hoist	
	Tra	ashrack Type	Fixed Steel Bar Screen	
	Trashra	ack Cleaner Type	Overhead Trashrack Cleaner	
		Туре	Restricted Orifice	Concrete Lined
Surge		Diameter	7.0 m	
Tank		U.S.W.L.	EL.191.5 <mark>87</mark> m	
		D.S.W.L.	EL.155. <u>165</u> m	
	-	Total	28.0 m	
		2nd Floor Elevation	EL.84.8 m	Overhead Crane Hook
Powerhouse	Height	Ground Floor Elevation	EL.80.3 m	Generator Floor
i owoniouse	Height	B <sub>1</sub> Floor Elevation	EL.76.0 m	Electrical equipment & Battery
		B <sub>2</sub> Floor Elevation	EL.72.2 m	Inlet valve & Fire-

Item		Specification	Remarks		
					fighting pump
		B <sub>3</sub>	Floor Elevation	EL.69.71 m	Draft Tube
	Width		th	16.3 m	Excluding Draft Tube Gate
		Leng	th	40.9 m	Excluding Office Building
		Тур	e	Vertical Shaft Francis Turbine	
	N	Number of unit		3 set	
	F	Power Output		15 MW	5 MW × 3 Units
		Efficie	ncy	94.36 (3 unit operation at rated head)	
		P	lant discharge	19.0 m³/s	
Turbino	Discharge		Maximum	6.33 m³/s	1 Unit
Turbine			Minimum	3.17 m³/s	
			Maximum	97. <u>47</u> m	
	Net Head		Rated	94. <u>47</u> m	
			Minimum	92. <u>47</u> m	
	Turbine setting elevation			EL.73.00 m	
	Dire	ection of	frotation	Clockwise Viewed from Generator	
	Туре		е	Brushless Synchronous Generator	
	Rated output		utput	6 MVA	
	Rated voltage			11 kV	
	Rat	Rated power factor		0.9 (lag.)	
	Ra	ated fre	quency	50 Hz	
Generator		Phase		3 Phase	
	Efficiency		ncy	97.39 (3 unit operation at rated head)	
	Voltage regulation		gulation	+5% to - 5%	
	Sh	Short circuit ratio		>1.1	
	Insulation class		n class	Class F	
		Installa	ation	Outdoors	
		Freque	ency	50 Hz	
	Num	Number of Windings		2	primary & secondary
	Nu	mber of	phases	3	
Main	T	ype of c	cooling	ONAN/ONAF	
Transformer	Continuous rat	ing of w MV/	vindings on all taps, A	14.5/18.0 MVA	
	Rated		Primary	66 kV	
	Voltage		Secondary	11 kV	
	Efficiency, minimum of		inimum of	99.2%	

# 2. Work Plan

- 2.1 Calculation of Working Days
- 2.2 Master Schedule
- 2.3 Critical Path
- 2.4 Schedule of Major Works
- 2.5 Key Date & Milestone

# 2. Work Plan

# 2.1. Calculation of Working Days

# 2.1.1. Precipitation Data Analysis

The recent precipitation data in Guadalcanal Province in Solomon Islands is analysed for scheduling plans. It is divided into the rainy season (Nov-Apr) and the dry season (May-Oct) as shown in figure below, and it is predicted disruptive days by the weather will be 9-10 days in the rainy season and 5-6 days in the dry season.



### <Figure 2.1-1> Recent Precipitation Data in Guadalcanal Province in Solomon Islands

The disruptive days is reflected in the whole construction period by creating a multi-calendar when scheduling plans. For that reasons, the non-working days reflected in the schedule minimizes construction delays by the weather conditions.

# 2.1.2. Application & Analysis of Working Days

The application of working time and shifts is limited by work classifications and weather conditions.

As shown in the following table, Earth works affected by weather conditions works on 20 days per month by one shift. RCC dam and Tunnel work that require continuous operations are double shifts.

Classification	Time / Day	Days / Month	Remarks
Earth work	10	20	-
RCC Dam	20	20	Double shift
Structural Work	10	20	-
Tunnel Work	20	25	Double shift
Architecture Work	10	20	-

### <Table 2.1-1> Working Day & Time Considering Weather Conditions

Earth work / RCC Dam = 20 days / month

- 365 14 of holidays 52 of weekends 63 of rainy days
  - = 236 days / 12 months

Tunneling work (Indoor work) = 25 days / month

- 365 14 of holidays 52 of weekdays 12 of equipment repair days
  - = 287 days / 12months

### 2.1.3. National Holidays

National holidays are included in non-working days. Solomon Islands National holidays for each country are shown in the table below.

Name	<u>Date</u>	<u>Name</u>	<u>Date</u>
<u>New year</u>	<u>01-01</u>	Independence Day	<u>07-07</u>
Easter Week	<u>2nd week of April</u> (4day)	<u>Christmas</u>	<u>12-25</u>
Whit Monday	First Monday of June	Thanksgiving Day	<u>12-26</u>
Queen's Birthday Week	<u>2nd week of Jun</u> (2day)		

2.1.4.

#### 2.1.4. Application of Multi-Calendar

A multi-calendar was created for project schedule by reflecting the weather conditions and national holidays as follows.

Each calendar is applied by reflecting the work characteristics and weather conditions, and the types of multi-calendar are shown in the table below.

### <Table 2.1-3> Multi-Calendar

Classification	Name	Remarks
Calendar 1	SITI_7D W/W	-
Calendar 2	SITI_6D W/W	
Calendar 3	SITI_6D W/W + Holidays(SOL) + RAN(hr)	
Calendar 4	SITI_6D W/W + Holidays(SOL)	
Calendar 5	SITI_5D W/W + Holidays(KOR)	-

Application of multi-calendar minimizes the risk of delays caused by weather conditions and holidays.

### 2.2. Master Schedule

Tina River Hydropower Development Project takes <u>67</u> months for the whole project. During this period, the net construction period excluding design and commissioning is 24 months

- Notice to Proceed: 2019-12-12
- Taking Over Certificate: 2025-06-13



<Figure 2.2-1> Master Schedule

# 2.3. Critical Path

The critical path (TF = 0) of this project is shown as main dam works.

Desalination of the main dam should be run in parallel with process control of the sub-structures. Therefore, it is necessary to manage the extra schedule of Headrace. Delay in sub critical path may lead to delay in the entire construction period



<Figure 2.3-1> Critical Path

## 2.4. Schedule of Major Works

The main schedule for each facility is shown in Figure 4.3-2



<Figure 2.4-1> The Main Schedule for Each Facility

### 2.5. Key Date & Milestone

The key dates and milestones that must be importantly managed during the construction period required by the client are as follows.

Activity Name	Start	Finish	Remarks
Notice to Proceed	2019-12-12	-	Key Date
Commencement of Access Road Works	<u>2021-05-17</u>	Ξ	
Completion of Base Camp	Ξ	<u>2022-05-31</u>	-
Submission of Detailed Design	1	<u>2020-10-30</u>	
Commencement of Ground Works for the Dam, Powerstation and Tunnel	<u>2022-03-12</u>	1	-
Completion of Access Road	z	<u>2023-10-12</u>	
Completion of Diversion Work	1	<u>2023-03-17</u>	
Commencement of RCC Dam Concrete Work	<u>2023-10-24</u>	Ξ	
Completion of Tunnel Breakthrough	1	<u>2024-01-05</u>	
Completion of Powerhouse Steel Structure	Ξ	<u>2023-10-13</u>	
Completion of Turbine and Generator	<u>_</u>	<u>2024-02-03</u>	
Completion of RCC Dam Concrete Work	1	<u>2024-09-30</u>	
First Reservoir Impoundment	<u>2025-02-13</u>	Ξ	
Completion of New Transmission Line by Offtaker		2024-02-11*	
Taking-Over Certificate		2025-06-13*	Key Date

### <Table 2.5-1> Key Date & Milestone

# 3. Plan for Manpower & Equipment Mobilization

- 3.1 Site Organization Chart
- 3.2 Manpower Mobilization Plan
- 3.3 Equipment Mobilization Plan

# 3. Plan for Manpower & Equipment Mobilization

# 3.1. Site Organization Chart



# 3.2. Manpower Mobilization Plan

# 3.2.1. Manpower Mobilization Plan

<b>Classification</b>	<u>Total</u>	Quarterly Maximum	Peck Time	<u>Note</u>
Manpower Mobilization	<u>17,782</u>	<u>1,605</u>	Third quarter of 2022	<u> Peak Time : 557</u>

# 3.2.2. Quarterly Manpower Mobilization Plan

Classification		<u>'19</u>		20	<u>20</u>			20	<u>21</u>			20	22			20	<u>23</u>			20	24		<u>'25</u>	Tetal
Class	sification	<b>Q4</b>	<b>Q1</b>	<u>Q2</u>	<u>Q3</u>	<u>Q4</u>	<u>Q1</u>	<u>Q2</u>	<b>Q</b> 3	<u>Q4</u>	<b>Q1</b>	<u>Q2</u>	<u>Q3</u>	<u>Q4</u>	<b>Q1</b>	<u>Q2</u>	<u>Q3</u>	<u>Q4</u>	<u>Q1</u>	<u>Q2</u>	<u>Q3</u>	<u>Q4</u>	<b>Q1</b>	Total
Man	Quarterly	<u>65</u>	<u>201</u>	<u>267</u>	<u>329</u>	<u>411</u>	<u>418</u>	<u>477</u>	<u>507</u>	<u>738</u>	<u>862</u>	<u>1,306</u>	<u>1,605</u>	<u>1,357</u>	<u>1,273</u>	<u>1,283</u>	<u>1,401</u>	<u>1,350</u>	<u>1,244</u>	<u>936</u>	<u>900</u>	<u>583</u>	<u>269</u>	
power	Cumulative Total	<u>65</u>	<u>266</u>	<u>533</u>	<u>862</u>	<u>1,273</u>	<u>1,691</u>	<u>2,168</u>	<u>2,675</u>	<u>3,418</u>	<u>4,275</u>	<u>5581</u>	<u>7,186</u>	<u>8,543</u>	<u>9,816</u>	11,099	12,500	13,850	15,094	16,030	16,930	17,513	17,782	17,782



# 3.3. Equipment Mobilization Plan

# 3.3.1. Equipment Mobilization Plan

<b>Classification</b>	<u>Total</u>	Quarterly Maximum	<u>Peck Time</u>	<u>Note</u>
Equipment Mobilization	<u>3,743</u>	<u>379</u>	Third quarter of 2022	Peak Time : 135

# 3.3.2. Quarterly Equipment Mobilization Plan

Classification <u>'19</u> <u>2020</u>		<u>2020</u> <u>2021</u>			<u>2022</u>		<u>2023</u>		<u>2024</u>			<u>'25</u>	Total											
Class	SINCALION	<u>Q4</u>	<u>Q1</u>	<b>Q2</b>	<b>Q</b> 3	<u>Q4</u>	<u>Q1</u>	<u>Q2</u>	<b>Q</b> 3	<b>Q4</b>	<b>Q1</b>	Q2	<b>Q</b> 3	<b>Q4</b>	<u>Q1</u>	<b>Q2</b>	<b>Q</b> 3	<u>Q4</u>	<u>Q1</u>	<b>Q2</b>	<u>Q3</u>	<u>Q4</u>	<b>Q1</b>	<u>10tai</u>
Man	Quarterly	<u>20</u>	<u>49</u>	<u>90</u>	<u>90</u>	<u>99</u>	<u>105</u>	<u>136</u>	<u>183</u>	<u>238</u>	<u>241</u>	<u>361</u>	<u>379</u>	<u>204</u>	<u>211</u>	<u>208</u>	<u>225</u>	<u>225</u>	<u>195</u>	<u>167</u>	<u>165</u>	<u>112</u>	<u>40</u>	
power	Cumulative Total	<u>20</u>	<u>69</u>	<u>159</u>	<u>249</u>	<u>348</u>	<u>453</u>	<u>589</u>	<u>772</u>	<u>1,010</u>	<u>1,251</u>	<u>1612</u>	<u>1,991</u>	<u>2,195</u>	<u>2,406</u>	<u>2,614</u>	<u>2,839</u>	<u>3,064</u>	<u>3,259</u>	<u>3,426</u>	<u>3,591</u>	<u>3,703</u>	<u>3,743</u>	<u>3,743</u>



# 4. Temporary Work Plan

- 4.1 Layout of the Temporary Work
- 4.2 Site Condition for Temporary Work
- 4.3 Temporary Office & Camp Arrangement Plan
- 4.4 Batching Plant
- 4.5 Crusher Plant (150 tons)
- 4.6 Aggregates Supply Plan
- 4.7 Disposal Area

# 4. Temporary Work Plan

# 4.1. Layout of the Temporary Works

The project area is composed of total three sites for effective execution of the construction.

The site camp is located near the blackpost Junction of existing road and the other two sites(B/P, C/P, office) are planned in the vicinity of the powerhouse as well as the main dam.



<Figure 4.1-1> Project Location



<Figure 4.1-2> Location of Site Camp

### 4.2. Site Condition for Temporary Work

The site camp include accommodation, canteen and athletic facilities.

The office site includes offices, batching plant, crusher plant, laboratories, safety management rooms, warehouses and workshop



<Figure 4.2-1> Temporary facility arrangement plan

- 1) Site Camp
  - Installed near the access road lot-1 sta. 3+320
  - Overall, the terrain is flat

### 2) Office/workshop

- Installed near the access road lot-2 sta. 1+000
- Positioned near Powerhouse and Tunnel considering work efficiency and location to minimize earthwork

3) BP(180m<sup>3</sup>\*1ea, 120m<sup>3</sup>\*1ea)

- Installed near the access road Lot2-2 sta. 2+660 Right side
- Positioning considering the transportation time of ready-mixed concrete

### 4.3. Temporary Office & Camp Arrangement Plan

The temporary office area is composed of several buildings such as office, clinic, workshop and others. All structures are equipped with basic furniture, heating and air conditioning system, lights and internet.

Major temporary facilities will be installed at the major location for efficient execution of works



<Figure 4.3-1> Temporary Office & Camp Floor Plan

The temporary camp area is composed of several buildings such as accommodation, canteen, sewage and others. All structures are equipped with basic furniture, refrigerator and air conditioning system.

# 4.4. Batching Plant

### 1) Scope of work

Two batching plants will be operated for the following purposes and amounts:

### <Table 4.4-1> Purposes of the Batching Plants

ltem	Purpose	Concrete Amount	Remark
Batching Plant (180m <sup>3</sup> /h)	RCC Dam Concrete only	248,600 m <sup>3</sup>	
Batching Plant (120m³/h)	GERCC(Grout enriched roller compacted concrete) CVC(Conventional Vibrated Concrete) • Powerhouse structure concrete • Intake and scour outlet concrete		
Batching Plant (60m³/h)	Headrace tunnel shotcrete Headrace tunnel concrete lining Slope Protect Shotcrete Penstock support concrete	20,000 m <sup>3</sup>	

Batching plant is installed close to access roads for the aggregate supply to main dam. Installation plan is shown in following figure.



<Figure 4.4-1> Batching Plant(60m<sup>3</sup>)





<Figure 4.4-2> RCC Batching Plant(180m<sup>3</sup>)

Concrete is produced using tested ratio approved by client and using twin shaft compulsory mixing plant.

The expected production of RCC batch plant is below.

- Rated capacity : 180m<sup>3</sup>
- Assumed actual capacity rate : 40%(72m<sup>3</sup>/hr)
- Working hours : 24hr
- Daily production capacity :  $72m^3 \times 24hr = 1,728m^3/day$

The expected production of CVC batch plant is below.

- Rated capacity : 120m<sup>3</sup>
- Assumed actual capacity rate : 65%(78.0m<sup>3</sup>/hr)
- Working hours : 12hr
- Daily production capacity :  $97.5m^3 \times 12hr = 936m^3/day$

Waiting time may occur by the working location and equipment combination, so adjust the operating time according to the amount of supply.

At least 3 days' worth of materials must be stored in the batch plant, and partitions shall be installed to store aggregates according to their specifications. In addition, cooling facilities are added to lower the water temperature, if necessary to maintain the quality of the concrete, and manpower also is put in for quality test.

2) Treatment facilities for residual concrete and polluted water

Treatment facilities for residual concrete and polluted water are installed to treat polluted water produced during cleaning process of the concrete truck mixer and recycles of residual aggregates. The recycling of sludge is completed by a filter press, so the dehydrated and compressed sludge will be transported to a dedicated disposal area.

### 4.5. Crusher Plant (150 tons)

The aggregates will be used for concrete works produced in this area for below.

- RCC dam concrete works
- Powerhouse concrete works
- Headrace tunnel and Surge tank concrete lining
- Penstock saddles and anchor blocks
- Shotcrete required in the whole area.
- Infrastructures, foundations, walls, etc.

This crushing plant will be fed by developed quarry. The stationary and mobile types are selected in consideration of the volume of aggregates in the quarry.

For the project, a crushing plant is planned with a production capacity of 150ton/hr, will be installed at the location of the figure below for the supply of rocks and aggregates.



<Figure 4.5-3> Crushing Plant installation location

Stationary crusher shall be repeated several steps of crushing and screening to maintain the required suitable quality.

The main equipment of that is as follows.

• Hopper & feeding System : Rock supply

- 1<sup>st</sup> Crushing : Jaw Crusher :
- 2<sup>nd</sup> Crushing : Cone Crusher
- Vibration Screen : Classification by size
- Belt Conveyor : Aggregate transfer
- Temporary Stock yard

The type and quantity of crushers should be changed according to required aggregate type.

An example of crusher plant installation with a production capacity of 150m<sup>3</sup>/hr is shown in the figure below.



<Figure 4.5-4> Crusher Plant (150ton) installation example

The following equipment is arranged in crushing plant

### <Table 4.5-3> Operating equipment list

Item	Excavator	Front-end Loader	Dump Truck	Remark
Capability	0.9m <sup>3</sup>	3.0m <sup>3</sup>	15.0ton	
purpose	Aggregate loading	Aggregate loading	Aggregate transport	
Quantity	1	1	48	

The following sub- facilities are installed for the operation of crushing plant.

- Electricity supply facility
- Water supply facilities
- Wastewater treatment facility (when washing aggregate)

# 4.6. Aggregates Supply Plan

The aggregate should be satisfied the strength and size of the each type of the materials to be used. Required aggregate quantity according to usage is as follows

Tuno of			Required aggre	gate quantity (Inc	lude Loss rate)	
material	Unit	Coarse (5mm~10mm)	Aggregate (Below 25mm)	Mixed stone (Below 75mm	Mixed stone (40~100mm)	Sum
Access road	m <sup>3</sup>	8,586	5,755	48,497	31,288	94,126
Structure	m <sup>3</sup>	28,990	32,703	-	1,842	63,535
RCCD	m <sup>3</sup>	-	-	252,824	-	252,824
Shotcrete	m <sup>3</sup>	1,067	-	-	-	1,067
Sum	m <sup>3</sup>	38,643	38,458	301,321	33,130	411,552

### <Table 4.6-1> Required Aggregate Quantity

Aggregates are supplied in the following ways

- Buy at local markets
- Blasting rocks generated during the access road construction
- Quarry development

The first and second methods are applied to construct the temporary road surface, shotcrete, box culvert, retaining wall and etc. of access road Lot 2 and Lot 3 for the main dam and power house access in the early stage.

The amount of aggregate required to construct the surface of temporary access road is shown in the table below.

### <Table 4.6-2> Aggregate Material Required for Construction of Temporary Road

ltem	Location	For concrete	Tem	porary road ι	usage before bla	asting	Total(m <sup>3</sup> )
item	(Chainage)	producing(m <sup>3</sup> )	Width(m)	Length(m)	Thickness(m)	Volume(m <sup>3</sup> )	Total(III')
LOT 1	STA. 12+000 ~ STA.13+237	For small scale	6	1,237	0.3	2,226	
LOT 2-1	STA. 0+000 ~ STA. 2+504	structure and shotcrete	6	2,504	0.3	4,507	
LOT 2-2	STA. 0+000 ~ STA.1+500	for Access road Aggregate size	6	1,500	0.3	2,700	
LOT 3-1	STA. 0+000 ~ 0+500	is under 25mm	6	500-	0.3	900	
Total		14,400				10,333	24,733

The estimated amount of excavated soil and blasting rock generated by the construction of Lot 2 and Lot 3 of access road is as follows. (refer to IFC design drawing July 17, 2020)

Excavation	LOT 2-1	LOT 2-2	LOT 2-3	LOT 3	Total excavated (m³)
Soil	141,699	344,143	17,949	258,270	762,061
Removable rock	-	81,862	-	-	81,862
Solid rock(blasting)	432	116,070	64,494	133,896	314,893

<Table 4.6-3> Excavation quantity for Construction of Access Road

The estimated volume of aggregate required for the construction of temporary access road is shown in the table below.

Access road	Location (Chainage)	Road Width(m)	Road Length(m)	Road Thickness(m)	Volume(m3)
LOT 2-1	STA. 0+000 ~ STA. 2+504	7.0	2,504	0.5	8,764
LOT 2-2	STA. 0+000 ~ STA. 2+732	6.0	2,732	0.5	8,196
LOT 2-3	STA. 2+260 ~ 2+696	6.0	436	0.5	1,308
LOT 3-1	STA. 0+000 ~ 1+509	6.0	1,509	0.5	4,527
Total	-	-	7,181	-	22,795

<Table 4.6-4> Aggregate Material Required for Construction of Temporary Access Road

Blasting rocks generated in Lot 2 and Lot 3 of temporary access road are sufficient to be used on temporary road surface, and if the quality of the paving aggregate is satisfied, it is used as a permanent pavement aggregate.

After completion of the temporary access road, various options are considered as shown in the table below, and aggregate will be supplied by selecting an optimized option.

Aspect	Option 1 (Quarry 1/3 identified in QMP)	Option 2	Option 3 (Existing source, Local Supplier)
Location	Right bank, upstream of dam site	Riverbed from downstream of dam site to powerstation within core boundary	Local supplier (Solomon Sheet Steel)
Assessment background	Detailed in ESIA (2017 and 2019)	Considered as part of Feasibility study (Entura, 2014	New option considered in 2020, for temporary Access Road only
Developable volume	Sufficient for use (if type of rock is suitable for quality spec) 2,500 m <sup>3</sup> (ESIA report) 2,500,000 m <sup>3</sup> (initial Feasibility study, Entura 2014)	250,000m³ (approx. 6km)	3,000 m <sup>3</sup> per month
Advantage	<ul> <li>Sufficient amount for project</li> <li>Recommended by DSAP</li> <li>Short distance to Dam site</li> </ul>	<ul><li>Short distance to Dam site</li><li>Developable without blasting</li></ul>	<ul> <li>No additional cost and effort for the development of quarry</li> </ul>

<Table 4.6-4> Quarry Location Options Assessment

Aspect	Option 1 (Quarry 1/3 identified in QMP)	Option 2	Option 3 (Existing source, Local Supplier)
Disadvantage	<ul> <li>Accessible after LOT2-2 road opening</li> <li>High cost for extraction due to blasting and need vibration impact assessment for dam structure</li> <li>Access Road will be on a steep slope</li> <li>Difficulty to approach in the flood season; no space to temporarily store aggregates above flood level</li> </ul>	<ul> <li>Concerns that there may be disputes with local community; grievances</li> <li>Additional access is require to reach the source</li> <li>Need mobile crusher</li> </ul>	<ul> <li>Not Sufficient resource (with current operation)</li> <li>Aggregate size not suitable for permanent surface and not sufficient volume for specific size (40mm above) for paving and RCC dam due to location of extraction location (downstream of the river)</li> <li>High cost</li> </ul>

### 4.7. Disposal Area

A total of five areas will be installed in the site. Those areas will be used for stacked the soils produced by construction or temporarily yard.

The types of soils produced by the construction;

- Surplus soil during road works
- Excavation for dam
- Sand : 90,000m<sup>3</sup>

Expected amount of aggregates available for each source;

- Excavation of headrace tunnel and surge tank
- Excavation of powerhouse and site renovation of switchyard
- Excavation for construction of other structure

The layout of disposal areas is shown in the following figure.



<Figure 4.7-1> The layout of disposal areas

The following table shows the quantity and purpose of use for each disposal area.

Division	Volume(m <sup>3</sup> )	Purpose	Remarks		
Disposal area- <u>1-1~1-3</u>	534,015	Road Work& Main dam Excavation			
Disposal area-2	147,979	Road Work	Camp Site		
Disposal area-3	577,196	Headrace Tunnel & Surge tank Excavation Powerhouse site renovation			
Disposal area-4	11,036	Headrace Tunnel & Surge tank Excavation			

<Table 4.7-2> The Quantity and Purpose of Use for Each Disposal Area

The disposal proceeds from bottom to top and keeping at slope with 1:1.8 ratio. During the disposal, facilities to prevent soil leakage or scattering are installed.

# 5. Plan for Civil Work

- 5.1 Flow Chart of Works
- 5.2 Access Road
- 5.3 River Diversion
- 5.4 Roller Compacted Concrete(RCC) Dam
- 5.5 Power Water Way
- 5.6 Powerhouse
- 5.7 Tailrace Outlet
- 5.8 Hydraulic Metal Works
- 5.9 Main Transformer and Switchyard

# 5. Plan for Civil Work

### 5.1. Flow Chart of Works

"TRHDP" is located in the Tina River, a tributary of the Ngalimbiu River and it includes a RCC dam, a headrace tunnel (approx. 3.3 km-long), and a powerhouse (5.4 km downstream from the dam).

The construction area is divided into dam, headrace tunnel, and power house.

Mechanical and electric work for each facility will be parallel to civil work or architecture work depending on the installation location and order.

The construction flow of each facility is shown in Figure 5.1-1.



<Figure 5.1-1> The Construction Flow of Each Facility

### 5.2. Access Road

### 5.2.1. Priority Management Plan

1) General

Road construction for the Tina River Hydropower Developement Project (hereinafter called "TRHDP") will include construction of new permanent access roads(powerhouse-dam) and improvement of an existing unpaved road.

In the following figure, the yellow line is the existing road of two lanes and is marked as Lot. The green line is the new road.



<Figure 5.2-1> Access Road Linear Diagram

### 2) Arrangement of Access Roads

After completion of permanent access roads, the construction work of TRHDP will be commenced. Arrangement of access road is shown in Table 5.2-1.

Classifi	cation	Section	Width (m)	Distance (km)	Paving			
Existing Road	LOT 1	Existing(Rehabilitation)	7.0	13.24	Gravel + Concrete			
	LOT 2-1	Managkiki to Mountain	7.0	2.50	Concrete + Cement Stabilized Pavement			
No. Decil	LOT 2-2	Mountain Crest to Intake/Dam		2.73				
New Road	LOT 2-3	Intake/Dam Crest to Dam Base		0.32	0			
	LOT 3-1	Managkiki to Powerhouse	4.5~9.5	1.51	Concrete			
	LOT 3-2	LOT 3-1 to Tunnel Outlet		0.02				
Tot	al			20.322				

<Table 5.2-1> Arrangement of Access Roads

Lot 1 is an existing road of two lanes and is constructed with gravel and cement stabilized pavement, so the reinforcement and repair is required.

Lots 2 and 3 of the new road are constructed in one lane with concrete and cement stabilized pavement. Spaces for crossing between construction vehicles should be created at regular intervals. The cross section of the new road is shown in the figure below.



<Figure 5.2-2> New Road Section

3) Detail schedule of access roads

The access road schedule was planned not to interfere with the main construction schedule, and the detailed schedule is as follows.

Classification		Period	od 19 2020						2021						2022					2023					2		2025			
	Classification	(Mth)	4/4	1/4	1	2/4	3/4	4/4	1/	4	2/4	3/	4	4/4	1/4	2/4	3/4	4/4	1/4	2/4	3/4	4/4	1	/4	2/4	3/	4	4/4	1/4	2/4
Milestone			V	NTP							<b>•</b> •	Cømme	encem	nent of A	ccess R	oad Works									First R	eservoi	r Impo	undmen	t 🔻	тос
1. Access Road																														
Lot 1_13.2km	Earth Work	25.1							Π	Π	-										•		П	Т					Π	
	Drainge Work	19.7												-					$\left  \right $		+									
	Structure Work	6.4																-												
	Pavement Work	22.6								Ш				-								+								
Lot2-1_2.5km	Earth Work	13.4	ł										÷					-												
	Drainge Work	10.8												-	╈			-												
	Pavement Work	1.7																												-
Lot 2-2_3.0km	Earth Work	18.2											l+																	
	Drainge Work	15.4	-											-																
	Slope Protection	14.4	L.												┝┿┿				$\left  \right $											
	Pavement Work	2.8																										•	+	
Lot 2-3_0.6km	Earth Work	13.4	ł																╞╎╎											
	Drainge Work	4.9																	+											
	Slope Protection	9.3																	╞║║											
	Pavement Work	0.5																										-		
Lot 3-1_1.6km	Earth Work	16.9											l+						₩											
	Drainge Work	13.0													┥┿				┿╽											
	Slope Protection	12.7													┥┿															
	Pavement Work	1.9																									-	_		
Lot 3-2_0.3km	Earth Work	1.9								Π																			Π	
	Drainge Work	0.0																												
	Slope Protection	0.0													•															
	Pavement Work	0.1																												

<Figure 5.2-3> Access Road Schedule

# 5.3. River Diversion

### 5.3.1. Priority Management Plan

### 1) General

The river diversion for dam construction consists of 3 components – diversion culvert, upstream Composite type(RCC + Earth fill) and downstream cofferdam. The design flood for longitudinal cofferdam, upstream and downstream cofferdams and diversion culverts is 360 m<sup>3</sup>/s, which is 2-year frequency flood.

Layout and profile of diversion facilities are shown in Figure 5.3-1 and Figure 5.3-2.



<Figure 5.3-1> Layout of Diversion Facilities



### <Figure 5.3-2> Profile of River Diversion

Specifications of river diversion works are described in table 5.1-1.

### <Table 5.3-1> > Comparison of River Diversion Works

Cla	assification	F/S	Basic Design	Detail Design				
Desi	gn Discharge	360 m³/s (2-year)	(Same)	(Same)				
Longitudinal Cofferdam	Туре		Earth Fill	(Same)				
	Crest EL.	Earth Fill U/S: EL.127.0 m, D/S: EL.126.0 m	U/S: EL.127.0 m, D/S: EL.126.0 m	(Same)				
	Crest Width	,	3.0 m	(Same)				
	Туре	RCC	RCC	RCC + Earth Fill				
	Crest EL.	EL.134.0 m	EL.134.5 m	(Same)				
Upstream Cofferdam	Height/Length	-	13.0 m / 69.8 m	(Same)				
	Gradient	1:1.0	1:0.5	1:0.5 / 1:1.5				
	Grouting Method	Cut-off wall or Grout curtain	Permeation grouting	(Same)				
	Туре	RCC	Earth Fill	(Same)				
	Crest EL.	EL.126.0 m	EL.127.5 m	(Same)				
Downstream Cofferdam	H/L	-	6.5 m / 62.1 m	7.7~9.5 m / 42.2 m				
	Gradient	1:1.0	1:1.2 / 1:1.5	1:1.5 / 1:1.8				
	Grouting Method	Cutoff wall or Grout curtain	-	-				
	Location	Right bank	(Same)	(Same)				
Diversion Culverts	Туре	Reinforced concrete (Precast)	(Same)	(Same)				
	Size	B3.6 m×H3.6 m×3row	B4.4 m×H4.4 m×2row	(Same)				
	Length	450 m (150 m×3)	332 m (166m×2)	464m (232m×2)				

### 2) Sequence of the Works

River diversion will be executed in 9 stages.

Stage-2	Stage-3							
CIT MAIN IDAM AXIS TRACKAY ACCESS ROLUTI TRACKAY ACCESS ROLUTI EL 10200 EL 102000 EL								
<ul> <li>Using temporary access road (1)</li> <li>Riverbed excavation (EL.122.0m)</li> <li>Embankment of longitudinal cofferdam (1<sup>st</sup>)</li> <li>Foundation excavation of main dam section</li> <li>1<sup>st</sup> Foundation treatment (Consolidation grouting)</li> </ul>	Using temporary access road (1)     Construction of diversion culverts     (1st)							
<u>Stage-5</u>	<u>Stage-6</u>							
<ul> <li>Using temporary access road (2)</li> <li>Embankment of longitudinal cofferdam (2<sup>nd</sup>)</li> <li>2<sup>nd</sup> Foundation treatment (Consolidation grouting)</li> <li>Construction of diversion culvert (2<sup>nd</sup>)</li> </ul>	<ul> <li>Using temporary access road (2)</li> <li>Embankment of upstream primary cofferdam</li> <li>Partial removal of longitudinal cofferdam</li> </ul>							
Stage-8	Stage-9							
<ul> <li>Using temporary access road (2)</li> <li>Embankment of upstream on the stream of th</li></ul>	<ul> <li>Constructed to EL.134.5m RCC</li> <li>Extension of temporary access road (3)</li> <li>Removal of temporary access road</li> </ul>							
	Stage-2 Using temporary access road (1) Niverbed excavation (EL.122.0m) Embankment of longitudinal cofferdam (1*) Consolidation grouting) Stage-5 Using temporary access road (2) Embankment of longitudinal cofferdam (2 <sup>m</sup> ) Consolidation grouting) 2 <sup>m</sup> Foundation treatment (Consolidation grouting) Construction of diversion culvert (2 <sup>m</sup> )							

<Figure 5.3-3 > Sequence of River Diversion Works

3) Detail schedule of river diversion

River diversion will be maintained for 21 months while the main dam is being constructed after 12 months of river diversion works, and then restored. The total duration of the river diversion is about 33 months.



<Figure 5.3-4 > Schedule of River Diversion Works

### 5.3.2. Longitudinal Cofferdam

The longitudinal cofferdam is temporarily installed during the construction of diversion culvert. Longitudinal cofferdams will be installed prior before diversion culvert to block water flow during diversion culvert construction.

The total length is 296.85m and the width of the Crest Level is 3.0m.

Layout of longitudinal cofferdam are shown in figure 5.3-5 à N 8,943,194,165



<Figure 5.3-5> Layout of Longitudinal Cofferdam

On the lower part of the longitudinal cofferdam, filter mat is laid after rock filling, and the central part is compacted and filled with random material. The exterior is arranged at a slope of 1.4:1.0 and a riprap is installed with 1.0m thickness to protect the slope.

Cross section of longitudinal cofferdam is shown in figure 5.3-6


<Figure 5.3-6> Cross section of primary cofferdam

The longitudinal cofferdam will be constructed in several stages. The division of stage is adjusted according to interference with the main dam or the schedule of diversion culvert.

The longitudinal cofferdam should be removed after the division culvert is completed and the river diversion.

# 5.3.3. Diversion Culvert

### 1) General

Specification of diversion culvert is as follows.

		Specifications	C OF DIVERSION CULVERT AXIS
Design D	ischarge	360 m³/s	700 4.400 1.000 4.400 700
Bottom	Inlet	EL.123.00 m	
EL.	Outlet	EL.120.90 m	
Max. Wa	ter Level	EL.133.55 m	& <del>2</del> ''' <del>''</del> <u>EL(+)123.000</u>
Si	ze	B4.4 m×H4.4 m×2row	

<Table 5.3-2> Specifications and Typical Section of Diversion Culvert

The bottom elevations of the diversion culverts have been set higher (EL.123.0m for the inlet and 120.9m for the outlet) than the annual mean water level in order that the <del>1st</del> diversion culvert can be constructed under dry condition.

The water level corresponding to the design flood of  $360 \text{ m}^3$ /s for upstream cofferdam is EL.133.55 m, to which 0.66m freeboard has been added to set the crest level of upstream cofferdam at EL.134.50 m.

The diversion culvert has a section of two rows and B=4.4m by H=4.4m.

Cast-in-place concrete will be used in consideration of the site conditions and constructability.

Materials in <Table 5.3-.3> are used for diversion culvert.

Division	Specifications	Remark			
Concrete	fc=30Mpa	Compressive Strength at 28days			
Lean Concrete	fc=18Mpa	Compressive Strength at 28days			
Steel Bar	fc=420Mpa	Grade 60			

### <Table 5.3-3> Materials of Diversion Culvert

### 2) Sequence of the Works



<Figure 5.3-7 > Sequence of Diversion Culvert Construction

Diversion culvert needs to be considered because the main dam, upstream and coffer dams are interfered.

Multiple work crews are required to be completed within construction period.

<Figure 5.3-8> shows the location of the Contraction Joint.



<Figure 5.3-8 > Contraction Joint Plan

Interferences in the main section are as follows.

Lot 2 proceeds with upstream dam. When diversion culvert is completed, RCC is poured over slab level of the diversion culvert.

Lot ④ is a section where the slot of the stop log for plugging of the diversion culvert is installed and has a complex shape, so procurement management of frame is important.

Lot (5), (6) and (7) is the interference section with main dam. They can be started after foundation grouting is completed after excavation.

Lot (1) and (2) are a section where downstream is constructed and does not affect the schedule compared to other sections.

The working group is operated by 2~3 work crews considering the continuity and efficiency of work.

3) Installation of Stop log

Once the main dam has been completed, take down all equipment in the dam. Then, stoplog and temporary river outlet pipe (for environmental flow during the initial reservoir filling) will be installed before constructing 1<sup>st</sup> plug concrete.



<Figure 5.3-9> Stop log Location



Stop log is made of steel. It is installed using 100ton mobile crane. The following figure is a concept drawing for stop log installation.

<Figure 5.3-10 > Stop log Installation

As shown in upper picture, the installation height is about 60m, and horizontal distance is 13.5m from the center of crest road. Therefore, maximum lifting height including crane height is 75.0m and the maximum horizontal distance is 17.0m.

Since the working time is very short due to the rise of the water level after installation of stop log, the stop log will not divided (or one per location) considering the installation time and operator's evacuation time.

To reduce the stop log installation time, each stop log will be mounted on the diversion culvert temporarily.

After the completion of stop log installation, the operator will evacuate by riding the elevating cage installed on the crane.

4) Concrete Plug of Diversion Culvert

Concrete plug is installing a stopper on the diversion culvert to fill the reservoir with water. Concrete plug is installed at 95m from upstream of diversion culvert and its length is 25.7m.



<Figure 5.3-11> Profile of Concrete Plug

The plug concrete shall be constructed to ensure shear resistance during the dry season with shear keys installed every 2.5m to secure shearing resistance.



### <Figure 5.3-12> Shear Key Plan

Concrete will be placed in four stages to prevent cracking by hydration heat. The height of one stage is constructed to a height of about 1.1m to minimize the generation of hydration heat.

Ļ			€ OF MAIN [	DAM AXIS	1		
0 _ 700		 	 		 	 	
00=4,40			 1-3			 2-3	
@1,1(		 	 (1-2)			2-2	
00		 	 (1-1)		 	 2-1	
1	_		 		 	 	

# <Figure 5.3-13> Plugging Concrete Pouring Plan

Cooling pipe is installed to control the hydration heat after cleaning the surface before next stage. The layout of the cooling pipe is shown in <Figure 5.3-14> and <Figure 5.3-154>.



<Figure 5.3-14> Cooling Pipe Plan



## <Figure 5.3-15> Cooling Pipe Section

In the final pouring, grouting pipes or non-contraction concrete can be used to fill the empty space due to the contraction of concrete.

Peripheral grouting outlet is shown in figure 5.3-14.

5) Construction Plan

Diversion culvert and plugging schedule is as follows.



<Figure 5.3-16> Diversion Culvert Schedule

# 5.3.4. Upstream Coffer(RCC)dam

The upstream cofferdam will be constructed as Roller Compacted Concrete (hereinafter called "RCC") type, same condition to the main dam excluding form work, to allow trial construction of the main dam.

Typical section of upstream cofferdam is shown in figure 5.3-17.



### <Figure 5.3-17> Plan of Upstream Cofferdam



# <Figure 5.3-18> Typical Section of Upstream Cofferdam

The construction will be carried out in the following sequence:

- ① River bed excavation (soil and rock)
- 2 Primary Coffer Dam Embanking & Permeation Grouting
- 3 Primary Coffer Dam Riprap & Base Concrete
- ④ Under EL(+) 125.500 RCC cofferdam construction (placed and compacted every 0.3m, same as the main dam)
- 5 Foundation Concrete

6 EL(+) 125.500~ EL(+) 134.500 RCC cofferdam construction (placed and compacted every 0.3m, same as the main dam)

After excavation, the primary coffer dam will be built. And permeation grouting to block the inflow of groundwater will be executed as shown in the following figure.



<Figure 5.3-19> Permeation Grouting Profile U/S COFFERDAM AXIS PERMEATION GROUTING 800 800 800 800 800 **1st GROUTING** Ь ىن 2nd GROUTING

<Figure 5.3-20> Permeation Grouting arrangement

Three types of concrete are used for the upstream dam, and specifications and required quantities are as follows.

### <Table 5.3-4> Concrete Specifications of Upstream Dam

Division	Compressive Strength(f'c)	Remark
Foundation Concrete	18MPa	AT 28 days
Mass Concrete	18MPa	AT 28 days
RCC	12MPa	AT 90 days

Mass concrete and foundation concrete will be transported by mixer truck and poured using a concrete pump car or chute, and RCC is constructed using the same equipment used in the main dam during test construction.

The external slope of upstream dam is finished by vibrating plate compaction.

The upstream and downstream of RCC will be filled earth to improve the stability and use the main dam construction road.

Riprap will be installed 1.0m-thick on the slope of construction road on upstream to control erosion.

<Figure 5.3-21> RCC Dam Slope Forming & Riprap

Upstream dam will be constructed before main dam in the dry season.

The construction schedule is as follows.



<Figure 5.3-22> Upstream Dam Construction Schedule

# 5.3.5. Downstream Cofferdam

The downstream cofferdam will be constructed to prevent back flow of river during the construction of the main dam. Therefore, in order to maintain flow of the river until river diversion will be completed, it will be partially executed concurrently with diversion culvert or started after completion.

The downstream cofferdam will be a central core earth dam which allows immediate utilization of excavated materials, prompting economical and rapid construction.

Construction road of 4.0m-wide will be installed on the upper part of downstream cofferdam, which is used as a connecting road for excavation of main dam and plunge pool



<Figure 5.3-23> Profile of Downstream Cofferdam

1:1.8

ROCK LIN

The construction will be carried out in the following sequence:

1 Riverbed excavation

DIVERSION CULVE

BACKFILL WITH SELECTED PERVIOUS MATERIAL

- 2 Simultaneous construction of core and Selected materials (layer compaction)
- ③ Filter Mat Laying & Rip-rap (upstream and downstream)

The equipment mobilization plan for the construction of Downstream Cofferdam is shown in the table below.

Division	Equipment	Capability	Number	Remark
Excavation	Dozer	19ton	1	Cutting
Excavation	Backhoe	0.7~1.0m <sup>3</sup>	1	Loading
	Dozer	19ton	1	Spreading
Embanking	Vibrating Roller	10.5ton	1	Compaction
-	Dump Truck	15~25.5ton	-	Transportation
Riprap	Backhoe	0.7~1.0m <sup>3</sup>	1	Placing

<Table 5.3-5> Downstream Cofferdam equipment input plan

Embanking of cofferdam will be executed according to regular compactness to a thickness of 0.3~0.6m using foundation or soil excavated from the nearby working area. The surface is inclined for drainage.

Downstream cofferdam will be maintain a slope of 1:1.8 in the lower part and 1: 1.5 in the upper part, and create 1.0m-wide berm in the middle part to improve the stability of the slope.

After installing a filter mat on the slope to prevent leakage of soil, a 0.5m thick filter zone and 1.0m riprap will be installed.



Typical section of downstream cofferdam is as shown below.

<Figure 5.3-24> Typical Section of Downstream Cofferdam

2023 Period Classification (Mth) 16 18 20 22 24 26 28 30 31 8 10 12 14 16 18 20 22 24 26 28 30 2 4 6 8 10 12 14 16 18 20 Downstream Cofferdam **Riverbed Clearing** 0.1 Embankment (EL.120.0~122.0) 0.1 Embankment (EL.122.0~124.0) 0.2 Embankment (EL.124.0~126.0) 0.1 Embankment (EL.126.0~127.5) 0.1 Riprap (EL.120.0~122.0) 0.2 Riprap (EL.122.0~124.0) 0.2 Riprap (EL.124.0~126.0) 0.2 Riprap (EL.126.0~127.5) 0.1

The downstream section of the culverts shall be partially demolished The construction schedule of downstream cofferdam is as follows.



# 5.4. Roller Compacted Concrete(RCC) Dam

# 5.4.1. General

1) Scope of Work

The main dam will be a RCC gravity structure located in the narrow gorge of the river. It contains an overflow ogee crest and a central flip bucket.

The power tunnel intake is located in the left abutment of the dam, and contains trashracks and an isolation gate.

The main dame has major features as follows:

### <Table 5.4-1> Major Specifications for RCC Dam

	Item		Quantity	Remarks
	Dam type		RCC	1Layer=300mm
	F.S.L.		EL.175.0m	Crest road Level
	PM	ΛF	5,008 m³/s	
Flood discharge	10,00	)0-yr.	3,290 m <sup>3</sup> /s	
Flood loval	PM	/F	EL. 187.2m	
FIOOU level	10,00	)0-yr.	EL. 184.4m	
Freeboard	PMF fre	eboard	0.3m	
	Crest	t EL.	EL.186.5m	
	Crest	width	6.0m	
	Hei	ght	71.3m	
	Len	gth	234.3m	
Main dam	Horizonta	l bending	Bending R506m	
	Parapet w	all crown	EL.187.5m	
	Clone gradient	Upstream	Vertical→1:0.1→1:0.35	
	Siope gradient	Downstream	1:0.6→1:0.7	
	Overflow	w width	55m	
	Chu	ute	Stepped chute (39m at flip bucket)	
Spillway	Chuteway	gradient	1:0.7	
opinitaj		Туре	Bucket+Splitters	
	Energy dissipator	Bucket R	11m	
		Lip EL	EL.136.0m	
	Curtain g	grouting	1row, C.T.C 1.0	
Foundation treatment	Consolidatio	on grouting	C.T.C 3.0x3.0 (right bank&spillway) C.T.C 4.0x4.0 (left bank)	

The main construction of main dam are as follows:

- a) Diversion
  - 2 Box Culvert(2@W4.40mxH4.40mxL232m
  - Placing concrete at the site with 3 shift form
  - Completing concrete work before rainy season
- b) Foundation Grouting/RCC Dam Wall(first)
  - Curtain C.T.C 1.0m×1.0m
  - Consolidation C.T.C 3m×3m (right bank & spillway), 4m×4m (left bank), Depth 5.0m
  - RCC is placed up to the sub base of the gallery foundation
- c) Dam Gallery
  - Length : 167.45m

- Size : W3.5xH4.7m, T=0.5m
- Gallery(L=51.0m) infiltrating from each drainage channel in the center of dam and draining it to the outside
- Placing precast Slab culvert L=115m(first)
- · Carrying out the rest part with RCC work together
- d) Sediment Sluice Box Culvert
  - Horizontal/Inclined part outside : 3.0mx4.5mx56.0m
  - Vertical part inside : H=36.5m using steel form
- e) Spillway Ogee Crest
  - Ogee part 8.0m×2.0m×55.0m
  - Placing concrete at the designated section at the site after form work
- f) Dam Crest
  - Left 6.0m×10.9m×60.0m
  - Right 6.0m×10.9m×104.0m
  - Applying RCC method
- 2) Construction Layout

General layout and construction image of Main Dam are as figures below.



<Figure 5.4-1> General Plan of Dam Area



<Figure 5.4-2> General Front View Upstream & Downstream

3) RCC Dam Work Flow and Construction Method



<Figure 5.4-3> General Front View Upstream & Downstream

#### 4) Schedule of RCC Dam

When construction preparations such as access roads are completed, main structure construction will be executed about 35.5 months. When the main structure is completed, the first impoundment and river diversion culvert plugging will begin.

The gallery or spillway installed in the RCC dam will be executed concurrently according to the construction stage of RCC Dam. Plunge pool and intake will be earlier or separate executed to prevent interference with RCC Dam construction.

Classification	Period	19	1/	1 24	2020	1 4/	 4   ·	202	21			1/4	20	22	4/4	1/	1	2023	2/4	A/A	1/	2	024			20	25
Milestone	(ivith)	₹	NTP	+ 2/4	5/4	4/4	4 4	2/4 ▼ Cor	5/4 nmence	ement o	4 of Acce	ss Roa	2/4 d Works	5/4	4/4		2	/4	5/4	4/4	1/*	First Re	servoir	4 4/	4 dment	<b>V</b> 4	2/4 TOC ▼
1. RCC Dam																											
Earth work																											
Site Clearing	0.2	2																									
Excavation																											
Left Side	1.7	7																									
Right Side	1.9	9																									
Riverbed	1.4	1																									
Foundation Works																											
Trim and Cleaning																											
Left Side	0.9	9																									
Right Side	1.1	1															ļ.										
Riverbed	1.0	0																									
Plume Concrete																											
Riverbed	0.6	5							+																		
Grouting																	H										
Left Side	2.7	7							+					++	<b>.</b>		+										
Right Side	2.9	9							+								+										
Riverbed	1.4	1																									
Dam Wall																											
Up to Diversion Level 1~21th(EL.115.2~121.5)	0.8	3																									
Up to Gallery Level 22~58th(EL.121.5~132.6)	2.0	5																									
Up to Scour Outlet Level 59~113th(EL.132.6~149.1)	2.6	5																		_							
Up to Intake Level 114~149th(EL.149.1~159.9)	10	2									-																
Up to Overfloe Level 150~193th(EL159.9~173.1)	11	1									-																
Up to Non Overfloe Level 194~236th(EL 173.1~185											-												T				
Left Side	,   06	5									-																
Right Side	0.5																										
Drainge Hole Drilling	28	3																									
Crest Road	24	1									-																
Parapet Wall	2:	2									-																
Pining Works	0.0	5									-														Т		
Instrument Works	11 7	7																									
2. Gallery (Incl. Drainage System)		-										⊢				-										$\vdash$	
Dam Wall	5 0																						L				
Pining Works	14	1																									
Lighting for Dam Gallery	80										-																
3. Spillway	0.1	-	+									⊢				+								F		$\left  \right $	
Dam Wall	9.3	3																									
4. Scour Outlet																+											
Civil Works Sediment Sluice Gate	9.0	9																									
Mechanical Works Sediment Sluice Gate	10 3	2																			Γ						
Electrical Power Supply	10	5																							Т		
Control and Instrument Sediment Sluice Gate	10																+										++
5. Riparian Outlet							$\vdash$											+					+	HF			
Structure Work	08	3															$\mathbb{H}$						L				++
Mechanical Works	5.6														$\left  \cdot \right $		+						Ē.				++
Electrical Work	0.0	,													$\left  \cdot \right $		$\left  \right $							T.			++
Control and Instrument	0.1														$\left  \cdot \right $		+			+-							++
6. Plunge Pool Earth & Foundation Works	2.4								+										+				+	Ľ			+
ge	2.0	1																									

<Figure 5.4-4> Schedule of RCC Dam

# 5.4.2. Main Dam Excavation

1) Description and Scope of work

The abutment area of the main dam is mainly composed of sandstone and conglomerate, and the riverbed area is composed of alluvium, so it is necessary to excavate to the solid ground to be integrated with RCC.

Main dam excavation will be undertaken from the top down using a combination of excavators and dozers. Hydraulic Breaker or Blasting may be required if necessary.

The below figure is shown the geological structure at the location of main dam.



<Figure 5.4-5> Geology at the RCC Dam site

The left and right abutments will be constructed first simultaneously with the river diversion works, and then riverbed will be excavated after the river has been diverted. Excavation works for the main dam will be completed during the dry season of the 1st year.

### 2) Sequence of the Dam Excavation Works

The both abutments will be excavated and then the riverbed will be excavated. Excavation of the abutments will be carried out simultaneously while the primary cofferdam and upstream cofferdam are being constructed.



<Figure 5.4-6> Sequence of the Dam Excavation Works

a) Clearing and Grubbing

For dam construction, trees, shrubs, stumps, and rubbish in the work area will be removed and dispose of or incinerate at a planned site. If necessary, the tree is transplanted to a designated place.

b) Left and right abutment excavation

Excavation proceeds as follows:

- (1) Site survey and marking: Survey points will be marked at the boundaries of all excavation areas. The spacing of survey points is adjusted according to the curve and slope. This step is accompanied by inspection by the owner or supervisor.
- (2) Excavation, loading and disposal of top soil: Part of top soil contains organic matter and is excavated separately. The initially excavated top soil will be kept separate from general waste or common soil and reused for vegetation in the site if necessary.
- (3) Excavation, loading and disposal of common soil:
  - Excavation will proceed downwards, maintaining a safe slope on both sides of the dam. When the slope changes rapidly or the level at which facilities will be placed is reached, the excavation section can be divided at the point connected to access road protect the slope. Since it is advantageous to excavate from the top and load from the bottom in the steep slope section, the excavation method may be changed according to the site conditions. The excavated soil is deposited in the planned area or used for other works. The excavation surface will be sprayed to reduce fugitive dust, and will form a drainage line for drainage during rainfall and maintain the surface slope.
- 3) Excavation section
- 4) Dam basement will be mainly composed of weak sandstone and conglomerate layers.
- 5) The left bank of dam will have a slope of about 45° and the right bank will have an average slope of 30°. The colluvium developed on the both banks is 0~3.8m-thick layer and it includes gravels and boulders. Alluvium have a 3.0~6.5m-thick layer of sandy gravel including boulder lies along the riverbed.

Figure 5.4-7 is shown in excavation section.



<Figure 5.4-7> Excavation Section of Dam

<sup>6)</sup> Soil & Weather Rock Excavation

Soil & Weather Rock is excavated by dozer and backhoe. Riverbed sand and gravel are also excavated with the same equipment.

Dozer will excavates a flat or gentle slope and collects it for easy loading. Backhoe will excavate and load of the slope at the same time.

In Riverbed, sand gravel is dewatered and some underwater excavation will be executed, so it will be excavated using backhoe.

The excavation of the riverbed will lead to onshore work with Temporary River Diversion using the raw material to prevent the reduction of work efficiency due to underwater work.

In order to prevent the deterioration of workability due to the underwater work of riverbed, the land work will be changed by temporary river diversion using the in-situ soils.

The excavated soil will be stacked separately from rocks for using of other works.

The below figure is shown in the combination of loading and transporting equipment in general excavation work.



<Figure 5.4-8> Dam Excavation of Abutment and Riverbed

### 7) Rock Excavation

According to F/S and geological reports, Conglomerate, baserock of the dam abutment, is about the same as the sandstone or about 18MPa.

Rock will be excavated in the following way.

- Breaking by Hydraulic Breaker
- Drilling and Blasting

The below figure is an example of the construction method.



<Figure 5.4-9> Hydraulic Breaker & drilling for blasting

The excavation method will be selected according to the rock strength and working conditions.

Generally, Hydraulic breaker will be applied to weather rock and soft rock, and drilling and blasting will be applied to Hard Rock.

Sequence of rock excavation is following:

- Excavation Rock by Hydraulic Breaker or Drilling and Blasting
- Scaling
- Loading and Mucking
- Bottom cleaning

Excavation will be executed top down.

The rough excavation surface will be executed scaling by an excavator breaker and bucket.

After scaling, check the excavation line and slope. The final excavation surface is surveyed and cleaned for RCC construction.

### 8) Disposal

The excavated soil is transported to the "2.6 Disposal Area" to be stacked or used to other works.

### 9) Major Equipment

Equipment will be input as required for construction. Combinations and specifications of equipment may change depending on site conditions.

Equipment	Size	Unit	Remark
Hydraulic Excavator	1.0m <sup>3</sup>	2	Excavation, Mucking
Ripper Dozer	38ton	1	Excavation
Dump Truck	25ton	4	Hauling
Crawler Drill	D 76mm	1	Blasting
Leg Drill	D 28mm	4	Blasting

#### <Table 5.4-2> Equipment for Excavation

# 5.4.3. Cut Slope Reinforcement Plan

1) Description and Scope of work

Cut slope will be occurred by dam excavation. Reinforcement and protection will be executed to prevent erosion by rainfall and weakening by weathering on cut slope

The following figure is shown where the cut slope occurs.



<Figure 5.4-10> Cut Slope Reinforcement and protection Plan

The excavated slope will be reinforced according to the slope and type of soil. Seed spray and covering will be installed on the soil cut slope, and left side of rock slope will be reinforced using anchor pin and shotcrete, and right side prevents soil erosion by installing a gabion retaining wall on the excavation boundary surface

The following figure is shown in example of cut slope reinforcement and protection.



<Figure 5.4-11> Example of Cut Slope Reinforcement and protection

# 2) Construction Plan

a) Soil cut Slope

Seed spray and covering method will be applied to the soil cut slope in dam site.

Hydro seeding for grass seeds on the slope and covered with a straw cover will be made shade to promote growth.

The seed spray and covering is as follows figure.



<Figure 5.4-12> Reinforcement and protection of Left bank

Nutrients necessary for seed growth will be mixed in the seed spray, and if necessary, will be managed such as sprinkling to increase the germination rate.

b) Left Bank Slope of Dam : Anchor Pin + Shotcrete

The specifications of materials used to reinforce the excavation surface are shown in the following table.

Division	Item	Specifications	Remark							
Anchor Pin	Diameter	16mm	C.T.C 1.0m x 1.0m, L=0.5m							
Wire Mesh	Size	Ф4.0-100 X 100								
Shotcrete	Compressive Strength	AT 28 days : fc'=21MPa	T=100mm							

#### <Table 5.4-3> Anchor Pin + Shotcrete Materials



<Figure 5.4-13> Reinforcement and protection of Left bank

Reinforcement on steep slopes such as the left bank slope should be executed with excavation or executed separately on the top after completing some excavation.

To install anchor pin on steep slope, a hand drill will be used and if necessary, the following method is applied for the safety of workers.



<Figure 5.4-14> Working method of cutting slope

The work method should be selected according to excavation speed, slope of the slope, and site conditions.

Shotcrete pouring will be excuted by manpower or by machine (robot), and executed concurrently or follow-up depending on anchor pile installation method.



<Figure 5.4-15> Shotcrete pouring method

The properties of shotcrete poured on the left bank slope are shown in the table below

Material	Minimum Compressive Strength	Remark
Chatarata	at 7days : 14Mpa	
Sholcrele	at 28days : 21Mpa	

### <Table 5.4-4> Properties of Shotcrete

c) Right Bank Slope of Dam : Mass Concrete for grouting works platform & Gabion Retaining Wall

Mass concrete for grouting works platform will be installed on the lower part of right bank slope with gentle slope, and gabion retaining wall will be installed on the upper part. The mass concrete for grouting works platform in the lower part was planned to be a scale for the protection of slope and grouting work.



<Figure 5.4-16> Slope Reinforcement and protection of Right Bank

Mass concrete will be constructed after excavation will be completed, the excavation surface will be cleaned, and the surface is sprayed to create a wet condition.

Panels made by euro form or wood are used to stepped form. Equipment used for concrete pouring is as follows.

### <Table 5.4-5> Mass Concrete Pouring Equipment

Equipment	Capacity	Unit	Remark
Agitator Truck	6.0~6.5m <sup>3</sup>	-	According to the transport distance
Concrete Pump Car	60 m³/hr	1	
Concrete vibrator	-	2	

The gabion retaining wall applied on the top of the right bank is a method of assembling a wire mesh of a specified standard to make a wire cage and filling the rock inside to resist earth pressure by the weight of the rock.

The construction sequence is as follows.



<Figure 5.4-17> Gabion Retaining Wall Sequence

Galvanized steel wire should be used for gabion retaining wall, and the detailed specifications are as follows.



<Figure 5.4-18> Specifications of Wire Cage

<table 5.4-6=""></table>	Dimensions	bv	Gabion	Type
		~ 」		

Wire core	Dimens	Pomark		
wire cage	Width, W1	Length	INGINAIN	
2.0m×1.0m×1.0m	2.0	4.0	Including center cage	
1.5m×1.0m×1.0m	1.5	4.0		
1.0m×1.0m×1.0m	1.0	4.0		

The fill rocks should not be weathered rock, but rocks containing iron should not be used. The main size should be  $\Phi$ 100~200mm. For gabion mattresses, river aggregate or crushed rock mixed

with a size of  $\Phi$ 75~100mm should be used.

Backhoe of 0.6~0.8m<sup>3</sup> should be used for excavation, filling, and backfill work.

The exposed surface of gabion retaining wall should be filled by hand to fill evenly. If necessary, a filter mat should be installed on the back to prevent soil leakage.

Pour concrete should be poured on the foundation under gabion retaining wall.

d) Other Method

In case of joint or breakage on rock excavation surface, Rock bolt and shotcrete should be executed.

Rock bolt has the effect of stitching rocks and rocks by inserting an iron bar into the rock. The sequence of rock bolt is as follows.



<Figure 5.4-19> sequence of Rock Bolt + Shotcrete Method

Crawler drill or hand drill is used for drilling, and the method suggested in <Figure 5.4-14> working method of cutting slope is applied according to the working conditions. The below figure shows the specifications of rock bolt.



<Figure 5.4-20> Rock Bolt construction Plan

In rock bolting, a pull-out test should be executed after grouting is hardened to check the designed anchoring strength. If the strength is insufficient, it will be installed additionally. Shotcrete is poured in two times so that the head of the rock bolt is buried.

# 5.4.4. Dam Grouting Works

## 1) General

Foundation treatment of dam will be carried out to reduce the deformation of the foundation, to secure water tightness, and to establish an adequate reinforcing method for transition zone produced by excavation. There are two foundation treatment methods; grout curtain and consolidation grouting. Grout curtain will be installed to prevent leakage and piping, whereas consolidation grouting will be installed to strengthen the foundation rock at the base of dam.



<Figure 5.4-21> Plan of Dam Grouting



<Figure 5.4-22> Grouting Profile of Right Abutment

2) Consolidation Grouting

10.0m-deep consolidation grouting will be divided to left abutment, spillway and right abutment.



The arrangement of consolidation grouting hole is shown in the following figure



After completion of the excavation, the foundation cleanup will be accomplished at least in part by hand labor, assisted by use of high pressure air or water jets. Faults and other weak or potentially pervious zones transverse to the structure will be removed and treated. Major irregularities such as shear zones and open joints shall be filled with dental concrete.

The consolidation grouting will be performed in 3 phases

- Drilling and re-drilling
- Pressure washing
- Grouting.
- a) Holes Drilling for Consolidation Grouting

As soon as the foundation area will be ready for drilling, the primary holes for the consolidation grouting will be drilled according to the approved drawings.



<Figure 5.4-24> Drilling Rig

Grout holes will be at least 46 mm in diameter, and will be drilled 5m into the rock measured from the surface of first dental concrete layer. Rotary drilling shall be adopted in order not to impart vibrations to the rock formation and adjacent grouted holes.

Once a hole has been completed, it will be washed with water until the return water is clear, without debris or other solid materials. When the washing is completed, a wooden temporary closure will be inserted in the hole in order to protect the hole from entry of debris, muck or dirt.

The holes drilled for each shift will be recorded in a specific form. The holes will be identified by station parallel to the dam reference line and by offset from the dam reference line. During the drilling of the holes, geometrical and geological details of the hole will be noted, such as soft seams, artesian water, etc.

b) Execution of Consolidation Grouting

Consolidation grouting will be performed by using a grouting plant with a mixer, an agitator, an injector, a pump, a pressure regulator, a pressure gauge (gauge will be cleaned on a daily basis and checked on a weekly basis), a water meter, a control and check valves, a medium hose (press. 25 bar).

Radio communication will be established between the grout plant and collar of hole grouted. A flow meter will be installed on the feed hose to the grout header and one on the return line. Injection will be performed with plunger pumps to create high grout velocity with injection rates up to 20m3/h.



<Figure 5.4-25> Grouting Plant (mixer, agitator, injector, pump)

Before the injection of the grout, the injection hose will be connected to the packer or injection pipe, and then the grout will be injected. Subsequently, the pressure will be increased until it reaches to the maximum pressure.



<Figure 5.4-26> Construction Sequence of Consolidation Grouting

## 3) Grout Curtain

15 to 45m-deep grout curtain will be installed with a hole spacing of 1.0m in one row.





The curtain works will be performed in 3 phases,.

- Drilling and re-drilling
- Pressure washing
- Grouting

### a) Holes Drilling for Grout Curtain

Drilling rig will be used for the drilling. The maximum depth of the holes will be in the range of 45 m for main dam and the diameter of the holes will be 46 mm. When the hole will be completed, it will be washed with water and compressed air until the return water is clear, without debris or other solid materials. When the washing is completed, a wooden temporary closure will be inserted in the hole in order to protect the hole from entry of debris, muck or dirt. The holes drilled for each shift will be recorded in the provided form 'Record of hole drilled'.

### b) Execution of Grout Curtain

Grout curtain will be performed by automated mixing unit fed directly by the cement silo.



<Figure 5.4-28> Automated Mixing Plant

Grout curtain will be carried out from a lower elevation toward higher elevation and shall be performed in different stages, starting from the bottom of the hole and then going upward. The connections for the subsequent stages of grouting will be achieved by setting the packers at different levels in the hole.

The range of pressures will be set after the readings of the water pressure test within the single drilled hole and in any case, the range will be between 0.5 N/mm<sup>2</sup> minimum and 2 N/mm<sup>2</sup> maximum.

Mixing of water and cement will be at a ratio of 3:1 by weight. The injection hose will be connected to the packer, and the grout will be injected and the pressure will be increased until the maximum pressure is obtained.

If refusal or the specified pressure for grouting cannot be achieved, the grout mix will be thickened and/ or sand will be added. The water vs. cement ratio may be changed according to specifications.

After the mixing of the grout, the injection of the grout will be completed within one hour for mixes with water vs. cement at a ratio of 1:1 or thicker, and within 2 hours for all other mixes. When the grouting is completed, the packer will be removed and the hose will be taken out. The grouting performed for each shift will be recorded on the form grouting report.

# 5.4.5. Cleaning of the Area and Rock Surface Treatment

Prior to placement of the RCC, a preliminary treatment of the rock foundation will be performed. It will consist of removing the material remaining from the excavation, by using hand tools (bars, trowels, shovels), air and water jet, in order to expose shear zones and open joints.

Open joints, shear zones and fractured areas shall be cleaned to a depth of at least three times their width. In case of seams, cracks or fissures containing sand, clay or other materials, those will be thoroughly cleaned. The bedrock surface shall be washed by compressed air. The water jet will be used only when necessary with the approval of the supervisor. All pools of water shall be removed in order that the surface is dry and clean.

If necessary, rock face mapping could be executed.



<Figure 5.4-29> Cleaning of rock

Joints caused by cracks in rock should be cleaned the depth of at least 3 times width and filled with suitable materials such as mortar.

The riverbed area will be kept dry by building the upstream and downstream cofferdams.

Occasional seepage of water will be pumped out of the area using a pumping unit, serving a trench for water collection.

In order to prevent contamination of the RCC placement areas, a protection for the surfaces will be provided. This will avoid presence of debris and contaminated water from grouting and drainage activities; protection will be used only to avoid flowing and contaminated water coming from the top of the foundation into the RCC working areas.

These protections will be removed before the placement of RCC and the foundation surface will be cleaned to the required standards.

Prior to the final cleaning and placement of RCC, all consolidation grouting will be completed in the area. Also the leveling concrete shall be placed prior to start of the placement of RCC. Rock bottom will be cleaned and moistened before the placing of RCC. If, after final cleaning, some points will be contaminated by oil, the surface will be cleaned with hot water jets.

# 5.4.6. RCC (Roller Compacted Concrete)

### 1) General

This procedure describes all the plants, materials, equipment and techniques relative to mixing, transporting, placing, compacting and curing of the RCC for dam construction.

Roller compacted concrete is a combination of crushed rocks and/or natural sand, gravels and/or soil having a controlled gradation, to which cementing materials (cement + pozzolan) is added. The use of fly ash is allowed to reduce the amount of cement and consequently the temperature of the layers.

The materials are mixed with water to a damp consistency which can be hauled in a dump truck or delivered by conveyor, spread with earth moving equipment and compacted with vibratory roller.

tal volume 205,000 m3

30

0.2~0.4m liters

### 2) Material

Materials used for RCC include aggregate, cement, chemical admixture and mineral admixture.

Aggregates should be collected as in "2.5 Aggregates Supply Plan" and processed for used in crushing plant.

Companies to supply cement, fly ash and retarding admix should be selected two or more in consideration of quantity and cost.

All materials should be supplied after checked quality by an accredited agency and approved by the client or supervisor.

### 3) RCC Mix Design & Trial Filed Test

Water

Retarding admix

RCC mix has been adopted on the basis of the F/S (Entura, 2014). A trial construction will be carried out prior to RCC construction in order to determine the mix ratio

Preliminary RCC mix: As no upstream membrane is proposed for the RCC dam, the mix needs to provide the necessary properties to ensure lift joints are relatively impermeable and well bonded.

This will require a medium paste mix design as per Table 5.4-3 below. The total quantities refer to the calculated constructed volume of the main dam RCC, plus the coffer dam:

Material	Mass/m3 (KN/m3)	Specific Gravity (KN/m3)	Total mass for 205,000 m3 (Million tonnes)	Total volume For 205,000 m (Million m3)		
Cement	0.85	31.2	17.5	5.6		
Fly ash	0.85	19	17.5	9.2		
Aggregate (volcanic/limestone)	21.20	27	435	160		

#### <Table 5 4.7> RCC Material Quantities (Extracted from E/S)

Placement: The RCC will be placed in 300mm layers (trial program may allow this to be increased to 350mm). The upstream and downstream faces would be placed with 0.3m-thick grout enriched roller compacted concrete (GERCC).

10

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It depends on design strength, the cement content is 160kg/~220kg in general RCC, and workability determined by loaded vebe test is 10~20sec.

The total fines content of under 0.075mm (Cement + Fly ash + Aggregate) is 12-14% to prevent segregation and minimize air gap.

All RCC mixing designs should be tested strength at each curing stage of 14, 28, 56, 90 and 180 days using test cylinders (150mm dia. x 300mm long) to check quality.

#### If necessary, test periods can be added for related construction.

1.40

1~2 liter/m<sup>3</sup>



<Figure 5.4-30> Test of RCC

After mixing design is selected through the indoor test, trial filed test should be executed at the upstream coffer dam.

The following items are determined in that test.

- Mixing and Transporting
- Compaction equipment
- One-time spreading thickness
- Number of compactions
- Mixing and spreading time
- GE-RCC production and placement methodology
- Curing methods



<Figure 5.4-31> RCC Trial

The sequence of the trial field test is shown in the following figure.



<Figure 5.4-32> Trial Filed test Sequence

Determined things through the trial filed test should be become the standard for construction management after approval of client and supervisor.

The general schedule of the trial field test is shown in the following table.

Activity	1	2	3	4	Stop	17	20	21	24	25	~	Remark
Batch Plant												
Mobilization												Equipment, Worker
				Over 72	hours	Over 72h	ours	Over 72h	ours			Cold-Joint
RCC			Cold 1 <sup>st</sup> layer	Warm 2 <sup>nd</sup> layer		Cold 3 <sup>th</sup> layer	Cold 4 <sup>th</sup> layer	Warm 5 <sup>th</sup> layer	Cold 6 <sup>th</sup> layer Hot 7 <sup>th</sup> layer	Hot 8 <sup>th</sup> layer	Warm-Joint Hot-Joint	
Test											Strenath test	
						Pull out etc						

### <Table 5.4-8> Trial Filed Test Schedule

Note: As the schedule for the Trial Filed Test is very dynamic at present, we would kindly request to adjust the placement schedule/joint treatment schedule in the field after the confirmed start of the Trial Filed Test and actual RCC progress is measured.

Verification of the cleaning method of each horizontal joint surface is also executed.

## 4) Equipment Preparation

During the construction of the dam, all equipment will be properly maintained in order to reduce the risk of oil and grease leakage onto the RCC surface. Hauling vehicles will be maintained in good operating condition and the risk of damages for the RCC surface will be reduced by avoiding the vehicles taking sharp bends, sudden braking or other actions that may damage the newly compacted RCC surface.

If a portion of the layer is damaged by a vehicle operation, the area will be cleaned and the damaged material will be removed.

### 5) Delivery

The delivery of the concrete will be performed by means of a conveyor belt system installed on the left abutment of dam.

RCC concrete requires large carrying capacity because it has to transport a large amount within a short time. The general transportation method is as follows.

- Dump Truck
- Conveyor belt system
- Cable Bucket

But, In "TRHDP", a conveyor belt system will be applied.



<Figure 5.4-33> RCC Conveyor System

The applied conveyor is about 1,500m<sup>3</sup> that must be transported per day, and a shuttle conveyor or mobile conveyor is combined at the end of conveyor belt line for efficient transport. In working lot, the dump truck and wheel loader are combined and operated.

The specification of transport equipment is shown in the following table.

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Equipment	Capability	Unit	Remark
Belt Conveyor	1,500m <sup>3</sup> /day or more then	1set	Refer to manufacturer's specifications
Dump Truck	25ton	2	
Bucket	3.0m <sup>3</sup>	1	Using Tower Crane

6) Spreading

The construction of the RCC dam will be completed in a nearly continuous operation. RCC will be spread within 5 minutes after dumping. RCC placing will progress in thin layers of around 300 mm thickness after compaction. In the upper areas of the dam layers of about 350 mm thickness will be adopted if approved by the Employer.

The following equipment is used for spreading..

<Table 5.4-9> RCC spreading equipment

Equipment	Front End Loader	Bulldozer
Poto		
Capability	2.87m <sup>3</sup>	19ton
Productivity	160m <sup>3</sup> /hour	200m <sup>3</sup> /hour
Туре	Wheel Type	Track Type
Each layer will be spread in parallel with the dam axis starting in both abutments, but some exceptions could be made in the lower layers. Coarse aggregate spread out o<sup>f</sup> the edge of the layer will be shoveled back and compacted by the roller.

Prior to compacting any segregated material will be properly re-blended using shovels and a loader. If any segregation appears after the first roller passes, it will be removed and properly backfilled with well graded material. For the accuracy of the layering process, the thickness of each layer after compaction will be clearly marked on the formworks and on the rock surface using paint or chalk. The alignment of the formwork and its verticality shall be checked with a laser level.

The laser will be installed on the corner between two lines and vertical and horizontal alignments of the formworks will be measured using the hand receiver directly on the points to be checked.

Whenever the width of the compacted layer is wider than 30m, some intermediate checks will be made using the stadia as to verify the accuracy of the leveling during the spreading operated by the dozer.

Whenever a cold joint at any edge of any lift is formed, it will be located at least 3 meters away from the position of any other previous cold joint set along the same direction.

No cold joints will be formed along the edge of a lift along the upstream and downstream direction for more than one third of the transversal dimension of the dam at the relevant elevation.

Layers will be spread and compacted starting in both abutments even though the different procedures might be adopted under some particular conditions.

RCC will not be spread under steady rain falls. Under light rain condition placing will not be suspended until a thin layer of rainwater begins to build up on the compacted RCC surface or when RCC starts adhering to the compactor roll. When rain is imminent, the newly compacted RCC layers and the unhardened RCC layers surfaces will be protected with the temporary plastic sheeting.

### 7) GERCC (Facing Mix Placing)

GERCC will be used to produce durable and impermeable upstream and downstream faces for RCC.

At the edges of the structure and at the abutments, the RCC is enriched by the addition of a water cement grout so that the workability changes and the RCC can be compacted using concrete vibrators by hand or machine.

Grout quantity should be determined by laboratory or field testing. For example, if the vebe of RCC is 15~20sec, it is displayed as 8ℓ/m/400mm for 300mm thickness. Admixtures such as water reducers, set retarders, air entrainers and plasticisers can be added to the grout if necessary



<Figure 5.4-34> Typical GERCC Construction Method

The standard method adopted in previous RCC dam projects is the following:

Grout is initially mixed in a high speed grout mixer drum mounted on a truck and poured via a hose directly to the face along the formwork.

Within 10 minutes from the spreading of the RCC a small quantity of grout is initially placed as a thin band along the edge of the previous uncompacted layer.

Only the minimum amount of grout shall be added to mobilize the mix. The function of this small volume of grout is to provide a source of material that will migrate into the RCC during the following vibration.

After grout mortar is poured on top of RCC, the contact zone is consolidated by hand driven concrete vibrator until air bubbles trapped in the mass and liquid grout come to the surface.

Following completion of the vibration, a conventional heavy roller is used to compact the RCC. Note that loose RCC can be compacted also prior to the grout enrichment procedure. In this case it is necessary to leave a narrow strip of about half a meter uncompacted so that the vibrators can be immersed.

After a suitable amount of grout enrichment process has been completed, the surface between GERCC and RCC shall be compacted. This amount depends on the time since the RCC was first placed, the temperature and the area within the reach of the vibrators.

Unlike conventional concrete, the grout enriched areas accept roller compaction without undesirable deformation.

The integrity of the RCC and its strength can be later determined by coring the mass along horizontal and inclined directions or by means of compression tests.

#### 8) Compaction

RCC will be compacted with self-propelled vibratory steel drum rollers. In tight areas such as adjacent to forms, gallery, pipes and rock abutments large power tamper jumping jacks will be used instead. Compaction of the RCC will be accomplished as soon as possible after spreading especially under hot weather conditions.

Typically, for RCC dam, compaction can start within 10 minutes after spreading. The thickness of the RCC layer after compaction will be 300mm. The RCC layer thickness before compaction will be controlled in the range 340-360 mm thick assuming a 20% reduction in volume after compaction. Each compacting strip shall be overlapped by the adjoining strip by 0.1~0.2 m and by 0.8~1.0 m at the end of the strip.

The vibratory mechanism on the roller will be disengaged before stopping or reversing direction to avoid producing a localized depression in the surface.

The compaction equipment should be selected in the test construction. The capacity and number of compactions also should be determined by test.

Generally the start and finish are vibration-free, and the intermediate compaction is executed three or more times.

Special equipment could be used for finishing construction joints and edges.

The standard running speed of compaction equipment is 1km/hr.

The compaction equipment is as shown in the following table, but equipment specifications are not limited to examples.

Equipment	Single Drum Vibratory Roller	Double Drum Vibratory Roller
Poto		
Capability	10.0ton	7.6ton
Drum	2,130mm	1,500mm
Productivity	114m³/h	90m³/h
Туре	Single Drum	Double Drum

#### <Table 5.4-10> Plate Compactor and Roller Compactor Specification

Note: It is based on the compaction thickness of 0.3m and the number of compactions 4 times, and the production differ by the conversion factor.

#### 9) Joints

If the RCC placement has to stop for any particular reason, the lift joint will become a cold joint, and a bedding mix consisting of fine aggregate mortar will be required before placing the next RCC layer.

a) Horizontal joint

Horizontal joints are inevitable in RCC dams because of the layered method of construction. Each layer is the thickness of material compacted. Lifts may be compacted as individual layers, or several layers may be spread before compacting them as one lift prior to initial set of the RCC. The performance of an RCC dam will almost entirely be dictated by the performance of the horizontal joints between the layers.

In addition, the joint surfaces must be scrupulously clean; this is generally accomplished by a vacuum truck or by air blowing. However, if any of these factors are not present, the performance of the joint may be less satisfactory.

Joint condition is generally described according to its age or state of set of the cement as follows.

- a fresh(or "hot") joint : This is a joint that occurs when the RCC layers are being placed in rapid succession and the RCC is still workable when the next layer is placed. Horizontal joints having an age less than initial set shall require no particular treatment other than that continuous aerial moisture is maintained by fine mist sprays above the layer to keep the surface damp but not 'wet' and no mechanical damage occurs to the layer surface. Any loose materials and pools of water that may have occurred shall be carefully removed before placing the next layer of RCC.
- an intermediate(or "warm") joint : This is the condition that occurs between a fresh joint and a true "cold" joint. Horizontal joint surfaces of RCC layers which have exceeded initial set but are less than final set shall first have all loose materials and any pools of water that may have occurred, carefully removed before being entirely covered with bedding mortar of approved mix to an average thickness of 8mm prior to placing of fresh RCC layer.

The mortar shall be placed only immediately ahead of the advancing spread RCC and covered by the RCC within a few minutes of it being spread. The mortar shall be spread with hand rakes or a mechanically drawn rake using downward pressure to ensure the mortar gets pushed into the minor voids and hollows as may exist on the RCC surface. The rake shall comprise a flexible rubber strip which is shaped or supported such that the specified 8mm mortar thickness is achieved.

• a cold joint : At this stage the surface of the previously-placed layer is judged to be such that little or no penetration of the aggregate from the new layer will be possible into the previously-compacted layer. Horizontal joint surfaces of RCC layers which have exceeded final set shall be cleaned of laitance and hardened surface cement paste to expose a clean rock surface on the RCC aggregate without undercutting or loosening individual rock particles in addition to removal of loose material and any foreign contamination by means of mechanical brush, High pressure water jet, etc. well in advance of placing the next layer of RCC. The surface shall be kept moist until it is finally prepared as for a "Warm" joint as specified above.



<Figure5.4-35> Mechanical brush & High pressure water jet

b) Vertical Joint(Longitude Contraction Joint)

The possibility of cracking may be slightly lower in RCC because of the reduction in mixing water and reduced temperature rise resulting from the rapid placement rate and lower lift heights. Thermal cracking may, however, create a leakage path to the downstream face that is aesthetically undesirable.

Thermal studies should be performed to assess the need for contraction joints. Contraction joints may also be required to control cracking if the site configuration and foundation conditions may potentially restrain the dam. In the RCC dam, contraction joints are. installed with no impact to RCC placement operations by inserting galvanized steel sheeting into the un-compacted RCC for the entire thickness and height of the dam.

The contraction joint was planned at 30.0m intervals, and arrangement plan is as shown in the following figure.







<Figure 5.4-37> Contraction joint Plan

The galvanized steel sheet should be used by bending 350 wide sheets into L shape (275mm\*75mm) The galvanized steel sheet are inserted vertically into the RCC by means of the excavator-mounted vibratory blade



<Figure5.4-38> galvanized steel sheet Installation

When the galvanized steel sheet will be installed, re-compact using small vibrators.

### 10) Curing

The downstream monolith joint surface and the horizontal RCC surfaces will be kept continuously moist to enhance the evaporative cooling process of the concrete and adequate curing. Water mists will be sprayed to keep the RCC surface damp without dripping of water on the surface or erosion of newly compacted RCC.

The humidity of the air above the surfaces should be kept at a rate of at least 80%.

Surfaces continuously exposed shall be water cured for at least 60 days.

The same shall be done for the upstream facing concrete.

After formwork removal the upstream face of the dam will be coated with the curing compound.

## 5.4.7. Formworks

To facilitate the continuous assembly and disassembly of the formworks along the downstream face of the dam where a stepped surface is involved, a large panel steel formwork system will be adopted.

Along the upstream face the formwork system will be made of climbing metallic panels. The formwork is displaced upwards with the help of one wheel crane once the hardening of the concrete has proceeded far enough. This will entail lifting of different sections according to the placing of new

RCC. The climbing formwork will transfer the loads into the previous section starting from one hour after compaction and thus allowing quick progress of compaction in a continuous sequence.

The upstream climbing formwork will be installed securing their attachment to the structure by means of heavy duty suspension point. The platforms will be equipped with ladder systems that will allow quick and safe utilization by the personnel.

The downstream formwork system is made of a modular metallic panel mounted on a multipurpose track railing linked to the previous horizontal frame through a telescopic prop. According to the above the downstream formwork, it will always have a minimum of two lines installed at the same time.

After the removal of the formwork the anchor rod/suspension point will be cut and the hole filled with mortar.



<Figure 5.4-39> Formwork of Upstream and Downstream

A sample illustration of the RCC dam formwork and concrete work are shown in below



<Figure 5.4-40> RCC Dam Structure Work

# 5.4.8. Crane Operation Plan

When constructing the main dam, heavy transport occurs.

Crane operation plan was established in consideration of a place that cannot be transported by vehicle due to small space.

Heavy structures related to dams is;

- Face concrete steel form, Gallery precast culvert(L=0.75m) : 3~5 ton
- Intake trash rack, Diversion culvert stoplog guide frame : 5~20 ton
- Intake stoplog guide frame, Scour outlet gate guide frame : 10~20 ton
- Supply of RCC in small places

The following figure is concept of crane operation of RCC dam



<Figure 5.4-41> Concept of Crane Operation of RCC Dam

The combination of equipment for dam construction consists of tower crane and hydraulic crane.

The combination of the two is as follows.

- 2 tower cranes
- 1 hydraulic crane(100ton)
- 1 hydraulic crane(50ton)

tower cranes are situated within a radius of operation, and the hydraulic crane is easy to move to the required place and can handle heavy objects.



## <Figure 5.4-42> Working range of Cranes

- a) Equipment for each part of the dam is followings.
  - Tower crane

transportation of forms and rebars, Installation of PC box

at the slope of the gallery  $\Rightarrow$  less than 5ton

• Hydraulic crane(50ton)

Gallery PC manufacture plant (Loading Slab)  $\Rightarrow$  5 ~ 9.3ton

• Hydraulic crane(100ton)

Installation of gallery Slab, Intake gate, etc.

⇒ 9.5 ~ 19.3ton

The specifications of tower crane are as follows.

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	oonohilitu	Lifting	the tip	Lifting the Maximum		Lifting th Po	e Middle int	Independe	
Model	(ton)	Jib Length	Tip Weight	Jib Length	Maximu m weight	Jib Length	weight	nce height	Mast
Liebherr 290HC	12	70	3.0T	22	12.0T	50	4.68T	5.8+13 ×5.8	2.45 ×5.8

Tower crane installation sequence is as follows and dismantling is performed in reverse sequence.



<Figure 5.4-43> Tower crane installation procedure



<Figure 5.4-44> Tower crane installation

Tower crane installation and disassembly should be used 100 tons of mobile crane, and 50 tons of mobile crane assists.

Tower crane is demolished using 100 tons of mobile crane at crest road after main dam is completed. The width of the crest road should be partially expanded to accommodate 100 tons of mobile crane and the disassembled tower crane.

The tower crane is installed on the upper left and right side of the main dam, and the detailed location is as shown in the following figure.



<Figure 5.4-45> Tower crane location

Hydraulic crane (50 tons) should be used for relatively light weight loading and close work.

The specifications of hydraulic crane (50 tons) are as shown in the figure following. (Source by LIEBHERR's LTM 1055-3.1 catalog.)



<Figure 5.4-46> Hydraulic crane (50ton) dimensions

The following table shows the lifting capacities on telescopic boom of hydraulic crane (50 tons).

	10,2 - 40 m	iwi	360°	12 t	DIN ISO							
	10,	2 m	13,6 m	17 m	20,5 m	23,9 m	27,3 m	30,8 m	34,2 m	37,6 m	40 m	
2,5 2,7 3	55 53 51	49										2,5 2,7 3
3,5 4	47	44,5 41	44,5 41	42,5 38,5	36.5							3,5 4
4,5	39,5 37	37,5	37,5	35	33	31 30 5	23.3					4,5
6	31,5 26	28,8	29 24 4	29,1 24.9	27,9	26,8	20,9	18,5 16.9	15,1 14.8	12 1	10.1	6
8	20	2.,,1	20,9	21,2	20,2	18,9	17,2	15,6	13,9	11,4	10	8
10 12			14,9	15,2 11 4	15,1	14,3	13,8 11 4	13	12,2	10,4	9,1 8,4	10 12
14				9,1	9,2 7.7	9,3 7.6	9,1 7.4	8,9 7.5	8,6 7.5	8,4 7	7,8	14 16
18 20					.,.	6,4 5.4	6,5 5,5	6,3 5,4	6,3 5,3	5,9 5.1	5,8 5	18
22							4,7	4,6 4	4,5	4,2	4,1	22
26							.,.	3,4 3	3,3	3,1 2,7	3,1	26
30								Ŭ	2,5	2,3	2,3	30
34 36										1,7	1,7 1,5	34 36



The hydraulic crane (100 ton) should be used for long-distance work and heavy objects such as stop logs. And it also moves and works in where tower crane operation is impossible.

It will be operated in combination with a hydraulic crane (50 tons) for installation and dismantling of tower crane.

The specifications of hydraulic crane (100 tons) are as shown in the figure following.





<Figure 5.4-48> Hydraulic crane (100 tons) dimensions

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$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$		11,	5 m	15,2 m	18,9 m	22,6 m	26,3 m	30,1 m	33,8 m	37,5 m	41,2 m	45 m	47,5 m	48,7 m	51,9 m	52,4 m	55,6 m	56,1 m	60 m	
36 4,0 4,3 4,4 4 4 3,7 3,6 3,3 3,2 34   36 4 3,8 3,4 3,5 3,2 2,8 2,7 36   38 40 3,5 3,3 3,4 3 3 2,7 2,8 2,3 2,3 38   40 2,9 2,9 2,5 2,6 2,3 2,3 1,9 1,9 40   42 2,5 2,6 2,2 2,2 1,9 2 1,5 1,5 42   44 5 3,2 2,8 2,3 2,3 38 38 34 3 3 2,7 2,8 2,3 1,3 1,4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 <t< td=""><td>3 3,5 4 4,5 5 6 7 8 9 10 11 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48</td><td>100 72,8 67,1 61,8 57,1 48,5 41,9 36,7 31,6</td><td>61,4 59,6 56,8 52,5 42,1 37 32,7 229,1</td><td>61,3 59,5 57 52,8 44,9 42,7 37,6 30,1 26,8 23,9 21,5</td><td>61,3 59,4 56,8 52,9 43 38,3 34,1 30,6 27,4 24,5 22,1 18,3 15,3</td><td>61,1 59,4 56,8 49,1 42,9 38,4 30,7 27,5 24,66 22,2 18,5 15,5 13,1 11,6</td><td>59,1 56,4 48,9 42,7 38,3 34,2 22,1 18,3 15,9 13,6 11,6 10 8,6</td><td>49 48,6 47,9 42,3 38 30,3 27 24,2 22,2 18,7 15,8 13,4 11,4 10,2 8,9 7,9</td><td>39,9 40,1 37,2 23,4 29,9 27 24,2 22,2 18,4 15,5 13,4 11,6 10,1 8,6,8 6,1</td><td>32,8 32,6 32,9 29 26,1 24 21,9 18,1 15,5 13,3 10 8,8 7,7 6,8 6 5,3 4,8</td><td>26,8 26,5 26 25 23,2 21,1 17,7 15,1 13,2 11,4 9,9 8,7,5 6,6 5,8 1 4,5 4 3,5</td><td>21,8 22,1 21,9 21,7 20 17,1 14,7 12,7 11,3 9,7 8,4 5,6 6,4 9 4,3 3,8 3,3 3,8 3,3 9,2,5</td><td>15,6 15,2 14,3 13,3 12,4 11,5 10,6 9,6 8,4 4,5,7 5 4,4 3,8 3,4 2,9 2,6 2,2</td><td>18,2 18 17,9 17,5 16,1 14,1 12,1 10,7 9,3 8,1 7 6,1 5,3 4 4 3,4 3,4 3,4 3,2,5 2,2 2,2 1,9 1,6</td><td>13,4 13,1 12,9 12,2 11,5 10,8 7 6,2 5,3 4 4 3,5 3 6,2 2,6 2,2 1,9 1,6 1,3</td><td>15,1 15 14,9 14,4 13,2 11,7 10,2 8,8 8 7,6,7 5,8 5 4,3 3,7 3,2 2,7 2,3 1,9 1,6 1,3 1</td><td>12 11,9 11,7 11,4 10,9 9,7 8,6 6,5 5,7 5 5,7 5 5,7 5 5,7 5 5,7 5 5,7 5 5,7 5 5,7 5 5,7 2,2,8 8,3,2 2,2,8 2,3,2 2,1,9 1,0,9 10,9 10,9 10,9 10,9 10,9 10,9</td><td>12,4 12,3 12,2 12,2 11,6 11, 9,4 8,1 7 6 5,2 4,5 5,2 4,5 3,3 2,8 2,3 2,8 2,3 2,8 2,3 2,8 2,3 2,9 1,5 1,2 0,9</td><td>10,2 10,2 10 9,9 9,5 8,9 7,8 6,7 5,8 5,8 5,8 5,8 5,8 5,2 2,7 2,3 3,2 2,7 2,3 3,2 2,7 1,9 1,5 1,2 0,9</td><td>3 3 3 3 4 4 4 5 6 7 8 9 10 11 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48</td></t<>	3 3,5 4 4,5 5 6 7 8 9 10 11 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48	100 72,8 67,1 61,8 57,1 48,5 41,9 36,7 31,6	61,4 59,6 56,8 52,5 42,1 37 32,7 229,1	61,3 59,5 57 52,8 44,9 42,7 37,6 30,1 26,8 23,9 21,5	61,3 59,4 56,8 52,9 43 38,3 34,1 30,6 27,4 24,5 22,1 18,3 15,3	61,1 59,4 56,8 49,1 42,9 38,4 30,7 27,5 24,66 22,2 18,5 15,5 13,1 11,6	59,1 56,4 48,9 42,7 38,3 34,2 22,1 18,3 15,9 13,6 11,6 10 8,6	49 48,6 47,9 42,3 38 30,3 27 24,2 22,2 18,7 15,8 13,4 11,4 10,2 8,9 7,9	39,9 40,1 37,2 23,4 29,9 27 24,2 22,2 18,4 15,5 13,4 11,6 10,1 8,6,8 6,1	32,8 32,6 32,9 29 26,1 24 21,9 18,1 15,5 13,3 10 8,8 7,7 6,8 6 5,3 4,8	26,8 26,5 26 25 23,2 21,1 17,7 15,1 13,2 11,4 9,9 8,7,5 6,6 5,8 1 4,5 4 3,5	21,8 22,1 21,9 21,7 20 17,1 14,7 12,7 11,3 9,7 8,4 5,6 6,4 9 4,3 3,8 3,3 3,8 3,3 9,2,5	15,6 15,2 14,3 13,3 12,4 11,5 10,6 9,6 8,4 4,5,7 5 4,4 3,8 3,4 2,9 2,6 2,2	18,2 18 17,9 17,5 16,1 14,1 12,1 10,7 9,3 8,1 7 6,1 5,3 4 4 3,4 3,4 3,4 3,2,5 2,2 2,2 1,9 1,6	13,4 13,1 12,9 12,2 11,5 10,8 7 6,2 5,3 4 4 3,5 3 6,2 2,6 2,2 1,9 1,6 1,3	15,1 15 14,9 14,4 13,2 11,7 10,2 8,8 8 7,6,7 5,8 5 4,3 3,7 3,2 2,7 2,3 1,9 1,6 1,3 1	12 11,9 11,7 11,4 10,9 9,7 8,6 6,5 5,7 5 5,7 5 5,7 5 5,7 5 5,7 5 5,7 5 5,7 5 5,7 5 5,7 2,2,8 8,3,2 2,2,8 2,3,2 2,1,9 1,0,9 10,9 10,9 10,9 10,9 10,9 10,9	12,4 12,3 12,2 12,2 11,6 11, 9,4 8,1 7 6 5,2 4,5 5,2 4,5 3,3 2,8 2,3 2,8 2,3 2,8 2,3 2,8 2,3 2,9 1,5 1,2 0,9	10,2 10,2 10 9,9 9,5 8,9 7,8 6,7 5,8 5,8 5,8 5,8 5,8 5,2 2,7 2,3 3,2 2,7 2,3 3,2 2,7 1,9 1,5 1,2 0,9	3 3 3 3 4 4 4 5 6 7 8 9 10 11 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48

<Figure 5.4-49> lifting capacities on telescopic boom of Hydraulic crane(100ton)

Since hydraulic cranes is varied by working conditions, lifting load of 75~80% should be applied to maintain a safe state.

Since the tower crane should be removed from crest load of the main dam, a part of crest load should be expanded to operate the hydraulic crane (100 tons).



<Figure 5.4-50> Crest rode Extension Location

# 5.4.9. Dam Gallery

1) General

Galleries should be installed in the bottom of dam for grouting during construction and maintenance after construction.

The lowest part is located at EL.(+)134.500.

In the middle of the dam, there are three galleries connected to drainage channel to drain outside.

- Gallery Length: 167.45m
- Drainage Gallery Length : 51.5m
- Gallery Size: W3.5 m x H4.7 m, T=0.5 m

. Dam gallery plan is shown in figure 5.4-51.





<Figure 5.4-51> Dam Gallery Plan & Profile

- 2) Manufacture and Installation
  - a) Manufacture

The walls of gallery will make by GERCC during RCC work. In order to pour GERCC, a form should be installed inside gallery. When the wall will be constructed to required height, the slab will be manufactured by precast and installed in gallery..

Precast Slab should be produced at the production site using CVC. Minimum Concrete Compressive Strength at 28days should be a 25Mpa. Steel bar should be a 420Mpa of Grade 60. Precast gallery is produced in two types. Type 1 should be installed in the horizontal section and Type 2 should be installed in the inclined section.

The shape and dimensions of Precast Gallery by type are as follows.



## <Figure 5.4-52> Shape and dimensions of Precast Gallery

The production schedule and storage yard of precast gallery should be planned to be sufficiently hardened in consideration of main dam schedule.

The production quantity is shown in the following table.

## <Table 5.4-12> Length by Gallery Type

<u> </u>		
Division	Туре 1	Туре 2
Length	154.95m	64.0m

The production site should be installed in batch plant that is easy to supply concrete and transport products.

### b) Conveyance & Lifting

Precast gallery should be loaded by 50 tons crane at the production site and transported by  $5.0 \sim 11.0$  tons cargo trunk or flatbed trailers.

The precast gallery transported near the site should be installed in the correct position by hydraulic crane (50~100 tons) and tower crane as in the 5.4.7. crane operation plan. The lug for lifting should be connected to the reinforcing bars of the structure during the rebar assembly process of precast gallery and should be firmly installed.



<Figure 5.4-53> Precast Gallery Transport Method

c) Installation

In cases where galleries are crossing transverse contraction joints, the galleries will be split collinearly to the contraction joints and then waterproof-plates will be installed with their joints positioned at the base of the galleries.

The sequence of the works is as follows:



<Figure 5.4-54> Installation of Precast Gallery

The gallery of the horizontal part should be installed before the RCC, and slope should be installed at height at least 1~1.5m higher so that it does not interfere with the RCC construction. Between the gallery and RCC is constructed with GERCC

# 5.4.10. Plunge Pool

### 1) General

Plunge pool in down stream of main dam should be constructed with a width of 38~45.0m and a length of 87.0m as shown in the following figure.

The plunge pool should be constructed by pre-excavating up to 3 or 4 rock grades in the flow channel. Depth of pre excavation should be  $5\sim6.0m$ 

Plan is shown in following figure.



<Figure 5.4-55> Plunge Pool Plan

2) sequence

The section of plunge pool should be constructed after downstream coffer dam is removed. Because the river flows through the diversion culvert, excavation work should be executed in a dry state.

The equipment input for excavation is shown in the following table.

<1	<b>Table</b>	5.4-13>	Plunge	Pool	Excavation	Equi	ipment

Equipment	Capacity	Unit	Remark
Excavator	1.0m <sup>3</sup>	2	Screen Bucket installed if necessary
Excavator + breaker	0.7m <sup>3</sup>	1	
Dump Truck	25 ton	6	Adjustment by distance

Excavation slope protection of grade 4 rock should be executed using reinforcement of concrete as shown in <Figure 5.4-56>.

Anchor bars of 19mm diameter should be installed at 2.0m intervals before reinforcement of concrete is poured on the slope.

The length of the anchor bar should be 2.0m and the perforated hole should be grouted by mortar.



<Figure 5.4-56> Plunge Pool Excavated slope protection Plan

The equipment required for excavation slope protection is shown in the following table

### <Table 5.4-14> Excavation slope protection equipment

Division	Equipment	Capacity	Unit	Remark
	Crawler Drill	38mm	1	
Anchor Bar Installation	Grout Pump	30~60ℓ/min	1	
	high place operation car	-	1	
Reinforcement Concrete	Agitator Truck	6.0~6.5m <sup>3</sup>	2	Adjustment by transport distance
pouring	Concrete Pump Car	60 m³/hr	1	
	Concrete vibrator		2	

3) Schedule of Plunge Pool

- 4) The plunge pool will be started on May 11, 2024, when downstream coffer dam is removed, and takes about two month to August 3. Since plunge pool is included in the critical path, schedule management is important.
- 5) When plunge pool will be completed, It should be closed diversion
- 6) The schedule is shown in the figure below

	Dariad								20	24							
Classification	(Mth)		1	9			1	0			1	1			1	2	
	(IVIUI)	1W	2W	3W	4W												
1. Plunge Pool_Earth & Foundation Works																	
Plunge Pool_Riverbed Clearing	0.1					_											
Plunge Pool_Plume Concrete_1/2	1.4																
Plunge Pool_Plume Concrete_2/2	1.1																



# 5.5. Power Water<u>w</u>ay

## 5.5.1. General

Power Waterway from main dam to Penstock is excavated by tunnel.

The power waterway should be passed through rock consisting of conglomerate and sandstone. The headrace tunnel and surge shaft should be in the sandstone section, and the pressure tunnel starts from the sandstone and passed through the conglomerate section of 1500m and entered the sandstone section again.

About 100m of entrance side of intake and pressure tunnel is conglomerate.

Rock grade by Q-system is grade  $||| \sim |V|$ , which shows poor excavation conditions.

There are two major tunnel excavation methods; NATM(mechanical excavation) and shield TBM.

<table< th=""><th>5.5-1&gt;</th><th>Tunnel</th><th>excavation</th><th>methods</th></table<>	5.5-1>	Tunnel	excavation	methods
1 0010	0.0-12	runner	CACUVATION	methous

Classification	Mechanical Excavation (Breaker or Drum Cutter)	Shield TBM (Tunnel Boring Machine)				
Poto		Duc Cutter Brokel Sinds Sinds Cutternal Passes Sinds Cutternal Passes Sinds				
Excavation	Without Blasting	With a large circular excavator				
Support	Shotcrete + Rock Bolt (Lining if needed)	Assembling segments made outside				
Strong Point	Cheap initial cost Fast reaction to ground deformation	High speed excavation High stability(circular section)				
Weak Point	Diffcult to apply to hard rocks Low speed excavation(high risk to finishing within the period	High initial cost(TBM is expensive) Economical when it is over 5km				
Application	Mainly applying Mechanical excavation method, and NATM depending on the ground condition Two-way excavation at the starting and end point 39months of expected construction period(including entrance, excavation, lining work	One-way excavation at the end point 24months of expected period(substitute segment for lining)				

The headrace tunnel excavation method will be mainly applied Shield-TBM, Power tunnel section will be excavated by mechanical excavation method using Breaker.

Waterway plan and profile is shown in Figure 5.5-1



<Figure 5.5-1> Waterway Plan and Profile

Intake should be installed at the entrance of power water way. And, headrace tunnel and pressure tunnel are connected that. The end of that should be connected to the penstock. Between the headrace tunnel and pressure tunnel, a surge tank to reduce the hydraulic hammering should be installed.

The following figure is the intake & Power Tunnel plan.



<Figure 5.5-2> Intake & Power Tunnel Plan

Waterway specification is shown in following table.

<	Table 5.5-2> Waterw	ay Specification	
	ltem	Method	Length
			3,220.5 <mark>9</mark> n

Item	Method	Length	Inner Diameter	Remark	
Headrace Tunnel	Shield-TBM(Circular) 3,220.55 (Include tran		3.8m	Segment	
Surge Tank	Open-cut(Circular) NATM(Circular)	46.8m	7.0m	Concrete lining	
Dower Tuppel	Shield-TBM(Circular)	40.0 m	3.8m	Segment	
	NATM(Circular)	33.5 m	3.0 <u>~3.8</u> m	Concrete Lining	
Penstock	-	1 <u>53.67</u> m	3.0m	Steel Pipe	
Tailrace Outlet	-	12.3m	W 20.9m H 4.5m	-	

# 5.5.2. Work at the Starting and End Point of the Tunnel

1) General

For the water way, portals for tunnel excavation must be established at the start and end point. The inlet site could be executed with excavation of the main dam, and pressure tunnel portal should be installed separately. Cut slope caused by excavation must be reinforced and protected in a short time by planned method to prevent damage to the excavation surface.

Additional reinforcement could be implemented on the portal workface as needed.

For every 5.0m of slope, a 1.0m wide berm should be installed. When installing berm, a breaker attached to backhoe should be used to prevent damage to rock due to external impact.

2) Inlet cut Slope reinforcement and Protection

The height of inlet cut slope is temporary back slope 26.5m, Back Slope 42.7m, should be formed to rock back slope.

Temporary back slope should be excavated at a slope of 1:0.5, and back slope should be excavated at a slope of 1:0, and brum should be installed at the boundary.

The back slope is guaranteed to have slope stability and does not require reinforcement, but the temporary back slope should be reinforced with anchor pin, mesh, and shotcrete to prevent falling rocks in the future.



The inlet cut slope reinforcement and protection plan is as follows.



The specifications of inlet cut Slope reinforcement and protection is shown in flowing table.

Material	Specification	Remark
Anchor Pin	L=0.5m, C.T.C 1.0m(V) x1.0m(H)	
Wire Mesh	Φ <b>4-100 x100</b>	
Shotcrete	T=100mm	

3) Pressure Tunnel cut Slope reinforcement and Protection

Back side slope (section A-A') has a 13.3m high rock slope, and left side slope (section B-B') has a rock slope of 19.1m out of 29.3m in height.

Stereographic projection analysis of the back slope in power tunnel does not require reinforcement, but systematic bolt and shotcrete method should be applied in consideration of the portal of power tunnel.



### <Figure 5.5-4> Pressure Tunnel cut Slope Reinforcement and Protect Plan

The specifications of pressure tunnel cut slope reinforcement and protection is shown in flowing table.

Location	Material	Specification	Remark
	Rock Bolt	L=4.0,5.0m, C.T.C 2.0(V)x2.0(H)	SD40 D25
Back Side Slope	Shotcrete	T=100mm	
	Wire mesh	Φ4-100 x100	
	Rock Bolt	L=4.0~6.0m, C.T.C 2.0(V)x2.0(H)	SD40 D25
Left Side Slope	Shotcrete	T=100mm	
	Wire mesh	Φ4-100 x100	

4) Slope reinforcement and Protection

Reinforcement and protection should be executed to slopes created by excavation according to the ground conditions.

The slope reinforcement minimizes the time that rock surface is exposed to the atmosphere should be executed after the slope is formed to enable efficient equipment operation.

The construction example in the following figure is shown.



<Figure 5.5-5> Examples of Slop Protection

Slope reinforcement and protection may result in an accident due to rock fall or slipping of workers, so it should be executed after surface cleaning and work road securing.

The axial force of the rock bolt, the compressive strength of the shotcrete, and the thickness of the casting should be inspected and tested at every step to ensure the quality to be determined.

## 5.5.3. Intake

1) General

The power tunnel intake is located in the left abutment of the dam, and contains trashracks and an isolation gate. Major specifications of the intake are shown in the following table.

#### <Table 5.5-5> Intake Specification

Item	Size	Remark
Intake size	W3.8m x H3.8m	
Gate bottom elevation	EL.161.50m	
Trashrack size	W5.5 m×H5.5 m	
Intake length	19.75m	





The excavation line would be adjusted according to the actual site condition in the field, and final excavation would be subject to modification.



<Figure 5.5-7> Top view of Intake Structure

### 2) Sequence and Staging of Works

Intake installation should be executed when excavating the main dam. Intake should be stared after excavation of transition section(L=8.0m) in headrace tunnel on main dam and the shield TBM excavated from the headrace tunnel is taken out.



<Figure 5.5-8> Last Lining of Headrace and Preparation for Intake

Work in the intake structure can be divided into stages as shown as follows;

Backfill concrete which is done after the completion of the final excavation work. This work was performed to restore the condition resulting from excessive excavation due to the poor rock conditions.

- Conduit Structure
- · Gate shaft and retaining wall works can be performed simultaneously
- Backfill(Mass) concrete
- 3) construction Plan
  - a) Intake Structure and retaining wall works

Method statement of structure concrete will be used for slab foundation, wall, top slab and retaining wall, and will be also including lean concrete work, installation of steel bar, work of formwork and work of pouring concrete.

Materials of intake structure is shown in following table .

#### <Table 5.5-6> Materials of Intake Structure

Division	Minimum Concrete Compressive Strength at 28days(f'c)	Steel Bars(fy)	Remark
Lean Concrete	18Mpa		
Intake Structure	30MPa	Grade60, 420MPa	ACI 318 and
Parapet Wing Wall	30MPa	Grade60,420MPa	ASTIVI A615IVI

Installation of steel bar is according to the distance which has been determined in construction engineering, with support and bracing.

Concrete work will be performed in conformity to standards and specifications.

Formwork will be firstly installed before pouring concrete.

Concrete will be batched at batch plan, mixed and transported to the site by mixer truck, and poured and subsequently placed to foundation.



<Figure 5.5-9> Detail of formwork



<Figure 5.5-10> Pouring Concrete at Wall of Intake with Concrete Pump

Formwork system by manual can be made in a workshop using the material that has been prepared before. Materials can be a plywood with wood frame, metal frame, or full metal formwork. Formwork lifting will be every 2 and 3 m each 5 days or according with the actual conditions. For moving of formwork to the next lifting, tower crane or mobile crane will be used. Crane is placed on the right side of conduit structure.

b) Portal Wing Wall

Portal wing wall with a slope of 1:0.25 and height of 16.m should be installed on the front of intake structure. The construction plan is shown in the following figure.



<Figure 5.5-11> Portal Wing Wall Plan

Portal wing wall should be installed in steps of 1.5m using general concrete structure method using formwork system by manual and pump car.



<Figure 5.5-12> Portal Wing Wall Plan

After concrete should be poured, cured the surface while maintaining moisture.

c) Backfill & Riprap

When the intake structure and portal wing wall should be cured satisfied a certain standard, the space behind portal wing wall is filled with selected pervious material.

Backfill should be executed at every step of pouring concrete to minimize work scaffolding and ensure safety of workers.

After backfill is completed, a 0.5m-thick riprap should be laid horizontally on the top and the slope should be finished with a 1:1.5 slope.

### 4) Construction Schedule

After RCC dam wall should be laid up to EL.155.9m and intake foundation mass concrete should be poured, intake structure should be started. Intake is connected by dry test of instrument and monitoring system after construction for about  $\underline{8}$  months.

Classification	Period	19	19 2020		2021				2022			2023				2024				2	025			
Classification	(Mth)	4/4	1/4	2/4	3/4	4/4	1/4	2/4	3/4	4/4	1/4	2/4	3/4	4/4	1/4	2/4	3/4	4/4	1/4	2/4	3/4	4/4	1/4	2/4
Milestone		▼	NTP						Commence	ment of A	ccess Roa	d								First Re	servoir Im	oundme	nt 🔻	тос 🔻
Intake Facility																								
Civil																								
Earth Work																								
Intake Excavation	2.9																							
Potal Excavation	0.7																							
Slope Protection	0.5													•										
Intake Foundation	0.4																							
Structureal Work																								
Intake Wall & Slab	0.6																							
Intake Gate Wall	6.5																							
Intake Potal Wing Wall	6.3																			-				
Mechanical Works																								
Intake Gate	10.8																							
Stop Log	10.2																							
Trashrack	8.4																							
Screen	1.0																					-		
Measuring and Gate House																								
Architecture	2.5																							
Mechanical Works	0.5																							
Electrical	1.7																					-		
Control and Instrument	1.0																					•		
Firefighting	0.2																					•		
HVAV	0.2																					1		

<Figure 5.5-13> Construction Schedule of Intake

Intake work with RCC dam is a critical path, so special management should be required.

# 5.5.4. Power Tunnel Excavation Plan : NATM method

1) General

The penstock (L=25.5m) and transitional zone (L=8.0m) of power tunnel should be excavated by NATM (New Austrian Tunneling Method) method, and 40.0M section connected to the surge tank should be excavated by shield-TBM.

Power tunnel specification is shown in following table

Itomo	Shield TPM	NATM					
items	Shield I Divi	Transitional	Penstock				
Туре	Precast Segment Lining (t=200mm)	In-Situ-Concrete Lining (t=1.050mm)	In-Situ-Concrete Lining (t=1.450mm)				
Diameter	3.80m (Inner Circular)	3.80m (Inner Circular)	3.00m (Inner Circular)				
Length	40.0m	8.0m	25.5m				
Slope	Level	Level	Level				

<Table 5.5-7> Power Tunnel Specification



<Figure 5.5-14> Power tunnel Plan



## <Figure 5.5-15> Profile of the Power Tunnel

The geological conditions of this section were analyzed by RMR and modified Q-method (Barton, 2015) and support system was planned. The reinforcement plans for each type are shown in the following table.

<Table 5.5-8> Supporting Systems Applied to Power Tunnel

Classification	TYPE-I	TYPE-II	TYPE-III	TYPE-IV	TYPE-V-1	TYPE-V-2
Rock Grade	I	II	III	IV	V	Fault zone

Class	sification	TYPE-I	TYPE-II	TYPE-III	TYPE-IV	TYPE-V-1	TYPE-V-2							
Q	Value	> 10	10~4	4~1	1~0.1	< 0.1	< 0.1							
Excavati	on Span (m)	3.0	2.0	1.5	1.2	1.0	1.0							
Excavat	tion Method			Fu	ll Face									
Shotoroto	Туре		Fiber Reinforced											
Sholcrele	t (mm)	-	50	100	150	200	200							
	Length (m)	3.0	3.0	3.0	3.0	3.0	3.0							
Rock Bolt	Longitudinal Spacing (m)	spot	2.0	1.5	1.2	1.0	1.0							
	Lateral Spacing (m)	spot	1.5	1.2	1.0	1.0	1.0							
Stool Dib	Туре	-	H- 100×100		H- 100×100×6×8	H- 125×125×6.5×9	H- 125×125×6.5×9							
	Longitudinal Spacing (m)	-	-	-	-	1.0	1.0							
Reinf	orcement	-	-	-	Forepoling		Steel Pipe Roof Grouting							
Арр	olication					۲	۲							



## <Figure 5.5-16> Selected Support Pattern for NATM

If the ground conditions change during excavation, the reinforcement should be also changed properly with the site conditions.

### 2) Sequence of the NATM

Excavation using NATM consists of a cycle of excavation, mucking and support installation. Observe the specified cycle to ensure the stability of the tunnel.

The following is the sequence of the tunnel excavation works.



<Figure 5.5-17> Sequence of Tunnel Excavation

### 3) Survey

Tunnel surveying should establish a reference point for excavation outside the tunnel. During excavation, the tunnel center line, level, and curve should be surveyed. If necessary, check the installation status of support materials and lining foam Total station and level are mainly used for surveying.

NATM Tunnel surveying should be executed every 100m in straight part, and curved part should be conducted at appropriate intervals in consideration of radius of curve, slope, and excavation speed. After excavation, survey to alignment and internal section should be executed at intervals of 5.0m



<Figure 5.5-18> Tunnel Survey

### 4) Excavation & Mucking

a) Cutting by Mechanical Equipment

Wheel excavator used for mechanical excavation will be equipped with bucket, drum cutter and hydraulic breaker, depending on the site conditions such as rock strength.

The following figure is shown in application of the excavation machine by rock strength.



<Figure 5.5-19> Application of the excavation machine by rock strength



<Figure 5.5-20> Applications for Drum Cutters

## b) Mucking and Hauling

The cut rocks will be loaded by a front loader or backhoe onto dump trucks and then hauled to the disposal area.



<Figure 5.5-21> Mucking and hauling

### 5) Supporting

a) Steel Rib

Main steel ribs will be installed within stand-up time on the excavation face in order to prevent relaxation of ground. It will be planned to avoid long time intervals between installation works for main steel ribs.

If the actual ground condition differs from the estimated condition, it will be changed to another appropriate support measure for the condition.

If abnormal deformation occurs on steel rib, necessary reinforcing measures, such as increase of rib strength and additional use of rock bolt, will be adopted.



<Figure 5.5-22> Install of Steel Rib

b) Shotcrete

Steel fiber Reinforce Shotcrete will be immediately applied to the excavation face after excavation. The strength is 21Mpa and thickness is 150~20mm. In case of steel rib, shotcrete will be spayed cautiously in order that shotcrete and steel rib are well unified. Shotcrete work will progress upward from the bottom while installing steel ribs first in order to enhance the unification between steel ribs and shotcrete.

During the second application of shotcrete, rebounded materials from the first shotcrete will be completely eliminated. The direction of nozzle will be kept perpendicular to the shotcrete face. Nozzle will be about 1m apart from the excavation face in order to minimize rebound.



<Figure 5.5-23> Shotcrete

c) Rock Bolt

Rock bolt will be installed immediately after shotcrete has been cured using leg drills or rock bolt machine. Drilling will be performed perpendicularly on the excavation face and thoroughly cleaned with compressed air.

The rock bolt will be sufficiently inserted as long as the designed length, and the void around the bolt will be filled with mortar. After the filler is hardened, tension will be applied to the rock bolt by assembled the plate and bolt to the rock bolt head.

If the actual ground condition differs from the design, the rock bolt pattern should be altered to a pattern that is more appropriate for the actual condition.



<Figure 5.5-24> Rock Bolt

d) Drainage during the excavation period

In the upward section excavated from the powerhouse to the dam direction, water will be drained by gravitational flow drainage by side ditches of tunnel.

6) Tunnel Concrete Lining

Pressure tunnel is designed as circular section and should be reduced from 3.8m to 3.0m in diameter to connect to the penstock. Thickness of concrete lining is  $1.05 \sim 1.45$ m



<Figure 5.5-25> Tunnel Concrete Lining

Before form work, a waterstop should be installed on the rebar and expansion joint. The concrete should be transported by mixer truck and filled into the form through injection hole using pump car and compacted with vibrator. Concrete should be filled evenly on both sides and completely filled to the top. If there is a void at the top, a pipe for Grouting should be installed. The sequence for lining is shown in the following figure.







<Figure 5.5-27> Placing Concrete on Rebar Cage and Installation Reinforced bar



<Figure 5.5-28> Installation of Sliding Form

The power tunnel is poured into 3 parts as shown in <Figure 5.5-29>. The steel penstock section is divided into 20.0m,5.5m and a transitional zone of 8.0m.



<Figure 5.5-29> Expansion and construction joint plan
The input equipment for lining construction is shown in the following table.

<table< th=""><th>5.5-9&gt;</th><th>Equir</th><th>oment of</th><th>Concrete</th><th>Linina</th></table<>	5.5-9>	Equir	oment of	Concrete	Linina
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Equipment	Capacity	Unit
Concrete Pump	80 m³/hr	1
Agitator Truck	6 m <sup>3</sup>	2
Concrete vibrator	-	4

#### 7) Tunnel Grouting

Drilling and grouting would be carried out through the concrete liner to consolidate disturbed and fractured rock by filling open joints around the tunnel periphery which are loosened by cutting and gravitational effects when the opening is created and grout contact between rock and concrete lining to fill voids above the spring line between the face of the excavation and the concrete backfill.

Injection pressure of grouting must be controlled to prevent damage to the lining, but must be high enough to ensure penetration. However, the injection of grout is effected by the external water pressure around the tunnel and the rock mass condition, and it will have a bad influence on the leakage and the stability of tunnel by causing the damage on the rock mass in the vicinity of the tunnel when injecting it forcibly even though the injection is not smooth. Therefore, grouting depth, spacing, installation section, and injection pressure shall be determined in accordance with the field condition and field test result.

Arrangement of Grouting Plan is shown in figure 5.5-30.



<Figure 5.5-30> Arrangement of Grouting Plan



<Figure 5.5-31> Power tunnel NATM grouting Detail

a) Backfill Grouting

Backfill grouting is applied to tunnel crown in order to fill the gaps between rock mass and lining. Cement paste for small space and cement mortar for large space are used.

Backfill grouting will be applied throughout the steel penstock section for stronger contraction joints.

(4) Construction Method

Inject with a pressure 0.5~1.0 Mpa

Insert more than 20cm of injection packer into concrete lining. Remove any obstacles beforehand.

If a hole has leakage water inside, first the surrounding holes, and then the leakage hole shall be injected. Install drain hole if excessive water inflow is present.

(5) Closure of Injection

It is assumed that injection into a hole is finished when the injection pressure has reached 0.5  ${\sim}1.0$  Mpa and/or when paste starts to leak from an adjacent hole

Apply waterproofing mixture (non-contraction joint, etc.) to the injected hole to finish

#### b) Consolidation Grouting

The sandstone and conglomerate beds present along the headrace tunnel alignment with "low" to "very low" strength. Because of weak characteristics of the bedrock, it is expected that surrounding rocks would be excessively loosened during tunnel excavation. Therefore consolidation grouting will be applied to sections with the rock grades, III, IV, V, PE and PF

Eight holes with 30° intervals will be drilled at each section for consolidation grouting. Consolidation grouting will be performed every two advances in the rock grades mentioned above. The installation length will be 5.0m.

(1) Drilling and Grouting Equipment

The list of drilling and grouting equipment used for consolidation grouting is shown in the following table.

<	Table	5.5-1	10>	List	of	mair	ı Equ	iipn	nent	

Equipment	Activity	Unit
Percussion Drilling Machine	Drilling of all grout holes	1
Air Compressor, 850 cfm.	Supply compressed air to drilling machines	1
Electric Generator 125-220 KVA, 380V	Supply electrical power for execution of the grouting work	1
Grout Mixer, Colloidal Type	Mixing of grouting materials, before transfer to agitator tank	1
Grout Agitator	Stirring of grout mix, transfer from the grout mixer	1

#### (1) Construction Method

- Carry out backfill grouting and curing prior to consolidation grouting
- 1st drilling with AX boring to required depth
- 1st injection and curing
- 2nd drilling with AX boring to required depth
- 2nd injection and curing
- Remove packer and finish
- (2) Closure of Injection

The maximum injection pressure for the each mixing ratio has been reached, the injection will be continued until the injection rate drops below 1L/min. If injection carries on at a higher injection rate than the planned value, the mixing ratio according to the criteria will be changed.

c) Grout Curtain

Grout curtain is applied to the joint between penstock and horizontal pressure tunnel in order to prevent leaking of probable seepage behind the lining to the surface.

One row of 12 holes will be drilled at 30° for grout curtain.

Although there is no certain rule to determine the depth, the grouting shall be able to sufficiently penetrate high-permeability zone. The depth has been determined to be 6.0m herein.

Construction method and equipment are basically same as consolidation grouting.

d) Pre Grouting

During tunnel excavation, probe drilling is applied to check the front geology. If a small fault and a large amount of water are expected, pre-grouting is applied the upper and side of tunnel for stability of tunnel excavation.

8) Detail schedule of tunnel

Power tunnel using NATM should be completed prior to the preparation of headrace tunnel excavation.

Breakthrough should be prepared before headrace tunnel excavation is reached.

Earth work at the starting and end point of the tunnel and slope protection are completed before rainy season.

The starting and end point of the tunnel are related to the work of dam intake and penstock pipe line, therefore work plan should be made considering relation among work.



<Figure 5.5-32> Schedules associated with the power tunnel

# 5.5.5. Shield TBM Excavation

### 1) General

Some sections of power tunnel and headrace tunnel will be constructed using shield TBM method.

Shield TBM is suitable for one-way long tunnels such as headrace tunnel. Segment is installed immediately after excavation to minimize ground deformation and reduce the time for concrete lining. Shield TBM has different types applied according to soil conditions and rock strength, and properties of each type are as follows.

Division	Slurry Shield	Earth Pressure Balance Shield
Diagram		
Overview	Face pressure is maintained to pressure to slurry with a pump	Entire pressure in tunnel is maintained to pressure to excavated soil by driving force
properties	Mechanical excavation by injecting slurry into the face excavation Mucking with slurry transport using pipe	Injection of additives to smoothly discharge excavated soil Pressed by driving force of shield jack and discharged soil
Pros. & cons.	Good working environment with mucking transport as a pipe High excavation speed and easy management of pressure and tunnel Requires intensive management of ground conditions	Excavation speed is faster than Sully Shield Easy check ground conditions and low cost. Requires transportation equipment for ducking
Adaptability	Applicable to all soil conditions	Viscous soil, sandy soil, rock, etc.

EPB shield TBM will be used in "TRHDP".

The special feature of Earth Pressure Balance Shields is that they use the excavated soil directly as support medium. This method is the first choice in cohesive soils with high clay and silt contents and low water permeability. A rotating cutting wheel equipped with tools is pressed onto the tunnel face and excavates the material. The soil enters the excavation chamber through openings, where it mixes with the soil paste already there. Mixing arms on the cutting wheel and bulkhead mix the paste until it has the required texture. The bulkhead transfers the pressure of the thrust cylinders to the pliable soil paste. When the pressure of the soil paste in the excavation chamber equals the pressure of the surrounding soil and groundwater, the necessary balance has been achieved.

A screw conveyor transports the excavated material from the base of the excavation chamber onto a belt conveyor. The interaction between the screw conveyor's throughput and the TBM's advance rate ensure that the support pressure of the soil paste can be controlled precisely. The balance in the excavation chamber is continuously monitored using earth pressure sensors. In this way, the TBM operator is able to fine-tune all tunnelling parameters to each other even under changing geological conditions, allowing for high advance rates and minimizing the risk of heave or settlement at the surface.



<Figure 5.5-33> Support pressure onto the tunnel face of EPB shield TBM

The specifications of shield TBM to be put into the field are as follows.



<Figure 5.5-34> Shield TBM machinery schematic

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<b>Division</b>	<b>Description</b>	<u>Parameter</u>	<u>Remark</u>
	Outter Dia	Ф <b>4,340mm</b>	
Chield	Overall Length	7.470m	
Shield	Shied Jack	<u>125<sup>T</sup>×1650<sup>ST</sup>×30MPa×16</u>	
	Finish inner diameter	<u>Ф 3,800mm</u>	
	Type	Full Face Cutting type	
Cuttor bood	<b>Revolution</b>	<u>0 ~ 4.3min<sup>-1</sup></u>	
	Cutting Torque	NOR.1065kN-m, MAX.1600kN-m	
	<u>Oil Hyd. Motor</u>	MX750A(WITH REDUCER)x11	
	<u>Diameter</u>	<u> </u>	
Screw Conveyor	Revolution	<u>0 ~ 17.8min<sup>-1</sup></u>	
Sciew Conveyor	Torque	NOR. 10.5KN-m, MAX.15.9kN-m	
	Drive Unit	<u>MX750×1</u>	
	<u>Type</u>	Ring Drum type	
	SEGMENT WEIGHT	<u>1100kg</u>	
	EXPANSION FORCE	<u>7⊺ 100kg</u>	
Segment erector	REVOLUTION	<u>0.8 ~ 1.9min<sup>-1</sup></u>	
	EXPANSION STROKE	<u>Max.500mm</u>	
	SLIDE STROKE	FORE 400mm, AFT 100mm	
	OIL HYD MOTOR	MX250BO(WITH BRAKE)×1	



Shield TBM excavation sequence is as shown in figure below.

<Figure 5.5-35> Shield TBM Tunnel of Sequence

Shield TBM is moved by gripper and trust jack. The following is the operating sequence of one shift.





<Figure 5.5-36> Moving Sequence of Shield TBM

2) Primary Work

a) Shield TBM delivery and preliminary preparation

Shield TBM will be manufactured at the factory and delivered through shipping. The equipment arriving at the dock will be delivered to start point by trailer.

For excavation, the site should be complete excavation of NATM section in start point, foundation work, and installation of operation facilities for shield TBM. Preliminary preparation for excavation is as follows.



<Figure 5.5-37> Sequence of the Shield Tunneling Method

## b) Shield TBM assembly

Shield TBM will be split and delivered because it weighs dozens of tons. After arriving at the site, first, the main part including the cutter head will be assembled. Second, segment and power transmission equipment will be assembled. Finally, Electricity and water for operation will be connected.

The following figure is the assembly plan of shield TBM. Total duration is about 1.5 months



#### <Figure 5.5-38> Assembly and Start-up of Shield TBM

c) Shield TBM Rail Installation

Guide rails made of H-beam should be installed on the bottom of the power tunnel to move shield TBM to the work face that starts excavation.

Shield TBM rail is installed on 300mm thick foundation concrete (18Mpa) to withstand the load of Shield TBM.

It is inclined inward to fit the circumference of shield TBM so that shield TBM moves stably in the rail. When moving the Shield TBM, apply sufficient lubricant to the shield TBM rail surface to reduce frictional force.



<Figure 5.5-39> Shield TBM rail plan

d) Temporary Truss frame Fabrication

In order for shield TBM thrust, .Reaction wall is installed using H-beams. Reaction wall will be designed to withstand thrust jack and pressure from initial excavation of Shield TBM.

The temporary segment should be installed correctly and firmly since it affects permanent segment.



<Figure 5.5-40> Reaction wall Installation Plan

e) Installation of Entrance

Before installing the entrance, the temporary wall should be removed. The temporary wall will be minimized the disturbance of natural ground through partial crushing.

The entrance gate will be installed around the excavation surface with concrete (25Mpa). It prevent back fill from leaking when installing the first segment into the entrance gate The entrance should be installed according to planned line.



<Figure 5.5-41> shield TBM entrance pack plan

### 3) Temporary Facility

The following temporary facilities will be installed for shield TBM operation and worker safety, but may be changed depending on the purpose of use.

- Crane: Capacity to input and lift shield TBM, segment, and various materials
- Power supply: Capacity for shield TBM use voltage(380 ~ 660V) and tunnel maintenance
- Water supply: Supply capacity(200 ~ 500ℓ/min) of cooling water and water for construction
- Ventilation: Ventilation facilities to make comfortable and safe working environment for workers
- Sewage disposal: Disposal of sewage using coagulant.
- Muck Disposal(option): Recycling using twin mixer, screener filter press



<Figure 5.5-42> Temporary Facility

There are Three working yard for temporary facility: TBM launching yard and TBM storage yard

TBM Launching yard(Detail "A") is equipped with facilities required for Shield TBM operation such as power and water supply, and TBM Storage yard(Detail "C") holds segment and shield TBM spare materials.

A Temporary treatment facility is installed in detail "B" to purify construction water generated during shield TBM operation.



<Figure 5.5-43> Working yard plan

4) Initial drive

At the beginning of excavation, Shield TBM system and truss frame reaction forces will be unstable, so slow. When the Shield TBM enters the tunnel, backfilling should be proceed immediately to the point where sufficient reaction force is secured in segment or Back facility of shied TBM can enter.

In the initial drive stage, the parameters to be applied during main drive stage such as thrust of the shield TBM, cutter head torque, and R.P.M. should be reviewed.

5) Main Drive

The parameters reviewed in initial drive stage should be applied in main drive stage. During the excavation, A prompt action should be made to prevent affecting the natural ground, Excavation data, location and slope should be checked. Excavation speed expected is  $300 \sim 400$ m/month in main stage.

#### 6) Survey

In the shield TBM excavation, leveling using the laser measuring device mounted on the TBM and the check survey to check the deviation of the reference point are used. The measurement error of each survey is managed within 1mm.

The laser gun is installed firmly so that it does not move, and the maximum measuring distance is installed not to exceed 120m for accuracy. Transparency laser beam targets will be installed at the front and rear of the TBM to increase the accuracy of the survey.



<Figure 5.5-44> Shield TBM Survey Concept Diagram

The laser check will be performed at least once a day during excavation to prevent path deviation of the Shield TBM, and frequently during the TBM passes through soft ground.

The curve section will be excavated in consideration of the deviation calculated for each advance of the TBM, and a Laser Confirmation Survey will be conducted before the excavation length exceeds 30m.

#### 7) Mucking and Hauling

The method of mucking discharged through belt conveyor installed in the shield TBM is as follows.

- Locomotive and Muck Car
- MSV(Multi service vehicles)
- Belt Conveyor

Mucking using locomotive should be returned to the dump truck to move to disposal area, but using MSV and Belt conveyor are not necessary. Alternatively, the above method can be combined for each section.

The following is an example of mucking.



<Figure 5.5-45> example of mucking

Mucking method will be determined by amount of transport per cycle, distance to disposal area, and the method of use.

In this project, the locomotive and muck car methods will be applied within the tunnel, and excavators and dump trucks will be used to transport the spoil from the collecting pit to the the disposal area.

In order to operate a locomotive and muck car in a circular section, a 200mm H-beam sleeper is installed in the tunnel, and a 22kg/m rail is installed on the sleeper.

Locomotive and muck cars carry muck, segment and utility materials, so 2~3 units are operated. Therefore, if the transport distance is long, place the intersection at each certain distance.

The following figure is a cross section of rall installation.



<Figure 5.5-46> Transport system section

The specifications of rails and sleepers will be determined after carrying out structural calculations according to the specifications of transport equipment. Detailed plans will be presented in the method statement submitted prior to construction.

#### 8) Segment Installation

Segment will be composed of 5 + 1key and made by concrete(Fck = 42Mpa), and thickness is 200mm.

The specification is as follows.



<Figure 5.5-47> Typical-Type Segment Arrangement Plan

Segments can be manufactured on site or factory. When ordering segments, the excavation schedule should be considered.



Segment manufacture sequence is as follows.

<Figure 5.5-47> Segment manufacture sequence

All segments should be marked with the type, manufacture date, and division between standard and curved type, and this symbol should not be erased until installation. Each segment will be connected by bolts and made one of ring.

In TRHDP, Bolt pocket + dowel method will be applied, planned with 100years durability.

Bolt connection method is as follows.



<Figure 5.5-48> Connection of Reinforced Concrete Segments

Segment's Waterproofing System is planned to be gasket type. Gasket type is excellent in durability and waterproof effect against segment deformation and water pressure.

Typical shape of gasket is shown in the figure below.



<Figure 5.5-49> Geometrical Definition of Gap/Off-Set and Typical Shape of Gasket

The Gasket will be attached by manpower before it is supplied to the shield TBM. In case of damage during transport, it must be repaired immediately.

9) Backfill Grouting

Backfilling is performed by longitudinal injection system from behind the shield TBM within a short time after the segments are assembled.



<Figure 5.5-50> Radial Backfilling through the Lining

After backfilling, due to the shrinkage of the filler, there may be cavity in the upper part as shown in DETAIL "A" in Figure 5.5-50. Secondary grouting is performed using the insert hole when the cavity on the back side of the segment is confirmed at the shield TBM has passed

The details of grout hole are as the figure below..



<Figure 5.5-51> Profile of Grout Hole

The grouting method using pipe or grout car will be selected according to the type, quantity, and composition of injection material. The general back grouting construction sequence is shown in the figure 5.5-31.



<Figure 5.5-52> Back Grouting sequence

The table below shows the mixing ratio of materials for back grouting. It can be changed considering site conditions.

#### < Table 5.5-13> The Mixing Ratio of Materials for Backfill Grouting

Cement(kg)	Sand(kg)	Admixture(kg)	Water(ℓ)	Remark
510	1,495	5.1-7.7	260	1:3 Mortar <u>~ 1:1</u>

In order to prevent leakage of the injected material, the tail seal installed between the tail plate and the outer surface of segment should be periodically checked and filled.

#### 10) Break though of Shield TBM

Shield TBM should be broken though the inlet transitional zone from STA 0+66.959 (section B).

Before the main drive will be completed to the end point of tunnel, the excavation surface should be reinforced. Shield TBM should slow down and be checked the center point of location, When it approaches a certain distance, should be excavated slowly.

Backfilling in the break though area should be explicitly managed.



<Figure 5.5-53> Break though (Location) of Shield TBM

11) Dismantle and Removal

Shield TBM rail should be installed in the same way as power transitional zone in order for shield TBM to break through inlet transitional zone. It should be extended to the outside by the length of main body of shield TBM.

Temporary segment should be installed in the transitional zone, and it break through the trust jack.

Removal of Shield TBM should not be affected by Intake construction. When it is Removal to the end point, it is possible to carry it out with minimal dismantling. But when it is exported to the start point, it must be disassembled into a transportable size.

In this project, Shield TBM will be exported from Intake, the direction of excavation. A 150 tons crane is used for disassembly and a row bed trailer is used for transport.

The sequence of Dismantle and Removal is as follows.



<Figure 5.5-54> Dismantle and Removal Sequence of Shield TBM

While the main body will be disassembled and taken out, the backup system and utility will be taken out to the back side. Tunnel from which all construction facilities will be removed should be cleaned.

# 5.5.6. Surge Tank

#### 1) General

Surge tank is one of the essential components in hydropower project involving long headrace tunnel. Function of the Surge tank is to control the sudden surge generally known as water hammer. Surge tank is to be built at the junction of headrace tunnel and power tunnel.

The general profile and section of surge tank is shown in following figure.



<Figure 5.5-55> Profile of Surge tank

The specifications of the surge tank are shown in the following table.

<table 5.5-14=""></table>	Surge tank S	pecifications

ltem	Height	Inner Diameter	Excavation Diameter (Max)	Concrete Lining Thickness
Surge tank	41.750m	7.0m	9.0m	0.5~1.0m

## 2) Pre grouting

Pre grouting for the Surge tank has been planned as below based on geology and groundwater at the section. Pre grouting will have effects such as cutoff of groundwater and strengthening of the ground, etc.

Pre grouting is 2.5~3.0m thick and should be installed in two rows every 6.0m in depth. The spacing of the pre grouting hole is 3.0m, and it should be drilled at an angle of 33° from the center.

The layout plan of the pre grouting hole is as follows.



<Figure 5.5-56> surge tank pre grouting plan and detail

Crawler drill to maintain the gap and inclination of holes for drilling the grouting hole will be used.



<Figure 5.5-57> Pre Grouting of equipment

During pre grouting, excavation will be stopped for worker safety, so the period of pre grouting is included in the construction period of the surge tank.

#### 3) Surge tank Excavation

a) Excavation Method

The excavation method of the shaft generally classifies as the full face top-down excavation method and pilot tunnel & expansion excavation method. The purpose, depth, section size, ground condition and construction schedule of the vertical tunnel will be reviewed synthetically. The feature of each excavation method is shown in the table below.

		Pilot tunnel & Expansion excavation			
ltem	Downward Excavation	RC + expansion blasting	RBM + expansion blasting		
Picture					
Construction Method	After installing crane on ground surface, full face or bench cut can be made downward Mucking upward by crane and followed is proper support system such as shotcrete, etc. Advance length for a cycle time: generally, 1.0-2.5m	Pilot tunnel is excavated by blasting, upward along the guardrail from under horizontal tunnel, while mucks fallen in free fall into the under horizontal tunnel. The final tunnel is expanded by blasting from the top to bottom while mucking through the pilot tunnel. According to the ground conditions, a proper supports such as shotcrete and so on are prepared and placed	At ground surface, primary tunnels are drilled in approximately $\Phi$ 300mm diameter, and 'reaming bit' is installed underneath the bottom of shaft in lower horizontal tunnel before excavating the pilot tunnel of $\Phi$ 2.4-3.05m upward. The expanded tunnel is excavated with blasting from top to bottom, mucking though the pilot tunnel, while placing proper supports for ground conditions such as shotcrete and so on.		
Feature	Depth : within 100m is optimized Possible to construct regardless of the excavation of lower horizontal tunnel Easy to cope with the rock quality change Excavation and support at the same time Lower efficiency over 100m depth of excavation Poor workability of muck treatment	Depth : 100-400m (Optimization : 200m) Possible to construct after the completion of lower horizontal tunnel excavation Difficult to construct the fracture zone. It is not economical unless depth of excavation is more than 100m Poor working condition of excavation in the pilot tunnel from bottom to the top can always cause the danger of cave-in.	Depth : 100-400m (Optimization : 200m) Possible to construct after the completion of lower horizontal tunnel excavation. Difficult to cope with the rock quality change It is not economical unless the depth of excavation is more than 100m. If the primary hole is likely to incline, vertical error can occur. (Special facilities needed)		
Apply	Ø				

#### <Table 5.5-15> Excavation Method of the Shaft

Downward Excavation method should be applied in this project.

b) Equipment input plan

The surge tank construction possesses very high risks of accidents such as fall, suffocation and so on. Thus, it should pay full attention to perform safety managements during the construction. In this regard, manpower construction is excluded as much as possible and mechanized construction process is planned instead.

In consideration of silt/clay colluvium and residual soils distributing between the surface and 3m below, and highly fractured sandstones and conglomerates lying underneath, small-sized excavator will be used for excavation while excluding drill & blasting method. Breaker will also be

used in case of weak rock mass. Excavation method may change based on site conditions and borehole survey results in the future.

The following equipment and machineries will be mobilized on site as per required for the schedule of the works

Equipment	Capacity	Unit	Purpose	Remarks
Excavator	0.2-0.3 m <sup>3</sup>	1	Excavating, Mucking	
Leg Drill		2	Rock bolting	
Shotcrete Machine	8-10 m <sup>3</sup> / h	1	Shotcreting	Dry mix type
Bucket Crane	3-4m <sup>3</sup> bucket	1	Hauling	
Mobile Crane	50ton 3-4m <sup>3</sup> bucket	1	Hauling	Alternative of bucket crane

### <Table 5.5-16> > Equipment for Excavation

Bucket cranes should be installed on the ground for the excavation equipment and mucking. After the excavation is completed, the scaffold for lining concrete should be installed. The figure below is an example of a typical bucket crane.



<Figure 5.5-58> Example of Bucket Crane

The specifications of bucket craned are shown in the table below.

<table 5.5-17=""></table>	Specifications	of Bucket	Crane

Equipment	Size	Capacity.	Speed	Lift	Power	Remarks
Bucket Hoist System	3-4m³	8.7-10.7ton	V=40m/min	60m	75HP	Electric or Hydrodynamic

a) Sequence of the Works

(1) Excavating

A Surge Tank will be constructed by mechanical excavation using small excavator ( $0.15 \sim 0.3 m^3$  capacity).

Hydraulic breaker is supported when solid rock is found.



<Figure 5.5-59> Excavator and Hydraulic breaker

### (2) Mucking

Mucking out cutting from the bottom of the shaft. It will be loaded to bucket by using a small excavator or a loader. Also, the clam-shell-grab equipment can be used depending on the field condition.



<Figure 5.5-60> Excavator

In this project, if the excavator loads the bucket, the crane lifts it to ground and then loads it into the dump truck.

(3) support installation

When excavation is completed, a support material will be installed on the excavation surface. Two patterns will be planned in the surge tank.



<Figure 5.5-61> TYPICAL SUPPORT PATTERN

Classification		ST- IV (if necessary)	ST-V-1	
Excavation Method		Method	Full Face (Breaker)	Full Face (Breaker)
Advance Length (m/round)		h (m/round)	1.2	1.0
Shotcrete Thickn		e Thickness(mm)	160(Steel Fiber Reinforced, 21mpa)	200(Steel Fiber Reinforced, 21mpa)
-		Length(m)	4.0	4.0
Support	Rock Bolt	Longitudinal / Transverse Spacing(m)	1.2/15(1.2)	1.0/13(1.0)
	Steel Rib	Туре	H-125×125×6.5×9	H-150×150×7×10
		Spacing(m)	1.5	1.0

#### <<u>Table 5.5-18> Support specifications by Pattern</u>

Main steel ribs will be installed within stand-up time on the excavation face in order to prevent relaxation of ground. It will be planned to avoid long term intervals between installation works for main steel ribs.

If the actual ground condition differs from the estimated condition, it will be changed to another appropriate support measure for the condition.

If abnormal deformation occurs on steel rib, necessary reinforcing measures, such as increase of rib strength and additional use of rock bolt, will be adopted.



<Figure 5.5-62> Steel Rib Installation

Shotcrete will be immediately applied to the excavation face after excavation. In case of steel rib, shotcrete will be spayed cautiously in order that shotcrete and steel rib are well unified. Shotcrete work will progress upward from the bottom while installing steel ribs first in order to enhance the unification between steel ribs and shotcrete. During the second application of shotcrete, rebounded materials from the first shotcrete will be completely eliminated. Thickness of shotcrete joint will get thinner from 16 and 20cm before completion. However, the original thickness will be applied to lower ground part in case of weak ground.



<Figure 5.5-63> Shotcreting

Rock bolt will be installed immediately after shotcrete has been cured using leg drills or rock bolting machine. A wire mesh is fastened to the wall evenly spaced rock bolts.

Rock bolting is a commonly used and it is an economical method. The rock-bolts increase normal stress on the joints in order that shear failure along joints becomes more difficult. Often rock bolts and mesh are used as a basis for shotcreting. Water in-flow during shotcreting severely reduces the quality of shotcrete.



<Figure 5.5-64> Rock Bolting and Meshing

4) Surge tank Concrete Lining

Concrete work starts from the bottom to the top each 1.5m by using a concrete pump which is placed at the top of the structure. Surge tank concrete lining will be placed using manual form work. Sequence of Surge tank concrete lining can be seen in the following flow chart.



<Figure 5.5-65> Sequence of Concreting Surge tank

a) Cleaning Area

Before starting the activity of concrete placement, the first step is to clean the work area and all materials that are not used should be cleaned in the work area. Immediately before placing concrete, all surfaces of foundations upon or against which the concrete is to be placed will be free from standing water, mud, debris, oil, objectionable coatings and loose, semi-detached or

unsound fragments. Directed surfaces of foundations will be cleaned with air-water jets, air jets and vacuuming.



<Figure 5.5-66> Cleaning Area at Surge tank

b) Survey and Marking

Before starting the concrete works for Surge tank, the excavated surface with reference to the center line shall be checked and suitably treated for any undercut which may halt the slip form movement and thereby may hinder the concreting work. Reinforcement at different levels is different due to varying lining thickness. Markings at the correct intervals indicating the change in the thickness will help the fitters laying reinforcement and will ease the form work handling. Also with varying thickness of lining, the markings done to identify them will also guide the varying concrete quantity requirement.

c) Manual Form Work Assembly and Installation

Formwork installed in accordance with design structure is as shown in the drawing. The formwork is applied as a manual form.



<Figure 5.5-67> Manual Formwork Installation of Surge tank

d) Concrete Lining of Each 1.5m

Placing concrete using concrete pump is placed at the top of the Surge tank. The process of placing the concrete starts from 1 piece then follows the direction of the flow of concrete in a row until the top elevation plans. Placing concrete process followed by compaction uses a vibrator.

#### e) Equipment

•	Concrete mixer capacity 6m <sup>3</sup>	: 4 units
•	Concrete Pump capacity 80m <sup>3</sup> /hours	: 1 unit
•	Manual form	: 1 unit
•	Air compressor 250 cfm	: 1 unit
•	Concrete vibrator	: 4 units
•	Waterjet pump	: 1 unit

5) Schedule of Surge tank

Surge tank construction is divided into upper part and tunnel connection part.

The under ground takes 5 months of excavation and 3.2 months of lining, and the above ground takes 2 months of lining. The entire construction period including the creation of the work yard was planned for about 11 months.



<Figure 5.5-68> Schedule of Surge tank

# 5.5.7. Steel Penstock

#### 1) General

The steel penstock connected to the power tunnel should be composed of a total of 181m with 19m in the upstream reclamation part, 125m in the inclined exposure part, 9m in the branch part branching into three, and 28m in the downstream reclamation part up to the power plant inlet valve. The main pipe before being divided into three branch lines is 3.0m diameter, and the branch is planned to be 1.2m diameter.

The inclined part should be supported by the ring girder and the bent part with an anchor block gauge, and the spacing of the supports on the inclined surface ( $35^\circ$  to  $43^\circ$ ) is 14.0 to 18.0 m.



<Figure 5.5-69> Profile of Penstock

Rolled steels for welded structure of SM400 should be used for the steel used in the steel penstock, and the thickness of each part is as follows.

Description	Diameter(mm)	Shell thickness (mm)	Remarks
Beginning portion	3,000	13	
Isolation valve portion	2,500	15	
Anchor Block #1	3,000	16	
Ring girder #1	3,000	16	
Anchor Block #	3,000	16	SM400(Rolled steels for
Ring girder #2	3,000	16	welded structure)
Ring girder #3	3,000	18	
Trifurcation	5,200	26	
Elbow #4	1,650	11	
End portion	1,200	10	

<Table 5.5-19> Steel Penstock thickness

2) Priority Management Plan

a) Checking related works

Minimizing interference and securing work space by implementing related works together when powerhouse works are underway

b) Working on safety control when slope works are underway

Considering room for lifting equipment and mobilization of it, and checking the equipment's capability and accessibility to the site in advance

c) Securing quality of junction among large caliber steel pipes

Considering measures to manage safety and quality of welding works of caliber steel pipes

3) Detail schedule of penstock

Schedule of penstock is related to Power tunnel and River Diversion.

The steel penstock should be installed after portal installation work of the power tunnel should be completed, and the diversion culvert should be closed when the penstock installation is completed.

And, manifold encasement should be installed after basement of the powerhouse. Penstock control valve chamber is possible to be installed after excavation of headrace tunnel and export of shield TBM. Therefore, the construction of Penstock is applied from bottom to top.

4) Installation Procedure

#### <Table 5.5-20> Installaion Procedure of Penstock



Place	Penstock installation procedure	Inspection	
		① Receiving & Inspection	
Inclined site		② Groove Inspection	
	Installation	③ Visual Inspection	
		③ Nondestructive Inspection	

#### 5) Delivery of Penstock to Project Site

Installation of steel penstock has two methods: the manufactured steel penstock is brought in, or the steel plate is brought in and assembled at the workshop on site. The method to be applied will be suggested in the installation plan.

The Steel penstock is moved to the installation site using a truck and installed with a support to prevent deformation.

6) Installation of Penstock on Site

The Contractor shall install or erect the pipes for the penstock in the positions and to the lines and levels in accordance with the approved Contractors drawings and the match and flow marks positioned during fabrication.

The installation/erection consists of laying down of penstock sections/spans between two anchor points or saddles and assembly by welding – manually (shielded gas welding, electric arc welding or shielded metal arc welding) or any other process.

For accurate alignment and suitable erection of the penstock at the project site, the following shall be prepared by the Contractor:

- Site installation plan
- Ground longitudinal profile
- Preparatory works on layout such as anchor blocks, saddles, etc.
- Storage area and site for installation
- Erection season and time available
- Transport & handling facilities of penstocks for installation, e.g., winches, rails, steel frame trolley or straddle carrier, hydraulic jack, sheave assembly, turn table or hydraulic cylinder, etc.



X The arrangement of mobile cranes in section 2 could be changed according to site conditions.



<Figure 5.5-70> Installation by Mobile Crane

## 7) Penstock Manifold

Manifold will be installed after poured foundation concrete the second basement floor of powerhouse.

Steel pipe of Manifold is asymmetric, so it is not easy to balance. Therefore, it is installed by maintaining the balance using the weight of temporary pedestal and concrete

Steel pipes will be divided based on curved part, brought in site, and assembled by welding. The steel pipe is marked with a fixture for maintaining shape from the manufacturing stage and a reference point during assembly. Concrete, which will be the basis of the Temporary Pedestal, is placed on the foundation and the slope where the steel pipe will be assembled. The steel pipe has holder for maintaining shape and reference point for assembly in manufacturing stage. Concrete, which will be foundation of temporary pedestal, should be placed on the slope where the steel pipe is installed.

The following figure is example of shape holder and temporary pedestal



<Figure 5.5-71> Example of Shape Holder and Temporary Pedestal



The construction plan of penstock manifold is as follows.







< Figure 5.5-72> Sequence of Penstock Manifold Installation

8) Ring girder and Anchor Blocks

Prior to erection of penstock, the Contractor will install the concrete Ring girder and anchor blocks at the desired locations and elevations indicated on the construction drawings. The installation works of Ring girder and anchor on the slope shall only proceed after the slope excavation, stabilization and protection works have been completed.



<Figure 5.5-73> Ring girder and Anchor Blocks

a) Ring girder

The Ring girder will be made of a concrete foundation topped with two pillars supporting the (double) ring with sliding feet. The distance between the supports is approx. 14~18 meters.


<Figure 5.5-74> Profile and Section of Ring girder

Work Sequence of Ring girder

- Excavate foundation
- Drill and grout 40mm dia. anchor bars
- Cast blinding concrete
- Install reinforcing bars
- Install formworks
- Cast concrete in stages

The materials used for the ring girder are shown in the following table.

#### <Table 5.5-21> Materials of ring girder

Division	Specifications	Remark
Concrete	fc=30Mpa	Compressive Strength at 28days
Lean Concrete	fc=18Mpa	Compressive Strength at 28days
Steel Bar	fc=420Mpa	Grade 60

#### b) Anchor Block

The anchor block of the penstock will consist of a solid concrete foundation and anchoring. The following figure shows a typical anchor block.



<Figure 5.5-75> Typical Section and Installation of Anchor Block

Work Sequence of Anchor Blocks : Below is the illustrative sequence of work for constructing the anchor blocks of penstock.

- Excavate foundation
- Micro pile(Φ57mm)
- · Casting 1st Concrete : Cast blinding concrete, Install reinforcing bars, Install formworks
- Penstock's Temporary Support : Install temporary steel support for penstock erection and against floatation above the 1st concrete block anchor
- Penstock Erection on 1st Anchor stud : Erect upper bent/elbow and pipes of penstock on 1st anchor stud
- 2nd Anchor Stud Site Welding of Penstock : Install reinforcing bars, Install formworks, Cast concrete in stages

Micropile should be drilled a 150mm diameter using a crawler drill, inserted a  $\phi$ 57mm anchor body, and filled the void with a cement face. The construction sequence is as follows.



<Figure 5.5-76> Micropile construction sequnce

Materials used for Anchor Block are shown in the following table.

## <Table 5.5-22> Materials of Anchor Block

Division	Specifications	Remark
Concrete	fc=30Mpa	Compressive Strength at 28days
Lean Concrete	fc=18Mpa	Compressive Strength at 28days
Steel Bar	fc=420Mpa	Grade 60

9) Steel penstock Welding

Main welding work for erection of penstock at the site is circular welding for the circumference of installed sections which will be welded from the inside first adopting a single sided inside groove or the V type groove or single U with a land on the outside and zero joint gap. As the outside clearance of the penstock from the ground is sufficient for welding at least 1.5m, therefore, the outside of the joint will be gouged to form the weld groove and to obtain full penetration.



<Figure 5.5-77> Site welding

a) Inspection

The applicable NDT of weld, e.g.,Ultrasonic Test, magnetic particle and dye penetrant methods, will be performed during the erection of the penstock at the site.

The QA/QC manager will request the pipe installer for correction and rectification of flaws found on welded joints. The rectified welded joints will be subject again for re-examination to the satisfaction of the QA/QC manager.

b) Protective Coating

After the welding inspection has been carried out for the erected penstocks and the result is satisfactory, the protective coating will be carried out as required

#### 5.6. Powerhouse

#### 5.6.1. General

Powerhouse will be constructed on the ground level and 2 basement levels.

On the 2nd basement floor, Turbine and draft tube connected to manifold will be installed. Also, tailrace channel for discharge will be installed. Generator is installed on the first basement floor. In addition, the ground floor will be installed over crane and a management room for maintenance.

Major specification of the powerhouse is shown in the table below.

<Table 5.6-1> Powerhouse Size

ltem	Description	Dimension	Remark
	Level	1F, B2	
	Substructure	Concrete	
Powerhouse	Superstructure	Steel frame & clad	
	Size	W16.3m x H28.0m x L40.9m	1F
	Turbine Type	Vertical Francis 15.0MW (5.0MW x 3unit)	
Tailraaa	Туре	Open Channel	
Talliace	Size	W26.250~29.937m x L15.945m x H2.765m	



<Figure 5.6-1> Cross Section(4) of Powerhouse

## 5.6.2. Priority Management Plan

The power house construction can be executed separately, but since occurring interface between the adjacent construction and other works, the following items must be considered.

- Management of work process(civil, architectural, mechanical, electrical work) for commencement of work at the right time checking related works
- Thorough quality control for prevention from defects in substructure
- · Working on safety control when slope works are underway

## 5.6.3. Schedule of powerhouse and tailrace

Powerhouse and tailrace construction will take about <u>28</u> months.

During this period, excavation takes about <u>3</u> months and substructure civil works takes <u>10</u> months. Among the substructure civil works, the draft tube liner of the turbine and the foundation of the

generator should be executed concurrently, so procurement management of related materials is required

The construction schedule of powerhouse is as follows.



<Figure 5.6-2> Schedule of powerhouse and tailrace

Powerhouse construction ends with removal of temporary cofferdam of tailrace, and the follow-up schedule is connected with diversion closure, so the entire schedule is the main process.

## 5.6.4. Powerhouse and Tailrace Outlet Earthwork

The powerhouse site and the slope of the penstock are connected. Therefore, it will be more effective to carry out the powerhouse excavation simultaneously with excavation of the tailrace outlet and penstock sections. If the powerhouse site is excavated first, the slope of the mowing slope may become unstable and proceed from top to bottom.

The section of the excavation plan is as follows.

L



<Figure 5.6-3> Excavation Portion of Powerhouse and tailrace

Since the ground in powerhouse site should be composed of soil and weathered rocks, blasting will be rarely used. When solid rock appears, excavator and breaker should be combined to excavate.

Equipment input for excavation is shown in the table below.

<table 5.6-2=""> Equipment of excavation inp</table>	out plan
--	----------

Equipment	Size	Unit	Remark
Excavator	1.0m <sup>3</sup>	3	Excavation, Mucking
Ripper Dozer	38ton	1	Excavation
Dump Truck	25ton	-	Hauling

The colluvial soil and weatherd soil on the cutting slope should be reinforced and protected with soil nailing (D29), and the bed rock should be reinforced and protected with system rock bolt (D25, L 4,000~6,000mm). The surface is coated with wire mesh( $\Phi$ 4×100×100)and shotcrete(fck=21Mpa).

Typical cross section is as follows







The reinforcement and protection plan of power site is shown in the following figure.

<Figure 5.6-5> Cut slope Reinforcement and protection plan

Since the cut slope of the power house site needs to be constructed in a relatively short time, 2 sets of work crew should be put in.

The equipment that composes each team is shown in the following table.

<Table 5.6-3> Reinforcement and protection equipment

	· · · · ·		
Equipment	Size	Unit	Remark
Crawler Drill	17m <sup>3</sup> /min	1	Soil Nailing, Rock Bolt, Horizontal Drainage hole
Air Compressor	21m <sup>3</sup> /min	1	
Mono Pump	30-60m <sup>3</sup> /min	1	
High place operation car	5ton	1	
Shotcrete Machine	13m <sup>3</sup> /hour	1	

#### 5.6.5. Structural Work

1) Cleaning Operations and Levelling Concrete

The preliminary work is basically the cleaning of the foundation ground where a levelling concrete will be placed to form a clean and well-arranged surface on top of which steel reinforcement and forms may be placed. This can be done with a combination of water and air or by using a powerful vacuum cleaner.

2) Formwork

Formwork system by manual can be made in a workshop using the material that has been prepared before. Materials can be the plywood with wood frame, metal frame, or full metal formwork. The typical formwork which will be used in the project is shown in the figure below



<Figure 5.6-6> Plywood Formwork

#### 3) Steel Reinforcement

Reinforcing steel bar should be using minimum yield strengths(f'y) Grade 60(fy=420Mpa). Diameter is 10~32mm.

The cut and bend of reinforcing steel bar will be installed in a covered factory with modern machinery by Contractor. The positioning in the erection place will be installed with mobile cranes



<Figure 5.6-7> Reinforcement Workshop and Installation of the Rebar on Site



<Figure 5.6-8> Positioning of Formwork and Reinforcement by Crane

4) Concrete Placement

Power house will use 30Mpa(28days) of compressive strength.

The Contractor will use mobile concrete pumps or concrete pump cars for the works. The concrete pumps will have a pouring capacity of 60m3/hr with 5" or 6" diameter pipes and maximum pouring

reach of 40 to 50 meter. In the powerhouse area, the concrete trucks will get the access to the pouring area from both upstream and downstream. The concrete will be placed by experienced workers and will be vibrated with air compressed or electrically driven vibrators 1 to 3 inches depending on the various structures to be poured.



<Figure 5.6-9> Pouring Concrete at Powerhouse with Concrete Pump Car

## 5.7. Tailrace Outlet

#### 5.7.1. General

Tailrace out is the final outlet passed turbine water that is discharged through draft tube gate.

it was planned to a waterway with a reverse gradient from the bottom of the draft tube gate to the bottom of the tailrace outlet.

Riprap will be installed in front of the tailrace outlet, and retaining walls will be installed around the power house.

Bottom elevation of the tailrace outlet is EL 72.0, the size is W 20.9 m x H 4.5 ~ 6.5 m x L 12.3 m, and the slope is 33.33 %.



<Figure 5.7-1> General plan of tailrace

Coffer dam should be installed during excavation of power house to prevent the inflow of river water during tailrace outlet construction.

The coffer dam should be maintained at least until the tailrace outlet and draft tube gate of the power house are installed, and should be removed after construction is completed.



The installation plan of Coffer dam is as follows.

<Figure 5.7-2> plan of coffer dam

## 5.7.1. Tailrace structural

Tailrace structural is divided into draft tube gate, bottom concrete, and retaining wall.



<Figure 5.7-3> profile of Tailrace structural

The specifications of materials used for tailrace structural are shown in the following table.

Division	Specifications	Remark
Concrete	fc=30Mpa	Compressive Strength at 28days
Lean Concrete	fc=18Mpa	Compressive Strength at 28days
Steel Bar	fc=420Mpa	Grade 60

<Table 5.7-1> Specifications of materials of Tailrace structural

As for the construction method, the general concrete method should be applied. When the retaining wall is constructed at the same height, backfilling using selected pervious material is performed on the back side.

#### 5.7.2. Riprap

After the bottom concrete is installed, a riprap for river bed protection should be installed with a thickness of 800mm.

The slopes on both sides of the tailrace outlet should be paved as follows.



<Figure 5.7-4> Typical section of the revetment

The protection of riverbank slope starts at toe trench and proceeds upward.

## Required equipment is shown in the table below.

#### <Table 5.7-2> Reinforcement and protection Equipment

Work Item	Equipment	Capacity	Unit	Remark
Excavation Gravel laying Riprap Protection	Excavator Dump Truck	0.6m <sup>3</sup> 25.0ton	1 -	
Concrete Pavement Mixer Truck	Pump car Mixer Truck	21m <sup>3</sup> /min 6m <sup>3</sup> /min	1 -	

# 6. Architectural Works

- 6.1 General
- 6.2 Specifications by building
- 6.3 Equipment Mobilization Plan
- 6.4 Method statement for Building

## 6. Architectural Works

## 6.1. Overview

The construction work was planned in consideration of the convenience of managers and workers related to the operation of this project.

It is constructed to optimize the traffic line and work environment for efficient management of power house and control & admin building.

The scope of architectural works is following 8 buildings.

- Power House
- Control & Admin. Building
- Water Pump Shelter
- Packing Shed
- Guard House
- Switchyard control Building
- Measuring Gate Control House
- Penstock Control Valve chamber

## 6.2. Specifications by building

#### 6.2.1. Power House

The power house is 39.7m long and 15.3m wide, and is constructed with two basement floors and above ground. The underground structure is concrete and the above-ground is a steel structure. Also, the roof is sloped on both sides.

The elevation of the power house is as follows



<Figure 6.2-1> Front Elevation of Power House



<Figure 6.2-2> Left Elevation of Power House

The exterior finish uses thermal insulated metal cladding and the roof is THK. 100mm, the wall is THK. 75mm.

The figure below shows the interior finish schedule.



<Figure 6.2-3> Interior Finish Schedule of Power House

Power house's architectural work is constructed in parallel with civil work and M&E work, so it is necessary to manage interference between works.

## 6.2.2. Control & Admin. Building

Control & admin. building is adjacent to the power house and proceeds at the same time. Control & admin. building is 27.5m long and 15m wide, and consists of two floors of steel structure. Thermal insulated metal cladding is installed on the wall, and a single corrugated metal panel with a slope of 10% is installed on the roof.

The figure below shows the front and left elevation.



<Figure 6.2-4> Front Elevation of Control & Admin. Building



<Figure 6.2-5> Left Elevation of Control & Admin. Building

The building is a space for operation and maintenance work, and it is divided in consideration of the number of workers and work characteristics.

The layout of each room is as follows.



<Figure 6.2-6> 1st floor plan of Control & Admin. Building

The figure below shows the Interior Finish Schedule.



## 6.2.3. Water Pump Shelter

The water pump shelter is installed on the right side of the control & admin. building. The figure below shows the location of the water pump shelter.



<Figure 6.2-8> Water Pump Shelter of location

The scale of the Water Pump Shelter is 5m long and 3m wide, and the frame is a steel structure made of H-200X200x8X12 as the main material.

The roof is a single corrugated metal panel with a 10% slope and 1m overhangs on all sides.

The figure below shows the Water Pump Shelter of side Section and Front view.



<Figure 6.2-9> Side Section of Water Pump Shelter



<Figure 6.2-10> Front view of Water Pump Shelter

## 6.2.4. Parking shed

Two parking sheds are installed within the power house site. The figure below shows the location of the parking shed.



<Figure 6.2-11> Location of Parking Shed

Parking shed-1 is 24.3m long and 5.4m wide and can park 9 cars, and parking shed-2 is 16.2m long and can park 6 cars. The frame is a steel structure using H-200x200X8X12, and the wall is not constructed. The roof is installed with a single corrugated metal panel inclined in one direction.

The figure below shows the side section and front view of the parking shed.



<Figure 6.2-14> Front Elevation of Parking Shed

## 6.2.5. Guard house

Guard house has a concrete structure, 3m long and 1.8 m wide. The interior consists of a guard room and toilet. The exterior wall is finished with emulsion paint, and the roof is a one-way sloping roof with an overhang of 0.8m. The plane and cross section are shown in the figure below.



<Figure 6.2-15> Floor plan & Cross Section of Guard House

## 6.2.6. Switchyard control Building

The Switchyard Control Building is a one-story building with a concrete frame, and reinforced concrete of fck = 30Mpa and fy=420mpa is used. It is 12.5m long, 5m wide, and has an internal height of 4.2m.

The inside is composed of work shop & storage and battery room, and the electrical cable trench is installed lower than the floor in the control room.





#### <Figure 6.2-16> Floor plan of Switchyard control Building

The switchyard control building is finished with emulsion paint. The roof is constructed of single corrugated metal panels with a slope of 20%.

The figure below shows the specifications and finish of the switchyard control building.





#### <Figure 6.2-18> Cross Section of Switchyard control Building

The interior finish schedule applied to each room is as follows.



<Figure 6.2-19> Interior Finish schedule of Switchyard control Building

## 6.2.7. Measuring & Gate Control House

Measuring & gate control house for main dam maintenance is constructed on the left side of main dam as shown in the figure below.



<Figure 6.2-20> Location of Measuring & Gate Control House

Measuring & gate control house is a one-story building with a reinforced concrete structure, and the EDG area is a steel structure. The total length is 18m and the width is 5m. This building consists of battery room, elec. room, and HPU room. The length of the EDG area is 2.5 m.



<Figure 6.2-21 Ground Floor plan of Measuring & Gate Control House

The walls are finished with emulsion paint, and the roof is a single corrugated metal panel with a slope of 20%.



#### The figure below shows the front and side sections of the measuring & gate control house.







The figure below shows the interior finish schedule of measuring & gate control house.

	INTERIOR FINISH SCHEDULE									
			FLOOR	SKIRTING	WALL	CEILING				
FLOOR	ROOM NO	ROOM NAME	SPETID OF RED MOTINE STLL TROWL PRIME ACD RESEMA PAINT ACD RESEMA PAINT ACD RESEMA PAINT ACD RESEMA PAINT USUN RESERVANT ACTION PRIME DAMAGENERA TAL (ACT) PRIME DAMAGENERA TAL ACTIONE (PL-SUI) ACTIONE (PL-SUI)	door fame activity fame heren fau(nood) y.activ eneme heren	CALERT INC.         CHERT INC.           CALERT INC.         CALERT INC.           CALERT SCIENCE (SMMC TLLS)         CALERT INC.           CALERT COLORS)         PMC           CALERT INC.         CALERT INC.           CALERT INC.         CALERT INC.           CALERT INC.         CALERT INC.           CALERT INC.         CALERT INC.           LUCLO RESERVER TALLS         CALERT INC.           LUCLO RESERVER TALLS         CALERT INC.	ALCO ESCIPTE AVI. ANITE AVI. DATI WART ANITE(CLI-ANI) ANITE(CLI-ANIT ANITE(CLI-ANITE) ANITE AN				
GROUND FLOOR	1001	BATTERY ROOM	• •	• 100	•	• -				
	1002	ELEC ROOM	* *	• 100		• -				
	1003	HPU ROOM	••	• 100		• -				



## 6.2.8. Penstock Control Valve Chamber

The penstock control valve chamber is installed on the portal of power tunnel as shown in the figure below.



<Figure 6.2-25> Penstock Control Valve Chamber of Location

The Penstock Control Valve Chamber is 10m long and 10m wide and has a reinforced concrete frame. As shown in the picture below, the Penstock penetrates the building, and the roof has an internal open 6m wide and 3.6m long







The figure below shows the finishing work as the main section of the penstock control valve chamber.

<Figure 6.2-27> Penstock Control Valve Chamber of Main Section

#### 6.3. Equipment Mobilization Plan

The equipment mobilization plan for major buildings construction is as follows

<Table 6.3-1>Equipment Mobilization Plan

Equipment	Work Item	Capability	Quantity
Bending machine & cutting machine	Rebar Work	D10~D25	2
Cargo crane	All Work	2.5~5.0ton	2
Mobile Crane	Steel Structure	25~50ton	1
Concrete Pump Car	Concrete Work	80m3/hr	1
High Place Operation Car	External Finish Work	3.5~5.0ton	1
High Lander	External Finish Work & Steel Structure	3ton	1
Fork Lift	All Work	3.0~5.0ton	For each 1EA
Welding Machine	Steel Structure Work	3	

The equipment mobilization plan will be adjusted according to site condition

## 6.4. Method statement for Building

#### 6.4.1. Preparatory Works

Before construction of the buildings begins, hardcore base will be installed in the foundation ground.

The buildings' boundary will be confirmed and marked in the worksite. To confirm the correct building's boundary, the survey will be re-conducted after the lean concrete is poured.

The plan for the construction method and materials used will be submitted to the Engineer and approved. If necessary, inspection of the manufacturer will be carried out.

## 6.4.2. Frame Construction

- 1) Rebar Work
  - a) Storage
  - All reinforcing steel will be stored off the ground, and covered with polyethylene sheet or other suitable protective covering when they are to be stored outdoors for longer than two months. And reinforcing bars will be tagged and marked so that the specifications are clearly recognized.
  - b) Fabrication
    - Prepareing the BBS (Bar Bending Schedule) will be done by an experienced individual, and given an utmost regard to standards (i.e. development length S1, and lap lengths S2, S3 and proper splice locations) and suggested rebar arrangements as emphasized on the drawings.
    - Rebar will be prefabricated and delivered on site. Prefabricated rebar will be installed against forms on site as per the latest drawings.
    - Fabricated rebars in bundles will be marked properly with tags indicating the structure, drawing number, release number, mark number, shape code, bar diameter, length, grade and bar quantity.
    - Processed rebar will also be tagged to show number of bars, size and length.
  - c) Rebar Assembly
    - Any soil, mud, oil or other materials that may adversely affect or reduce the bond between the bar and the concrete will be cleaned.
    - Chairs will be used to support top mats of slab reinforcement or any structure with top and bottom reinforcement. The chair will have diameter sufficient to prevent any sagging of top reinforcement. Rebar will be cut, bended, and installed where splicing is permitted as per standard rebar arrangements. All connection points of the rebars will be firmly fixed so that the rebar does not move.



<Figure 6.4-1> Rebar Assembly

2) Form Work

- a) Installation of form
  - Formwork will be carried out by compling with the required shape, position, levels subject to the tolerances, and the standards of finish required by specification.Materials used in formwork will have no surface defects, and will be resistant to the action of cement and water, and will be cleaned and satisfactory reconditioned before being re-used.The faces of the formwork in contact with the concrete will be coated with non-staining shuttering oil.Special care will be

taken to ensure the cleanliness of formwork prior to concrete plaicng. Temporary openings will be provided in stop-ends for the removal of water and debris. The whole or part of the tie will be removed so that no part remaining embedded in the concrete is nearer the surface than the specified cover to reinforcement. Special care will be taken to maintain the stability of the formwork and tightness of joints particularly during vibrating operation.

- a) Removal of Form
- All formwork will be removed without shock or vibration so that concrete is not damaged. Forms
  will be removed after characteristic strength of concrete placed meets requirement in
  accordance with the specification.All formwork will be thoroughly scraped, cleaned, and
  repaired before being re-used.

3) Concrete Placing

- Concrete will be poured into its final position as soon as possible, and placed in such a manner as to avoid segregation of the concrete materials, displacement of formwork, re-bar and other embedded items, temperature rise, initial hardening, and cold joint.
- Maximum height of free fall for the concrete will be less than 1.5 meter to prevent segregation of the concrete materials.
- The concrete will be compacted throughout the full extent of the layer. Special care will be taken to prevent the formation of air bubbles against vertical or sloping formwork, and to avoid honeycombs. The power driven poker vibrators will be used to ensure that the concrete is satisfactorily and uniformly compacted.
- Concrete will be discharged within 1.5 hours after the mixing
- The laitance on the surface of concrete casted will be removed by compressed air or water jetting, and the surface will be roughened by chipping with rake. Special care will be taken not to crack concrete or loosen the aggregate. Before the concrete is placed, the surface will be cleaned by removing loose and foreign materials, and will be wetted thoroughly.

4) Concrete Curing

- Curing will be carried out while protecting against loss of moisture, rapid temperature change, rain and flowing water, mechanical damage, contamination by air borne dust, drying wind, and surface heating by the sun's rays. Curing will be carried out by keeping wet surface by sprinkling potable water for period required from the specification.
- Curing compound (membrane) will be sprayed if necessary. It will be used to the exposed surfaces immediately as soon as all free water has evaporated from the surface after placing, and be used to the formed surfaces immediately after form removal. (Only vertical surface need to be applied curing compound (not horizontal surfaces)).
- For moisture (water) curing, the concrete surface will be covered with hessian, sacking, or other absorbent material, etc. and will be kept constantly wet for required duration, also covered with plastic sheeting to reduce loss by evaporation. Curing materials for moisture curing should be overlapped with enough margins not to make gaps between the mortar ends.
- Covers will be used to protect against wind, and to minimize the effect to sunshine, and to be in close contact with the surface of the concrete.
- Water with a temperature that is as close as possible to the temperature of the cured concrete will be used for curing.

## 6.4.3. Lifting Work

Installation of the reinforcing bar and formwork will be carried out by using a mobile crane. Capacity of the general crane is 25~50ton, and the equipemnt will be used appropriately according to quantity of the material and lifting distance.

Since the external finishing work is carried out by the worker on the window frame and the gress, etc. a high place operation car with a working platform and a high lander will be used.

The high lander will be used instead of the mobil crane in the low floor frame construction.

## 6.4.4. Steel Structure

Structural Steel will be manufactured after notifying the Engineer of the manufacturing plan and verifying the manufacturing capability. And the Structural steel will be inspected at the fabrication site.

HEC will furnish to the Engineer a copy of all mill orders and certified mill test reports. Mill test reports will show the chemical analysis and physical test results for each heat of steel used in the work.

Where required by the Engineer, the certified mill test reports for steels with specified impact values will include the results of Charpy V-Notch impact tests in addition to other test results.

The working drawings below will be submission prior to performance of the work involved.

- Shop Drawings
- Erection Drawings
- Camber Diagram

Structural members will be marked so that each can be easily and clearly identified.

The structural material, either plain or fabricated, will be stored above the ground on platforms, skids, or other supports. It will be kept free from dirt, grease, and other foreign matter, and will be protected as far as practicable from corrosion.

The structural members will be loaded on trucks or cars in such a manner that they may be transported and unloaded at their destination without being damaged

Field connections of main members of trusses, arches, continuous beams, plate girders, bents, towers, and rigid frames will be preassembled prior to erection as necessary to verify the geometry of the completed structure or unit and to verify or prepare field splices.

Material to be stored at the job site will be placed on skids above the ground. It will be kept clean and properly drained. Girders and beams will be placed upright and shored. Long members, such as columns and chords, will be supported on skids placed near enough together to prevent injury from deflection.

During erection, segements of the structure will be supported in a manner that produces the proper alignment and camber in the completed structure. Cross frames and diagonal bracing will be installed as necessary during the erection process to provide stability and assure correct geometry.

When field assembly is carried out,

HEC will comply with the following.

• Set structural members to the lines and elevations indicated. Align and adjust the various members forming a part of a complete frame or structure before permanently fastening to the total structure. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

- Before assembly clean bearing surfaces and other surfaces which will be in permanent contact after assembly.
- Splice members only where indicated on Structural Drawings or where accepted by the Engineer.
- Do not enlarge unfair holes in members by burning or by the use of drift pins. Ream holes that need to be enlarged to admit bolts. Where a hole is required to be enlarged by more than 2.4mm- ream to and use next larger bolt size.
- Do not use gas cutting torches in the field for correcting fabricating errors in the structural framing unless accepted by the Engineer. Finish gas cut sections equal to a sheared appearance when permitted.
- The quality of field welds or bolting shall be the same as that performed in the shop.
- Erection bolts for welded connections shall be tightened securely and left in place during welding works. Upon completion of the connection, the erection bolts shall be removed, and the holes made good.
- Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint. Apply paint to exposed areas using same material as used for shop painting. Apply by brush or spray to provide minimum dry film thickness of 1.5 mils.

## 6.4.5. Exterior Finish Work

1) Transportation & Storage

Panels will be loaded either on truck platforms or in containers, and the floor of transportation means will be level, without any protrusion that might damage the panels,

The panel transported will be unloaded in a designated place with a flat and solid terrain that does not cause settlement by using a forklift or a crane.

When panels are stored, comply with the following.

- Support packages on wooden or polystyrene spacers width 200mm, every 1.00m
- Place packages slightly inclined (min. 5%), to allow for eventual infiltration and condensation water drainage.
- Maximum 2 or 3 packages will be stacked in height (as transported).
- Stored packages at sheltered places. If not possible, Protect them from rain and sun rays with rainproof membrane, ensuring, at the same time, adequate ventilation of the packages.
- Not expose the removable protective film of panels' surface to sun rays for prolonged periods.

In any case, removed within 45 days from panels' production date.

- 2) Roof and Wall Cladding Installation
  - a) Roof Cladding
  - b) When roof cladding is installed, safety measures will be implemented as per current regulations for working at height (parapets, anti-fall safety net, life line, etc.)
  - c) Workers installating roof cladding will wear bear hand gloves (cutting precaution) and footwear with soft soles in order avoid eventual panels' surface scratching and damaging.
  - d) When panel packages are lifted directly on the roof structure, unloading with crane instructions will be followed. In addition, a rope fixed on one package's end will allow for better handling (swinging rotation) of the package.
  - e) Packages will be placed on the roof purlins, close to the main trusses (load bearing structure), and distributed along roof's length, taking into consideration the installation direction
  - f) Packages will be secured on the roof structure against slipping and wind uplifting forces.

- g) Wall Cladding
- h) When wall cladding is installed, POSCO E&C will check that the project terrain along building's perimeter is smooth and even for the safe placement of panel packages on the ground, and for the safe movement of eventual elevated working platforms.
- i) Safety measures will been implemented as per current regulations for working at height (parapets, anti-fall safety net, life line, etc.)
- j) Panel packages will be distributed along the building facades to be clad, close to their installation position, in order to optimize individual panel's handling during installation works.
- k) In case of using a crane, a rope fixed on one package's end would allow for better handling of the package.

#### 6.4.6. Interior Finish Work

The finishing materials for the workshop are more functional, durable and efficient in maintenance due to its hard working environment. The interior for the administrative building is focused on comfortable and quality spaces.

The inner wall of the building is finished with emulsion paint on THK 18 cement plaster, and the ceiling is finished with acoustic ceiling tile or 2ply of gypsum board.

#### 6.4.7. Pipework and Accessories

All pipework shall be constructed of new pipes and accessories conforming to the dimensions shown on the Drawings and to the methods of construction herein specified and/or shown on the Drawings.

Cross-Connections and Interconnections

No Plumbing fixtures, special equipment, device, or piping, shall be installed which will provide cross-connection or interconnection between a distributing supply for drinking water or domestic water and a polluted supply or waste such as adrainage system or a soil or waste pipe so as to make possible the backflow or back siphonage of sewage or polluted water into the potable water supply system.

Layout

Give careful consideration to clearance under beams, over windows, etc. to provide maximum headroom in all cases and to the locations of lines and type of fittings used to obtain these clearances. Ascertain from the drawings the heights of all suspended ceilings and the size of all pipe shafts in which piping is to be concealed, and the location and size of structural members in and adjacent to all pipe shafts. In any case where insufficient room is provided for piping above suspended ceilings or in vertical shafts, obtained approval from the employer before any work is installed.

Installation

The Pipes shall be cut at right angle to the pipe axis, cutting shall be done with a hack-saw or other tools which may not cause any change in cut pipe diameter. Burrs on the interior and exterior surfaces at the cut end shall be eliminated and the surfaces of finished ends shall be smooth. The pipes shall be jointed only after chips and scraps are eliminated from the interior surface.

#### 6.4.8. Ductworks and Accessories

The requirements of the ductwork are as follow:

• Wherever necessary in ductwork, provide suitable access doors and frames to permit inspection, operation and maintenance of all valves, controls, fire dampers, automatic dampers, coils, filters, sprays, bearing, traps, or other apparatus concealed behind the sheet metalwork. Unless otherwise specified or shown on the Drawings, all changes in duct size shall be made in a gradual manner with a total angle of divergence not exceeding 15 degrees. Whenever possible, bends shall be made with an inside radius not less than the duct width in the plane of the bends, but where this is not possible due to space limitation, small radius bends with properly designed and approved turning vanes shall be provided.

• All ducts shall be cleaned internally before starting of fans. During installation, properly fitted

sheet metal covers shall be provided at all times to prevent ingress of rubbish. Rags, newspaper and like materials will not be accepted as a suitable covering. Doors in mixed air plenums and at humidifiers shall have 30 x 30cm (12" x 12") double glass inserts for observation of dampers and humidifiers without opening doors. Connections and Details; Connections to diffusers, grilles and register faces shall be absolutely air tight. Lined ductwork shall be of airway size as indicated.

• For installation of the seams of rectangular and round ducts, Groove and Pittsburgh lock seams and slip joints shall be used for all rectangular ducts unless otherwise specified. For kitchens and showers, exhaust ducts, soldering or seams with sealing packing shall be used. For PVC ducts, solvent welding shall be used. Rectangular ducts shall be connected with flange joints.

• Flanges shall be of welded angle steel, and the welding portion shall be of ground smooth prior to the punching work. The connected portion between the flanges shall be fitted with fire resistant tape to meet and be of the same width as the flange, and the outside surface of the plug joint, and both ends shall be inserted into the air duct for a length of not less than 25mm. After finishing the process, screw joint be made, followed by two windings of tape to duct.

• Suspension fittings and the support fitting of vertical shall be installed in accordance with the specified spacing. If the transmission of vibration must be prevented, any vibration absorbing material shall be attached.

#### 6.4.9. Air Conditioning System

The variable capacity, heat pump heat recovery air conditioning system will be a (Variable Refrigerant Flow) zoning system.

The system will consist of outdoor unit, multiple indoor units, and M-NET DDC (Direct Digital Controls). The sum of connected capacity of all indoor air handlers will range from 50% to 130% of outdoor rated capacity.

The outdoor unit will be a horizontal discharge, 208/230volt, single-phase unit. Each MULTI indoor unit or group of MULTI indoor units will be independently controlled.

# 7. E&M Works

7.1 Mechanical Part

7.2 Electrical Part

7.3 C&I part

7.4 HAVC

7.5 Fire Fighting

7.6 Water and Sewage

## 7. E&M Works

## 7.1. Mechanical Part

## 7.1.1. Turbine

#### 1) General

The turbine is of the vertical-shaft, single runner Francis with capacity of 5.3MW. It will be delivered to the project site in pre-assembled condition to reduce efforts and time of the on-site works considering transportation limitation and simplified foundation interfaces.

#### a) Specification

Major specification of turbine is shown in the table below.

Item	Descr	iption	Unit	Specifications	Remarks
1	Туре		-	Vertical shaft Francis Turbine	
2	Numbe	r of unit	set	3	
3	Rated turb	vine output	MW	5.3	
4	Rated e	fficiency	%	94.36 (3 unit operation at rated head)	
Б	Disabarga	Plant discharge	m3/s	19.0	
5	Discharge	Rated	m3/s	Unit         Specifications         R           -         Vertical shaft Francis Turbine            set         3            MW         5.3            %         94.36 (3 unit operation at rated head)            m3/s         19.0            m3/s         6.33            m         94.84            EL.m         73.00            rpm         600            rpm         1,110            nos         13            mm         955.0            mm         1,549.6            nos         19	1 unit
6	Net Head	Rated	m	94.84	
7	Turbine setting elevation		EL.m	73.00	
8	Rated speed		rpm	600	
9	Runaway speed		rpm	1,110	
10	Number of runner blades		nos	13	
11	Runner discha	arge diameter	mm	955.0	
12	Spiral casing inlet diameter		mm	1,135.5	
13	Pitch circle diameter of stay vanes		mm	1,549.6	outer
14	Number of stay vanes		nos	19	
15	Dimension of guide vanes (PCD)		mm	1,171.7	
16	Number of g	guide vanes	nos	20	

#### <Table 7.1-1> Specification of Turbine

#### b) Major Components

The turbine equipment consists of the following components for the 3-machine arrangement:

- ① Draft tube liner and elbow
- ② Draft tube cone
- ③ Spiral casing assembled with welded spiral plate sections, stay-ring with vanes, supporting feet with anchor material for embedding in concrete, top-cover, bottom cover, guide vanes, regulating mechanism with regulating ring and guide-vane servomotor
- ④ Turbine Runner
- (5) Shaft seal and balancing pipes
- 6 Generator support / skirt



<Figure 7.1-1> Typical arrangement of vertical shaft francis turbine

2) Site assembly and installation

The turbine will be installed in accordance with the following step.

- a) Step-1: Draft tube liner and elbow
  - 1 Assemble the jack screws of draft tube liner and elbow.
  - O Verify the status of piping on the pressure port and dewatering piping.
  - ③ Lower the draft tube liner and elbow on its supporting plates in its reserved part of civil.
  - ④ Bring the draft tube to its supporting plates in its reserved part of the civil engineering.
  - (5) Finalise the adjustment of position of draft tube elbow and liner (altitude, inclination, position according to 3 axes).
  - 6 Finalise the dewatering pipe connection.
  - $\ensuremath{\overline{\mathcal{O}}}$  Weld all the jack screws.
  - ⑧ Put the water stop (according the drawing TA) and make the formworks.
  - 9 Carry out the concreting while respecting the height of all concrete layers / stages.
  - 10 Check civil layout drawing in reference with turbine layout drawing.
  - ① Check new dimensions of the civil engineering.
  - 2 After concreting, dry and remove formworks.


<Figure 7.1-2> Turbine: Draft tube liner and elbow installation

- b) Step-2: Spiral case, upstream extension, pit liner and concreting
  - 1 Assemble the spiral case jack screws.
  - ② Place the spiral case equipped with test cylinder on its supporting plates in the reserved part of the civil engineering.
  - ③ Adjust spiral case position (altitude, inclination, position) in relation to the site marks.
  - ④ Put in place the turnbuckles.
  - (5) Clamp the spiral case using the tensioners.
  - 6 Put mobile flange in inverted position with seals (cylinders, frontal) on spiral case inlet.
  - ⑦ Put the upstream extension on mobile flange.
  - 8 Assemble all mounting bolts.
  - 9 Confirm spiral case position (altitude, inclination, position) with respect to site markings.
  - 10 Put in place the pit liner, if applicable.
  - (1) Verify the vertical position of pit liner and orientation position of access, if applicable.
  - 2 Verify vertical and horizontal position of input flange of spiral case (tolerance 0.5 mm/m).
  - <sup>(3)</sup> Verify horizontal position of spiral case distributor flange, generator side.
  - ${\scriptstyle \textcircled{14}}$  Verify horizontal position of spiral case distributor flange, draft tube side.
  - <sup>(5)</sup> Weld all the jack screws and finalise all pipes connections (e.g. drain pipes, balancing pipes, etc.).



<Figure 7.1-3> Turbine: spiral case, upstream extension, pit liner and concreting

- c) Step-3: Assembly of distribution in the spiral case
  - 16 Put the distributor fully equipped on the trolley
  - 17 Assembly of distributor fully equipped in spiral case.
    - ·Use specific site tooling.

·Check the orientation of distributor command lever vis-a-vis actuator support on spiral case.

·Assemble all mounting bolts.

- 18 Install distributor servomotor:
  - •Present the servomotor with its control rods on its support on spiral case.
  - •Connect the control rod to distributor control lever. Manoeuvre control lever to obtain a full opening of distributor.
  - Block the control lever in position.
  - •Open the cylinder up until it mechanically stops.
  - Determine thickness of the shim for full opening and machine it.
  - ·Check thickness of the machined shim.
  - •Put in place the machined shim.
  - ·Manoeuvre to confirm a fully open position.
  - Determine the thickness of closed thrust shim, check different gap as well as distributor stroke.
- 19 Finalise all pipes connexions, such as balancing piping.
- 20 Remove the trolley



<Figure 7.1-4> Turbine: distributor in the spiral case

- d) Step-4: Installation of generator on generator support skirt
  - 21 Lift the assembled Generator from service bay and lower it to the machine hall floor, align to place it on the generator support skirt welded on top of the spiral case.
  - 22 Place the generator on generator support skirt and check for generator shaft's axial position as well as the elevation of the shaft flange according the drawing.
  - 23 Make the formworks if required and carry out concreting while respecting supplier documentation.
  - 24 Check Civil Engineering according supplier documentation and drawing.
  - 25 Check the new dimensions of the civil engineering.
  - 26 After concrete drying, remove formworks.



<Figure 7.1-5> Turbine: generator support skirt

- e) Step-5: Assembly of runner and draft tube upper cone
  - 27 Lift and place the runner on the trolley and bring it under the distributor.
  - 28 Centre the runner in distributor labyrinths.
  - 29 Fit the runner on generator shaft with superbolt using specific site tooling.
  - 30 Remove the trolley.
  - 31 Put the draft tube upper cone on the trolley and place it under the distributor
  - 32 Fit and maintain the draft tube upper cone on the distributor with the specific site tooling.
  - 33 Assemble all mounting bolts.
  - 34 Remove the trolley.



<Figure 7.1-6> Turbine: assembly of runner and draft tube upper cone

- f) Step-6: Assembly of shaft seal
  - 35 Take into account the position of generator shaft.
  - 36 Check and confirm the runner and head cover labyrinth gap.
  - 37 Proceed to bearing installation according supplier documentation.
  - 38 Check and confirm the runner and head cover labyrinth gap.
  - 39 Proceed to shaft seal active parts assembling according supplier documentation.



<Figure 7.1-7> Turbine: assembly of shaft seal

- g) Step-7: Assembly of draft tube upper cone
- 40 Put draft tube upper cone equipped with wheels tool kit and place it under the distributor.
- 41 Fit and maintain the draft tube upper cone on the distributor with the specific site tooling.
- 42 Assemble all mounting bolts on upper cone.
- 43 Assemble all mounting bolts on lower movable flange.
- 44 Remove the wheels tool kit.



<Figure 7.1-8> Turbine: assembly of draft tube upper cone

# 7.1.2. Generator

#### 1) General

The generators will be synchronous vertical shaft type, directly coupled to turbine. totally enclosed, three phase, brushless, salient pole type. Cooling will be provided by closed circuit air to water heat exchangers located within the generator housing. Airflow will be provided using rotor mounted fans.

#### a) Specification

Major specification of Generator is shown in the table below.

<]	Γable	7.'	1-2>	Sp	pecifications	for the	generato	or

ltem	Description	Specifications
1	Туре	Brushless Synchronous Generator
2	Rated output	6 MVA
3	Rated voltage	11 kV
4	Rated power factor	0.9 (lag.)
5	Rated frequency	50 Hz
6	Phase	3 Phase
7	Rated speed	600 rpm
8	Runaway speed	1,110 rpm

ltem	Description	Specifications
9	Efficiency	97.39 (3 unit operation at rated head)
10	Mass moment of inertia (GD2)	36 ton-m2
11	Voltage regulation	+5% to - 5%
12	Short circuit ratio	>1.1
13	Type of construction	IM
14	Rotor construction	Salient Poles
15	Insulation class	Class F

## b) Major equipment

The generator equipment consists of the following components for the 3-machine arrangement:

#### <Table 7.1-3> Description of Generator Related Equipment

ltem	Description		
Generator	Vertical shaft, totally enclosed, three phase, brushless, salient pole type synchronous		
Excitation System	Brushless system, utilizing a rotating diode rectifier		
Neutral Earthing	Dry type grounding transformer and resistor		
Turbine Control Cubicle	Auto/manual synchronizing devices, synchronism check relays, breaker open/close switches, etc.		



<Figure 7.1-9> Typical arrangement of vertical shaft synchronous generator

#### 2) Site assembly and installation

The generator will be delivered to the site in disassembled condition considering transportation limitation and assembly of these disassembled components will be done at project site in accordance with the following step.

#### a) Step-1

- ① Lift the lower bearing bracket from service bay along with sole plate (if applicable)
- 2 Lower, position & align lower bearing bracket with generator interface part /cut-out in foundation



- b) Step-2
  - ③ For tilting & lifting steps of rotor complete
  - ④ Lift the rotor complete with flywheel, align it with respect to turbine centerline & lower the rotor on the lower bracket so that flywheel rest on brake jack
  - (5) After alignment & assembly of rotor complete remove the rotor lifting device
  - 6 Assemble the lower bearing housing & pads



## c) Step-3

- O Lift the stator complete as shown & place on the lower bracket assembly
- ⑧ Assemble stator complete on lower bracket assembly



- d) Step-4
  - ④ Lift the upper combined bearing bracket assembly as shown, aligned properly & place on the stator complete



## e) Step-5

- ${\scriptstyle \textcircled{10}}$  Assemble thrust head assembly on rotor
- (1) Assemble bearing component of upper bearing & rest of the lower bearing components



## f) Step-6

1 Assemble the exciter rotor on rotor complete



# g) Step-7

- (3) Assemble the exciter stator complete on upper combined bracket housing
- (4) Assemble rest of the components on generator



# 7.1.3. Main Inlet Valve

## 1) General

The type of main inlet valve is butterfly valve and placed just before the spiral casing in the water conductor system. It is used for normal operation and for isolating the unit in case of emergency and maintenance. Major specification of MIV valve is shown in the table below.

ltem	Description	Specifications
1	Type of main valve	Butterfly valve
2	Type of bypass valve	Slide valve
3	Number of unit	1 set / 1 unit
4	Diameter of main valve	1,200 mm
5	Diameter of bypass valve	150 mm
6	Design head	12 bar
7	Maximum discharge	6.33 m3/s (1 unit)
8	Method of operation (Opening)	Hydraulic oil system
9	Method of operation (Closing)	Counter weight

<Table 7.1-4> Specifications for the Main inlet valve



<Figure 7.1-10> Typical arrangement of Main Inlet Valve

2) Site assembly and installation

The main inlet valve along with the accessories such as by-pass valve, dismantling joint, etc. will be manufactured in the factory. Upon completion of manufacturing, the valve will be delivered to the site in pre-assembled condition and assembled with the accessories at project site in accordance with the following step.

- a) Step-1
  - $(\ensuremath{\underline{1}})$  Weld the upstream ring to the existing pipe acc dimension given above.
  - 2 Put studs/anchors with its washer and nuts into hole in foundation acc. dimension above.
  - 3 Fill space in holes by concrete or equivalent acc. civil engineering project



- b) Step-2
  - 4 Put levelling device with nuts, washer and sleeves on the foundation.
  - (5) Hang up the foundation plates on lifting slings
  - 6 Slowly lower foundation plates to levelling devices



## c) Step-3

- O Put levelling device with nuts, washer and sleeves on the foundation
- 8 Hang up the foundation plates on lifting slings
- (9) Slowly lower foundation plates to levelling devices
- 10 Screw nuts tightening torque given in the table



- d) Step-4
  - Insert both O-rings and to the grooves on flanges of butterfly valve BTV-B
  - 2 Insert all connection bolts in the UR flange
  - I Hang up the butterfly valve BTV-B on lifting slings
  - (1) Slowly lower butterfly valve BTV-B to foundation plate
  - 15 Remove temporary locking device



- e) Step-5
  - 16 Screw together valve's legs with foundation plate
  - 17 Use washer and nuts
  - 18 Torque acc. tightening table
  - 19 Screw together BTV+B valve and existing pipeline using bolts
  - 20 Insert O-ring to the groove on the flange
  - 21 Insert studs in the holes facing to the connections and lifting eyes
  - 22 Insert all studs in the holes of existing pipeline flange
  - 23 Hang up the dismantling joint on lifting slings
  - 24 Slowly lower dismantling joint on pipeline axis
  - 25 Install lever, using bolts and pins
  - 26 Install cover, plate, scale with all electric equipment



## f) Step-6

- 27 Screw together BTV-B valve with dismantling joint using nuts
- 28 Screw together dismantling joint with existing flange in the pipeline using nuts



- g) Step-7
- 29 Lower counterweight to lever (use its lifting eye)
- 30 Use studs, nuts to screw
- 31 Dismount yoke plate
- 32 Install servomotor
- 33 Mount yoke plate and tight/fix it using bolts and pins
- 34 Connect lever with servomotor by bolt, plate and screw
- 35 Connect hoses and fittings with servomotor and con.block
- 36 Insert locking bolt in the locking bolt hole



## h) Step-8

Install By-pass on the connection on BTV-B valve and acc. instruction



- i) Step-9
- 37 Install gate valve using studs, nuts and flat seal
- 38 Install welded section of the by-pass and distance ring using studs, nuts and O-ring
- 39 Install slide valve SLV using O-ring, studs and nuts
- 40 Install distance ring and O-ring.
- 41 Screw together by-pass with dismantling joint using studs, nuts, flat seal
- 42 Install reach rod system. Install support bearing on the concrete. Distance from the wall fit by adjusting plates supplied with support bearing



# 7.1.4. Overhead Crane

## 1) General

The overhead crane will be used for installation and maintenance of Turbine & Generator parts. The type of crane is overhead travelling bridge crane and the capacity of main hook crane is 50 ton and, the auxiliary hoist capacity is 2.5 ton. Major specification of overhead crane is shown in the table below.

<table 7.1-5=""> Specifications for the Overhead cr</table>	ane
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Item	Description	Specifications
1	Туре	Overhead travelling bridge crane
2	Classification	A-Standby Service
3	Number of unit	1 set
4	Capacity	main 50 ton, aux. 2.5 ton
5	Crane span	13.3 m
6	Length of travel	39.50 m
7	Lifting height Main hook	19.322 m
8	Method of speed control	Remote controller



<Figure 7.1-11> Typical arrangement of Overhead Crane

#### 2) Site assembly and installation

The overhead crane with the accessories such as girder, rail, beam, frame, hoist, etc. will be assembled at project site in accordance with the following step.



<Figure 7.1-12> Overhead Crane Installation Flow Chart

a) Step-1: Assembly Main Girder 1 and 2

Main Girder supplied in a part from vendor and need to be joint welded as per design drawing and vendor Specification. The welding joint must be 100% tested by Ultrasonic Test (UT). Assembly must be proceeded in temporary table which is flat, same level and stay still to avoid any changes of straightness and verticality during process fit-up and welding. Fit-up should be checked by quality control inspector and must built report before welding proceed and UT test after welding. The Welding Joint must be applied by touch-up painting as per Vendor Specification. The assembly procedure is as follow:



### b) Step-2: Installation Works

① Installation Travelling Rail

Traveling rail is Main rail for traveling a long both side of powerhouse. The main point for rail installation is the rail must be straight as per level elevation design from Vendor and distance between rail (rail Span), everything must follow dimension of the drawing. The installation procedure is as follow:



2 Installation Saddle Frame

Saddle will be installed on top of main traveling rail. Before installation, conduct site survey for rail to check straightness, verticality, level and bolt torque status. After finishing, installation of saddle frame can be proceed. Saddle frame will be installed and hang with temporary support to column of powerhouse building. Proceed the tack weld after verticality check by survey. This temporary support will make saddle frame stay still and ready for erection main girder.

## ③ Installation Main Girder 1 and 2

Main Girder will be installed after all sequence of assembly Main girder is completed. There 2 girders to be lift to upper of saddle frame.

Preparation is to move assembled main girder to position by mobile crane. Area of lifting main girder must be restricted for unauthorized worker.

## ④ Alignment Saddle frame, Main Girder

After both Main Girders are Installed, proceed with alignment with distance and dimension as per drawing and vendor specification. All bolt must be tightened and torqued as per vendor specification.

5 Installation Main Hoist Assy.

After alignment for main girder and saddle frame are finished, Main hoist shall be installed on top of main girder. Before proceeding installation of main hoist, main girder movement must be locked to avoid unpredictable crane range lifting.

6 Installation Platform and Walkway

Platform and walkway shall be installed after main girder and main hoist installation completely. Handrail, Grating and Toe plate by using connection bolt must be tighten. Damaged part on surfaces during assembly must be touch up painting as per vendor specification.

c) Step-3: Testing

The following test for overhead crane shall be done before certification. The details for each inspection item shall be discussed with the Employer later.

Item	Description	Specifications
1	Inspection of Structure and Dimension	Dimension specified in drawing and applicable standard shall be measured by proper means.
2	Load Test (MAX 100% load)	Hoisting is operated up and down and it will be tested several times under no load and operated with rated load without any problem
3	Current Check	The current shall be measured during operation of hoist under rated voltage and current
4	Hoisting Speed Check	During operation the speed measured under the rated voltage and current with acceptant standard specification
5	Traversing Test	The speed of traversing shall be measured during operation of hoist under rated voltage and current with acceptant specification
6	Traveling Speed Test	The speed of traveling main girders shall be tested during operation with rpm gauged and surface of rotating wheel with rated current. Acceptant standard for speed is specification
7	Limit Switch Operation Check	The limit switch on while testing hoist, traversing and traveling shall be checked during operation
8	Brake Test	Braking system shall be tested with rated capacity and must be correctly operated and no slip
9	Insulation Resistance Test	Measure the insulation resistance between each terminal and ground with acceptance standard over 5 $M\Omega$ measured with 500 V megger
10	Deflection Measurement of Girder	The maximum vertical deflection of the girder produced by the weight of the hoist, trolley and the rated load shall not exceed 1/888 of the span
11	Inching Test	Inching Test shall be tested with the rated capacity during operation and shall be checked if it is operated correctly and no slip
12	Over Load Test	Over Load Test is 125% from Max Capacity of this Crane Ton. As per Vendor Specification Is 50 Ton. All function must be tested with this weight without any problem on all part.
13	Protection Relay Trip Test	After completion of overload test, the overload protector must be reset in order to prevent hoisting when lifting overload capacity. According to standard, the overload protector is set to cut at about 110% of the nominal load
14	Operational Test	To confirm operational readiness and to ensure that the overhead crane meets operational requirement

<Table 7.1-6> Overhead crane testing procedure

# 7.1.5. BOP of Mechanical Part

## 1) General

Mechanical BOP (balance of plant) facilities consist of cooling, shaft sealing water supply system, drainage and dewatering system, compressed air supply system, oil separation system and etc. Major specification of Mechanical BOP is shown in the table below.

<table< th=""><th>7 1-6&gt;</th><th>Specifications</th><th>for BOP</th><th>Facilities</th></table<>	7 1-6>	Specifications	for BOP	Facilities
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Description	Туре	Num. of Unit			
Cooling and Shaft Sealing Water Supply System					
Cooling Water Pump	Horizontal centrifugal	2 sets (1 standby) / 1 unit			
Automatic Duplex Filter for cooling water system	Duplex type auto changeover & automatic backwash filter	1 set / 1 unit			
Cyclone Separator for Shaft Seal	Cyclone separator	1 set / 1 unit			
Duplex backwash filter Separator for Shaft Seal	Duplex automatic backwash	1 set / 1 unit			
Bare Tube Type Heat Exchanger	Bare tube type heat exchanger	1 set / 1 unit			
Drainage and Dewatering System					
Drainage Pump	Submersible motor pump	2 sets (1 standby)			
Dewatering Pump	Submersible motor pump	1 set			
Compressed Air Supply System					
Air Compressor	Piston & Cylinder Type, Reciprocating two stage oil	2 sets (1 standby)			
Pulsation Dampener	Inline mounted-Cylindrical Pulsation dampener	2 sets (1 standby)			
Air Dryer	Refrigerated type, Non-cyclic compressed air dryer	2 sets (1 standby)			
Coarse Air Filter	In line mounted air filter	2 sets (1 standby)			
Fine Air Filter	In line mounted air filter	1 set			
Compressed Air Tank	Vertical/Horizontal Steel Fabricated Cylindrical Air Vessel	1 set			
Filter Regulator & Lubrication unit	In line mounted air filter, Pressure regulator & lubricator unit	1 set			
Portable Air Compressor	Reciprocating Air Compressor	2 sets			
Oil Separation System					
Oil Separator	EIP (Effective oil interceptor plate pack)	1 set			
Oil Separator Pump	Vacuum self-Priming	2 sets			
Oil Skimmer	Floating type	1 set			
Separated Oil Storage Tank	Cylindrical	1 set			
Oil Filtration System					
Oil Filtration System	Off line portable oil filtration system	1 set			

## 2) Site assembly and installation

This is general method statement for installation of BOP facilities. The BOP facilities such as general equipment will be installed at powerhouse in accordance with the following step.

a) General equipment



b) Chemical anchor (General installation procedure)





c) Sleeve anchor (General installation procedure)



#### d) Bolting

- $(\ensuremath{\underline{1}})$  Cleaning of the threads and inspection for deformation
- Before assembling, remove rust-preventives, dust rust, and other foreign substance on the bolts and nuts and confirm that are free from any flaw, crush or any burr on the threads.
- ② Fitting before tightening
- Turn a bolt into a hole by hand till the bolt is fully inserted making sure of no excessive play or tightness of the inserted bolt. Then tighten the bolt with a spanner
- ③ Sequence of tightening for a number of bolts and nuts
- Tightening should be done in diagonal positions. Primary tightening should be done with a tightening torque of  $70 \sim 80\%$  of the prescribed value.
- e) Grouting
  - ④ Set the wooden forms on the area of foundation pit for the grouting
  - ⑤ Further, continually apply water on the surface of the normal concrete for more than 24 hours so that is held wet state, and then place the grout
  - ⑥ Forcefully push the grout by means of bar or vibrator so that the grout may go round even to the narrowest corner
  - ⑦ Pay attention for the temperature after grouting. The temperature is not supposed to be below 5 degrees centigrade. It takes more than 3 days for the setting period.

# 7.1.6. Gate

1) General

In this project, gates will be installed in four facilities: intake, scour outlet, diversion culverts, and draft tube outlet. This method statement describes the general installation procedure for the heaviest of these, the intake gate. Major specification of gates is shown in the table as below.

	Description		Specification
Intake	Gate	Gate	Type: Roller gate Quantity: Gate 1 / Guide frame 1 set Opening size: W 3.8 x H 3.8
		Lifting device	Type: Hydraulic cylinder + HPU Quantity: 1 (2 cylinders) set Lifting capacity: 50 (25 × 2) ton
	Stoplog	Gate	Type: Slide Gate Quantity: Gate 1 / Guide frame 1 / Lifting beam 1 set Opening size: W 3.8 x H 3.8
		Lifting device	Type: Electric hoist Quantity: 1 set Lifting capacity: 20 ton
	Trashrack	Screen	Type: Fixed steel bar screen Quantity: 1 set

#### <Table 7.1-7> Specifications for the gate

Description			Specification
			Opening size: W 6.3 x H 5.9
		Cleaner	Type: Overhead Trashrack Cleaner Quantity: 1 set Lifting method: Electric hoist + Hydraulic bucket
Scour Outlet	Gate	Gate	Type: Roller gate Quantity: Gate 1 / Guide frame 1 set Opening size: W 3.0 x H 3.0
		Lifting device	Type: Hydraulic cylinder + HPU Quantity: 1 (2 cylinders) set Lifting capacity: 50 (25 × 2) ton
	Stoplog	Gate	Type: Slide Gate Quantity: Gate 1 / Guide frame 1 / Lifting beam 1 set Opening size: W 3.0 x H 3.0
		Lifting device	Type: Electric hoist Quantity: 1 set Lifting capacity: 20 ton
Diversion Culvert Bulk Head Gate	Gate		Type: Slide Gate Quantity: Gate 2 / Guide frame 2 setOpening size: W 4.4 x H 4.4
	Lifting device		Mobile crane
Draft Tube Gate	Gate		Type: Slide Gate Quantity: Gate 2 / Guide frame 3 / Lifting beam 1 Opening size: W 2.039 x H 1.379
			Type: Electric hoist Quantity: 1 set Lifting capacity: 5 ton

## 2) Gate installation

The scope of works for Intake Gate installation includes installation of anchor plate, guide frame, lifting equipment, and electrical equipment from gate to local panel. The gate with the accessories will be installed at project site in accordance with the following step

#### a) Flow chart



- b) Step 1: Install Anchor plate
- 1. Survey for position of anchor plate
- 2. Fit-up the anchor plate to the marked position
- 3. Tie the embedded plate anchor plate with rebar tire wire. Set the anchor plate as level shown in drawing, check all plate anchor (must be level and flat). After all the plate are level, tack weld to make it stay still to its position.
- c) Step 2: Install Guide Frame
- 1. After civil handing over to mechanical, check all anchor plate straightness from concrete. If some bending is found, make it straight using hammer or heat it first with oxy acy flame, then make it straight.
- 2. Survey for position of anchor plate compare with design drawing of anchor bolt of Guide Frame.
- 3. Install anchor bolt and weld it to anchor plate. The position of guide frame will be adjusted by adjusting bolt and will be fixed by welding to anchor plate and bolting
- 4. Install Guide Frame Sill Beam part at lower position
- 5. Install Side Guide Frame; Main Track, Side Track, and Front Track
- 6. Install Guide Frame, Lintel Beam part
- 7. Install Upper Frame
- d) Step 3: Install Intake Gate
- Assembly each gate leaf block with accessories (side roller, main roller)
  Fit-up each gate leaf by bolting connection (If the gate is divided due to limit of transportation.)
- 2. Welding as per specification.

- 3. Non-destructive test (ultrasonic test)
- 4. Touch up paint on welding point.
- 5. Assemble the gate seal on the gate (bottom, side and top)
- 6. Install lubrication pipe (if the gate has)
- 7. Blowing the lubrication pipe by air compressor
- 8. Filling the lubrication pipe with grease
- 9. After completion above, proceed to lowering the assembled gate to the lowest position by mobile crane
- e) Step 4: Installation of lifting device and its accessories
- 1. Assemble and install each connecting rod from bottom (from top of gate)
- 2. Hold the end of connecting rod at top
- 3. Install block out & anchor pad for lifting device
- 4. Install bed frame and bracket with hydraulic cylinder
- 5. Place 2<sup>nd</sup> concrete on frame
- 6. Install the HPU in the operating room
- Install and connect the oil pipe between HPU and hydraulic cylinder (Before installation of oil piping, clean-up the oil pipe inside.)
- 8. Pulling cables to Local Panel of HPU
- 9. Termination of Power Cables
- 10.Dry test
- 11. Fill the oil inside of oil sump tank and do the Wet test

# 7.2. Electrical Part

# 7.2.1. 66kV Switchyard

## 1) General

The 66kV Switchyard is located about 300m north of the transformer yard. It is outdoor type switchyard, and will be accessed via new access road. The size of the 66kV Switchyard has been planned on the basis of the topographical conditions as well as a sufficient space considering the size and operation of power facilities. 66kV Switchyard has been planned to be wide 44m, long 33m in size. The cable wiring from the main transformer yard to 66kV Switchyard is connected to the 66kV Switchyard equipment through the duct bank. A gantry with insulator strings will allow the connection of the line bays to the 66kV outgoing line (two circuits) to 33kV Lungga diesel station located 24km away from Tina River hydropower plant

The main facilities are as follows

- · A 66kV Bus with bus section disconnector.
- Two of 66kV transmission line bays complete with circuit breakers, disconnectors, current transformers, voltage transformers and surge arrestors.



#### · A switchyard control building.

<Switchyard Structural Plan>

## 2) Installation

- a) Pre-assembly of the gantries and supporting structures.
  - Gantries and supporting structures are lattice works structures screwed together out of single component.



- The prepared and sorted steel parts are to be assembled according to the given stud torques on the drawings.
- If components must be re-worked (e.g. new bore holes), the resulting blanks surfaces have to be touched up with zinc-powder paint.
- b) Erecting of columns
  - After hardening of the concrete, the column should be mounted. The column consists of several pre-assembled components. Each individual component and the relevant item number shall be taken from drawings.
  - The column components can be assembled on the ground and subsequent erection of the complete column. The fixing screws of the main column leg are to be pulled tight only after the beams are fixed. The columns are shall be erected by means of crane.
  - Ensure one again that load capacity, height of the hooks, and arm length of crane already comply for columns erection.
- c) Fixing the gantry beams (girders)
  - The beams consist of several pre-assembled components and already screwed together on the ground same as the columns.
  - The proper measures for the gantries (from column to column) shall be taken from the drawings. Finally, tighten the fixing screws of the main column legs of the gantries.



- d) Erection the supporting structures for the MV units
  - Ensure for the actual erection location of the supporting structures for the MV units by the latest
    drawings
  - · The erection of supporting structures shall be done by mobile crane or crane.
  - Ensure the position of crane is as easy as possible to reach out and pick the steel structures up to installation location.
  - Tie each structure by webbing slings or sling belt and do not make any mistakes.
  - Lift up and swing slowly the steel structure toward the holes position of support base or holder and then lift down slowly to the sitting place, proceed to install bolt and tightened.
  - The longitudinal and transverse axis are aligned by means of a rope as a guide. The supporting structures have to be wedged tight on all 4 sides with squared timber and wooden blocks to prevent the supporting structures moving during grouting.
- e) Preparation for erection of MV equipment
  - Ensure the supporting structures are properly installed. Any unevenness can be rectified by means of shims/supporting washers
  - When the MV equipment are placed in position, care must be taken primary connections (e.g. current transformer connections P1 and P2) are in the right position.
  - The devices are bolted in position using torque wrenches, taking into account the strength class for each screw connection, in accordance with either the manufacturer instructions.
  - Screw connection on base plates, intermediate flanges and covers/terminal plates must be mechanically firm and must show minimal contact resistance.
  - When the individual units are joined, all flanges and connection surfaces must be cleaned with a steel brush (if necessary), making crisscross strokes, wiped with a clean cloth, and grease with acid-free vaseline.
  - · Ladders must not be leaned against the insulators/porcelain housings.
  - Lifting ropes must never be attached between the porcelain fins, as tight might damage the insulators, lifting chains, and steel ropes must not be used.
  - · Precise directions are given in the relevant operating/installation instructions.
- f) Erection of voltage transformer
  - Ensure the lower capacitor unit with attached tank (electro-magnetic unit) shall be transported and stored only in a standing position.
  - Ensure the upper capacitor unit shall be transported and stored in a lying position (note arrow on base)
  - Basic unit/tank must be lifted by crane onto appropriate supporting structure and the bottom of tank will be fixed in place by means of 4 bolts.
  - · The voltage transformer must be fastened to the crane hook by means of two ropes.
  - In the upper part of the capacitor unit a securing rope must be attached to the porcelain fins, in order to prevent tilting

• The upper capacitor unit with fitted cover cap must then be stood up from its lying position, lifted by crane over the assembled base unit and set down.



- The lifting lug on the cover cap of the capacitor unit may be used to lift only one capacitor unit (max. 500 kg).
- · Both units are then joined together by means of the bolts supplied by manufacturer
- g) Erection of current transformer
  - · Current transformers of the 66 kV voltage range are always transported in a horizontal position.
  - When the device is lifted out of the packing, care must be taken that the loop of the lifting rope (broad straps, E-round slings) is attached to the upper end of the insulator; the second rope is fastened to the transport lifting lugs on the tank.
  - After the current transformer has been lifted out of its packing, it is set down with the upper third of the insulator resting on a soft support.
  - The crane hook is then attached to the sling/strap at the top end of the insulator and the current transformer thereby lifted into an upright position.
  - Ropes can now be attached with hooks to the lifting lugs on the current transformer tank. The ropes must be secured with a further rope on the upper part of the transformer, to prevent the unit from tipping over.
  - The transformer must then be lifted by crane onto the appropriate supporting structure and fixed in place through the mounting holes in the tank by means of the bolts provided.



- h) Erection of the surge arrester
  - The surge arresters are supplied as individual modular assemblies, either in crates or boxes, depending on the stresses encountered in transport.
  - Surge arresters may be transported, stored and mounted only in a standing position. The longest modular assembly should be mounted as top unit.
  - · First of all, the bottom unit with the base flange is prepared for fixing.
  - Two transport ring eyes are screwed into the upper flange surface of the modular unit, two hemp ropes or slings with lifting lugs attached and the modular unit lifted by crane onto the supporting structure.
  - The modular unit is aligned by means of a spirit level (if necessary, place shims underneath) and bolted in position by means of the insulating bases/stubs and bolts provided.
  - The insulating tube must not be removed from the bolt. The top units are mounted likewise. The metal plate supplied must always be fitted between two modular units.
  - Before mounting and bolting the top unit, it is advisable to fit the high voltage terminal plate, the struts and the grading ring.
  - Finally, with the aid of an extension ladder/raised working platform, the transport lifting lugs are removed and the original bolts screwed back in. After mounting of the surge arresters, a surge counter may be fitted and connected between the lower flange and to ground.
- i) Earthing connections
  - Precise details for the earthing of high-voltage devices and steel components (supporting structures, gantries, switching station fencing, gate entrance, cable racks) are given in the drawings.
  - The earth terminals are produced with the aid of press-on cable lugs. The stranded conductor end is cleaned with a wire brush until the metal is bright, greased with acid-free Vaseline and the cable lug is then pressed on with the aid of a high-pressure press.
  - Care must be taken that the press dies fit the conductor cross-sections. The operating instructions of the HP press must be strictly observed.
  - The compression process is complete when the jaws have firmly closed and the overflow valve of the press has responded audibly.
  - For the earthing connection on switchgear devices, the earthing screws already provided by the manufacturer complete with spring and u-washers must be used.
  - The earthing connection point/screw point of the cable lug on the structure/device must be cleaned of paint and dirt and greased with acid-free vaseline.
  - The screw threads must be lightly greased with MolykoteTM. The washers are always applied on the cable lug side; on the rear side of the steel the strain washer is always fitted.
  - Contact washers under screw head and nut for earthing connection are not permissible in outdoor switchgear installations (danger of corrosion). The screws are tightened with a spanner in accordance with the installation instructions.



## j) Bolting

- · All nuts should be tightened properly using correct size spanners.
- Before tightening, it should be ensured that filler washer and plates are placed in relevant gaps between members, bolts of proper size and length are inserted and one spring washer is inserted under each nut.
- $\cdot\,$  It should be ensured that the threads do not fall on the members connected.
- The tightening shall be carried on progressively from the top downwards, care being taken that all bolts at every level are tightened simultaneously.
- Installation method of bolts and nuts for horizontal direction shall be from inside to outside (nut position is outside), and for vertical direction shall be from bottom to top (nut position is on the top)
- $\cdot$  The threads of bolts shall project outside the nuts by two to three threads.

# 7.2.2. Main Transformer

## 1) General

The main transformer is planned located on the left the powerhouse. It is an outdoor type transformer yard, and will be accessed via outdoor access road. The size of the transformer yard has been planned on the basis of the topographical conditions as well as a sufficient space considering the size and operation of power facilities.

The transformer yard arrangement consists of two 66/11 kV step-up transformers, solid grounded, surge arrester and cable support structures. Cables from units and equipment inside the powerhouse to power transformers installed in the transformers yard are planned to be installed on utility tunnel planned.



<Main Transformer Structural Plan>

2) Installation

- Main Transformer installation shall be met with the requirements in related specification and drawings.
- Main Transformer installation will be following below flow chart as the guideline for installation works.



<Transformer Installation Flowchart>

a) Unloading Main Body of Transformer to Foundation

Main transformer will be unloading by using slide rail and hydraulic double acting pump to move main body of transformer from lowbed trailer to permanent foundation.

To proceed unloading of the main body of main transformer, ensure the installation follow below steps:

• Arranging the h-beam, wooden box, and wooden plank as a support and correct elevation for slide rail.



<Arrangement of H-Beam, Wooden Box, and Wooden Plank>

 Arranging wooden box and wooden plank below lowbed to secure lowbed position during unloading the main body


<Wooden Box and Wooden Plank Arrangement Below Lowbed>

• Lift the main body of transformer using hydraulic jack that controlled by operator, and install the rail slide below the main body from lowbed to permanent foundation.



<Hydraulic Jack and Pump for Lifting Main Body of Transformer>



<Installation Rail Slide Below Main Body of Transformer>

• After rail slide already installed, move the main body of transformer from lowbed to permanent foundation using horizontal hydraulic jack. And ensure the centre position of main body during movement process.



<Horizontal Hydraulic Jack Arrangement>

• If the main body already set on position, lift down the main body using hydraulic jack again until top of foundation.



<Lift Down the Main Body Of Transformer on Top of Foundation>

b) Manifold & Bracket Assembly

After installation of transformer main body was finished than we could continue to assembly parts & accessories of main transformer, such as:

- $\cdot\,$  To assemble radiator, manifolds has to be assembled in advance.
- · Brackets for external accessory also has to be assembled in advance.



<Process of Bracket Assembly>

• Surface of manifold's flange or mounting has to be clean to prevent oil leakage.



<Make sure Manifold's Flange Clean to Prevent Oil Leakage>

- c) Radiator Assembly
  - $\cdot\,$  Before assemble radiator, please check valve status.
  - Because radiator is easy to be broken during lifting, operator of crane has to be experienced person.



<Assemble Radiator Using Crane with Carefully>

 $\cdot\,$  Surface of radiator's flange for mounting has to be clean to prevent oil leakage.



<Make sure Radiator's Flange Clean to Prevent Oil Leakage>

- d) Conservator Assembly
  - $\cdot\,$  Before assembling conservator, it needs to be tested
    - Oil Level Gage float condition check
    - Oil Level Gage Operation Test



- Air Seal Cell Pressure Test (0.1 kgf/cm2, hold 1 hour or more)

<Testing Before Conservator Assembly>

- $\cdot\,$  After check inside, then please assemble the conservator
- e) Bushing Turret and Bushing Assembly
  - · Before assembling bushing turret, CT need to be tested.
    - CT Ratio, Polarity Test
    - CT Insulation Resistance Test
    - Check CT's external appearance



<Testing of CT Before Bushing Turret Assembly>

- $\cdot$  The weather condition during turret assembly has to be sunny day.
- · Must be caution to let things fall.



<Process of Bushing Turret Assembly>

- $\cdot\,$  Before assembling the bushing, it needs to be tested.
  - Insulation Resistance Test
  - Power Factor Test
  - Check Bushing external appearance.



<Testing Before Bushing Assembly>

 In general, direction of bushing oil level gauge is as shown below (but always review the bushing manufacturer's manual and transformer's drawing to determine how the bushings should be oriented)



<General of Bushing Orientation>

 $\cdot$  For lifting the bushing from box, apply two clean lifting slings as shown below,



<Two Lifting Sling for Unloading Bushing from Box>

• Lift the bushing to vertical position and to angle according to the figures below. When lift it, use a soft bedding (e.g. rubber mat) under the bottom end of the bushing.



<Applied Soft Bedding when Bushing Assembly>

- f) Gas Pipe and The Other Accessory Assembly
  - Assemble remaining accessories of main transformers, such as gas pipe, protective relays, copper pipe, sampling device, ground cable, and surge arrester.



<Gas Pipe Material and Assembly Process>

- $\cdot\,$  When assemble gas pipe, do not assemble it as forced status.
- After finished for external assembly, the step can continue for internal lead connection that will explain detail below,
  - Check no. and type of tools bring in.

- Connect winding lead to bushing conductor (bottom connection, draw lead, and draw rod type)



<Bottom Connection Type>

## 7.2.3. MV & LC SWGR

- 1) General
- a) Electrical Equipment
  - ① Main and Auxiliary Supply System

Electrical facility of hydropower plant will be provided with a reliable, easy to operate and maintain AC auxiliary supply system consisting of 66kV Switchyard, Powerhouse 11kV MV system, Generator MV feeders, Station transformers, LV main switchboards, LV distribution boards, diesel generating unit.

Control and relay panel containing digital relays with communication systems complying with international standards will be provided. It will also contain accurate electronic meters for each machine that will communicate with the control and supervisory system. It will also include indicating meters (or a display) for voltage, current, active and reactive power for each machine and other meters or display indications including status indications, alarms and trips as needed to monitor the operation of the station.

b) Local Service Transformer

The Local service transformer will feed the auxiliary low voltage switchboard for the operation of different type of power station auxiliaries, essential services and DC supply for equipment protections. The proposed transformer is dry type and installed in the electrical room on the basement floor 1 of the power plant.

c) 11kV Medium Voltage Switchgear

The Medium Voltage Switchgear will be, 3-phase, 3-wire indoor heavy-duty type metal-clad switchgear. The operating voltage of the equipment will match the turbine generator voltage offered. The switchgear will be furnished complete with bus, draw-out vacuum circuit breakers, current and voltage transformers, surge protection equipment, terminal blocks, control wiring, and other miscellaneous devices.

d) Local Service AC Supply Systems

The 415V Local Service Switchboard will comprise two main bus sections each fed from one of the two local service transformers via an air circuit breaker.

The 415V Local Service Switchboard will also include a diesel generator bus section, located between the two main bus sections, and supplied from each main bus section via bus coupler air circuit breakers. In the event of the supply from one local service transformer failing, the supply will automatically switch to the second local service transformer.

2 415V Local Services Switchboards

The powerhouse local service switchboard will conform to the requirements of IEC 60439, as applicable to low-voltage, metal-enclosed, air-circuit-breaker switchgear. The switchboard will be designed for use on a 415/240V, 3phase, 4wire, 50Hz system. Although front panel operation of the switchboard will be possible, the switchboard will be designed to permit switching of all incoming and bus coupler air circuit breakers remotely from the station control system.

③ 415V Motor Control Centers

Each Unit will be provided with a Motor Control Center for supplying all motors and other 415/240V AC loads associated with the turbine, generator and ancillary plant. It will be possible to isolate all 415/240V AC loads to a particular Unit by isolating the associated MCC at the main switch. Each MCC will conform to the requirements of IEC 60439, as applicable to low-voltage, metal-enclosed, mold-case-circuit-breaker switchgear. The switchgear will be designed for use on a 415/240V, 3phase, 4wire, 50Hz system.

### 2) Layout Plan of Electric Room

Make the arrangement as the one considering maintenance movement line of flow in placing electricity room equipment and secure enough space for taking instruments and equipments in and out.

Also, secure space to prepare for future enlargement and plan by increasing convenience of operation and maintenance with centralization of power receiving and distributing facility.



#### 3) Installation

- LV & MV switchgear, panel, and cubicle installation shall be met with the requirements in related specification and drawings.
- Mark and line out the route of LV & MV switchgear, panel, and cubicle as per approved shop drawings with marking threads.
- LV & MV switchgear, panel, and cubicle installation shall be in compliance with the manufacture's instruction manual and recommendations and approved drawings.
- Supports shall be selected form the following types, to suit the site conditions as per approved drawing, such as: wall support brackets; cantilever arms; steel channels.

- · Crane with suitable capacity to lift the panel shall be used for placing the panels.
- Guides rope shall be used to prevent twisting and swinging of the unit once it has been lifted clear on the ground.
- The manufacture recommended minimum clearance shall be maintained at rear side of the panels, so that installation and maintenance works can be carried out.
- · Ensure that all opening carried out with the proper approved sealant.
- LV & MV switchgear, panel, and cubicle should be bolted to the floor with anchor bolts ensuring the assembly is horizontally and vertically in alignment.
- All fishplates to interconnect bus bars will be carefully installed after removing the appropriate cover plates.
- All connections will be torqued to the required figure as per the manufacture's recommendation.

## 7.2.4. 11 kV Distribution Line

## 1) General

Intake main system is supplied with electric power from powerhouse at downstream under normal condition One (1) 11kV distribution line will be run on electric poles constructed along the access road, and the main system will be power supplied through this Services line. Supplying the main systems with power will be achieved after lowering voltage to 415V through 100kVA distribution transformer installed in measuring & gate control house.



- 2) 11kV Intake Distribution Line Design Description
- a) Security Level and Design Wind Speed

The distribution line will be designed for a Region C, based on AS1170.2

### b) Line Maintainability

The design and construction of the line will provide for ease of maintenance and be optimised to ensure the maximum reliability and utilization of the line, while reducing the need for outages for maintenance.

c) Poles

Poles will have a minimum 11.5kN safe working load and minimum 16kN UTS. Poles will also be selected and installed in a manner suitable for the addition of underslung insulated LV conductors.

All poles shall be fitted with a warning sign approximately 1.8m above ground level.

Poles along roadways will include a reflective traffic marker on the side facing oncoming traffic.

Intake main system is supplied with electric power from powerhouse at downstream under normal condition One (1) 11kV distribution line will be run on electric poles constructed along the access road, and the main system will be power supplied through this Services line. Supplying the main systems with power will be achieved after lowering voltage to 415V through 100kVA distribution transformer installed in measuring & gate control house.

### d) Crossarms

The crossarms will be hardwood or galvanized steel type, with galvanized steel braces.

All support brackets and other ferrous parts other than stainless steel will be galvanized in accordance with AS 4680 and AS 1214.

e) Stay Wires

All stay wires, including deviation wires, will not obstruct roadways, walkways or accessways.

Stay wire will be manufactured to AS1222 "Steel conductors and stays - Bare overhead". All stays will include insulating ferrules. Stay anchors will be galvanized screw type.

### f) 11kV Conductor

The conductors will operate no hotter than 40 degrees C. coincident with the surrounding air being still and the ambient air temperature is up to 30 degrees C.

The maximum conductor tension will be no more than 50% of the calculated breaking load (CBL) for the selected conductor under serviceability limit conditions and no more than 90% under failure limit conditions. Lower conductor tensions may be used if necessary for vibration or clearance requirements.

### g) 11kV Insulators

Suspension insulators will be 12kV line post, composite type with silicone rubber sheds.

## h) 11kV Fittings

Fittings will be helical type in accordance with AS1154.3 "Insulator and conductor fittings for overhead power lines - Part 3: Performance and General Requirements for helical fittings".11kV Intake Distribution Line Design Description

## 3) Installation

- a) Method Statement
  - ① Flow Chart



## 2 Route Survey and land Clearing

Prior to the commencement of the 11kV Distribution Line and FO cable installation works, the coordinates will be surveyed, verified and set-out as per the related drawings.

③ Supply Materials, Fabrication and Erection

Based upon owner specification requirement of Installation the 11kV line, the pole length and other materials has been chosen according to the approved documents.

The supply comprises, of all materials as required for completion of work 11m long concrete pole, ACSR conductor, insulator, stay wire, binding materials, clamps, galvanized wire (ground wire), Fiber optic single mode cable, angle/channels, plates/clamps etc. it also includes fabrication of cross arms, bracing, clamps etc. as per approved design.

### **④** Working Preconditions

All necessary components such as plans, specifications, permits and other pertinent documents and drawings, equipment, tools and key personnel must be available at site before commencement of work.

All personel entering the site shall have received a site safety induction and have attended a toolbox meeting talk.

<sup>(5)</sup> Materials Receiving and Storage

Concrete Poles and other components are delivered bundled to the foreign construction sites.

Small accessories like screws, nuts, washers etc. are to be stored properly, so that rain cannot soften/soak and rot the packing.

To lift the concrete poles from the vehicle to the storage it should be done carefully to prevent from possibility of any damage to the body of poles.

Concrete poles shall be stored properly. ini order to prent from any damages.

Every material on site shall be received properly and inspected by every stakeholder in order to record and report the historical of material delivery especially related to the visual, quantity and specification check by using MRI (Material Receiving Inspection) form.

6 Distribution Line Construction Specification

· Construction of Line Pole with 0°-10° angle

This type of construction pole shall installed in  $0^{\circ}-10^{\circ}$  of distribution line angle with the arrangement of three (3) set post insulator and one (1) set cross arm.



· Installation of Galvanized Steel Wire (GSW)

Galvanized Steel Wire shall be installed aboved 11kV phase line in every point of Distribution pole refer to the approved drawing.

The arrangement of this construction consists of galvanized steel wire, support, stainless steel strap, stoping buckle.

Galvanized Steel Wire will be grounded by using 32 sqmm Bare Copper cable and Grounding Rod in every point that already decided refer to the approved drawing.

· Installation of Fiber Optic Cable

Fiber optic cable shall be installed below the 11kV phase line in every point of Distribution pole refer to the approved drawing.

The arrangement of this construction consists of 24 core single mode fiber optic cable, bracket support, stainless steel strap, tension clamp.

Stringing of fiber optic cable shall be done carefully to prevent any damages such as isolator damage or sharp bend. Maximum bending radius allowed during installation process is  $\ge 20 \text{ x}$  outer diammeter of cable.

## 7.2.5. BOP of Electrical Part

### 1) Lighting system

The system should have sufficient capacity to secure the safety from fault caused by short circuit.

The power system for the lighting system shall be designed to operate at proper voltage even under poor condition, and its standards are as follows.

- · 3-phase and 4-wire, 415V / 240V, 50Hz
- a) Lighting Requirements

All indoor / outdoor luminaires will be light emitting diode (LED) type with built in driver and control gear.

Generally lighting configurations for powerhouse area and dam area are shown below.

• Interior lighting in the powerhouse, switchyard control building, intake control building and dam galleries.

• Exterior floodlighting at the powerhouse, switchyard and intake.

• Emergency evacuation lighting at the powerhouse, switchyard control building, intake control building and dam galleries.

- · Auxiliary emergency lighting at the powerhouse.
- b) Illumination Level Standard

### <Table> Intensity of Illumination of each room

Indoor Areas	Intensity (Lux)
Control Rooms	500
Offices	400
Workshops	400
Powerhouse main level	300
Powerhouse lower levels	200
Lavatories and showers	200
Dam galleries	100
All other indoor areas	200
Switchyard Building	400
Outdoor Area	
Switchyard	50
Intake	50
Powerhouse stoplog platform	50
Parking areas	20
General areas near buildings and structures	10

## 2) Lightning & Grounding system

a) Grounding system Requirement

### 1 Power Station

The entire interconnected grounding electrode system at the power station shall be designed to provide a maximum 1.0 ohm resistance to earth. The power station 'switchyard' earth mesh shall extend 1.5 m outside the perimeter fences. The grounding mesh shall be designed to limit touch and step potentials to acceptable values. Grounding platforms shall be installed at all switch operators inside the switchyard.

### 2 66kV Switchyard

The grounding electrode system shall be designed to provide a maximum 1.0 ohm resistance to earth. It shall consist of earth electrodes inter¬connected by a buried mesh of bare copper grounding conductors. The switchyard earth mesh shall extend 1.5m outside switchyard fences. The grounding mesh shall be designed to limit touch and step potentials to acceptable values. Grounding platforms shall be installed at all switch operators inside the switchyard.

The 66kV switchyard and powerstation earthing systems shall be interconnected, but must meet the required resistance to earth criteria individually.

### 3 Dam, intake, penstock and penstock valve

The Contractor must design and install an effective grounding system that fully complies with the latest edition/version of all relevant standards, guides and recommended practices.

The entire interconnected grounding electrode system shall be designed to provide a maximum 1.0 ohm resistance to earth.

### (4) Instrumentation and Control

A separate instrument earth system is to be provided for the instrumentation and control systems.

b) Grounding system

5 Grounding Electrodes (Earth Rods)

Grounding electrodes shall be 3-m sectional type, copper clad with steel core, suitable for driving into the earth.

### 6 Grounding Electrode Conductors

The grounding electrode conductors shall form a grid of closed loops of 120mm2 (min) bare copper conductor (bar or stranded) embedded in the Project structures and buried in the adjacent areas for interconnecting the grounding electrodes.

### ⑦ Equipment Grounding Conductors

Grounding conductors used to interconnect the grounding electrode system to equipment and structures shall be bare, stranded copper cables. Grounding electrode conductors shall be sized on the basis of their ability to resist fusing and deterioration of electric joints under fault conditions. However, in order to ensure adequate mechanical strength of the interconnected grid, no conductor smaller than 50 mm2 shall be used for embedment in concrete or buried in earth.

All electrical equipment shall have at least two connections to the grounding system.

An equipment grounding conductor shall be attached to one side of each cable tray.

The size of equipment grounding conductors shall be adequate for the available short circuit ampacity.

### (8) Grounding Connections

An exothermic (welded) process, such as the "Cadweld" process, shall be used for making the following connections:

- $\cdot\,$  Grounding electrode-to-grounding conductor.
- $\cdot\,$  Between grounding electrode conductors within the grid.
- $\cdot\,$  Taps and splices of grounding electrode and equipment grounding conductors.

- · Grounding electrode conductor-to-equipment grounding conductor.
- · Equipment grounding conductor-to-embedded or buried building steel and metal.
- Equipment grounding conductor-to-crane rails.

Unless otherwise specified, exposed connections from equipment grounding conductors to equipment and structures shall be made using bolted type connectors suitable for the installation.

9 Fittings

Earth fittings and connections shall include:

- · Conduit grounding bushings.
- · Cable-to-pipe connectors.
- · Copper braid-to-pipe connectors.
- · Connectors for cable-to-bar and cable-to-flat structural steel surface connections.
- · Cable-to-tray connectors.
- · Armoured cable shall be earthed per regulatory requirements with grounding straps.

• Exposed grounding conductors connecting to grounding inserts shall be terminated with cable lugs.

c) Lightning system

10 General

Appropriate lightning protection is to be provided for all exposed phase conductors to be installed as part of this Contract. Lightning protection is to be provided for, but not limited to:

- · Powerstation.
- · 66kV switchyard
- · All 11kV overhead lines and exposed switchgear/control buildings

Any building or structure that may be reasonably considered to be at risk, based on the expected kauric level must be provided with appropriate lightning protection. The buildings will include, but not be limited to:

- · Power House.
- · Dam and intake.
- Penstock, surge chamber and penstock valve.
- 11 General Requirements

The basic materials and methods shall be in accordance with Section 2D - General Technical Specification.

### · Protection of Phase Conductors

The Contractor must identify and determine the set of shielding constraints which must be satisfied to achieve effective shielding against lightning for all of the phase conductors of the overhead transmission line and switchyard in relation to earth-wire placement.

Once the earth-wire(s) position has been determined to achieve effective shielding for a nominated critical lightning stroke current, the shielding of the phase conductors must still be maintained for stroke currents greater than the critical value.

An optimal shielding design is to be developed in which the cost function relating to earth-wire(s) position(s) is minimized subject to shielding constraints and specified clearance constraints

Protection of Buildings and Structures

Lightning protection for buildings and structures must be designed and implemented to fully comply with the requirements of AS/NZS 1768:2007: Lightning Protection if required by Law, or if there are no local requirements IEC/IEEE may be used.

## 7.3. HVAC

## 7.3.1. General

The HVAC & Sanitary plumbing systems design, equipment selection and operation shall be in accordance with the following codes and standards organized or their recognized equivalent, where applicable. The latest editions of all codes and standards pertinent at the design contract award date, shall apply in each case.

- ASHRAE : American Society of Heating, Refrigerating, and Air Conditioning Engineers Inc.
- ASME : American Society of Mechanical Engineers
- ASTM : American Society for Testing Material
- UPC : Uniform Plumbing Code
- SMACNA : Sheet Metal and Air Conditioning Contractors National Association, Inc.

All equipment shall meet requirements specified in material requisition and be suitable for installation at the site. Alignment and/or adjustment of HVAC equipment shall be in accordance with the manufacturer's instructions unless otherwise indicated.

The cooling capacity of the air conditioning shall be design for safety factor 10% min.

The HVAC equipment configuration of each location is shown in the table below.

Location	Applied HVAC System	HVAV Equipment Configuration
Control Room of Control & Administration Building	Cooling system	<ul> <li>Variable refrigerant flow type air conditioning unit(multi air conditioner &amp; inverter type)</li> <li>50% x 2sets Duty</li> </ul>
Office, Kitchen & Other Air Conditioning Aare of Control & Admin. Building	Cooling system	<ul> <li>Variable refrigerant flow type air conditioning unit(multi air conditioner &amp; inverter type)</li> <li>100% Duty</li> </ul>
Rack Room, Control Room , Elec. Room & Battery Charger Room	Cooling system	<ul> <li>Split type air conditioning unit or Variable refrigerant flow type air conditioning unit</li> <li>50% x 2sets Duty or 25% x 4sets Duty</li> </ul>
Kitchen, Changing/Shower Room, Toilet, Store, Smoking Room & Janitor	Exhaust System	• Wall or Duct In-line Fan •100% Duty
Guard Room	Exhaust System	Wall Fan for Toilet     100% Duty
	Cooling System	<ul> <li>Split typeair conditioning unit</li> <li>100% Duty</li> </ul>
Battery Room	Exhaust System	• Wall Fan • 50% x 2sets Duty
	Fresh Air Intake System	<ul> <li>Fresh air intake louvers on the external wall</li> </ul>
	Spot Cooling System	<ul> <li>Spot Cooling for worker (movable spot cooler type)</li> <li>50% x 2setsDuty</li> </ul>
Workshop	Fresh Air Intake System	<ul> <li>Fresh air intake louvers on the external wall</li> </ul>
	Exhaust System	• Wall Fan •100% Duty
Fire Fighting Doom	Fresh Air Intake System	•Duct In-line Fan & Fresh air intake louvers • 100% Duty
	Exhaust System	•Duct In-line Fan •100% Duty
EDG Room	Fresh Air Intake System	Fresh air intake louvers on the external wall

### <Table 7.4-1.>HVAC Equipment Configuration

Location	Applied HVAC System	HVAV Equipment Configuration
	Exhaust System	• Wall Fan •100% Duty
	Fresh Air Intake System	<ul> <li>Fresh air intake louvers on the external wall</li> </ul>
HPU Room	Exhaust System	• Wall Fan •100% Duty

# 7.3.2. Sequence of work



<Figure 7.4-1> Inland Transportation Route to Dam Site from Honiara Port

## 7.3.3. Construction Method

- 1) Exhaust Duct Work
  - a) Exhaust ductwork shall be designed following equal friction method. Friction loss rate shall not exceed 0.8 pa/m ~ 1.0 pa/m. Ductwork shall be constructed from galvanized sheets and made in compliance with ASHRAE HANDBOOK and SMACNA HVAC DUCT CONSTRUCTION standards.
  - b) Galvanized steel sheet (ASTM A653/A653M G90 (Z275) coating) shall be used for general ducts.

## <Table 7.4-2.> DUCT THICKNESS TABLE & TRANSVERSE (GIRTH) JOINTS

		DUCT T	HICKNESS			INTERME
Duct Size	GAGE NO.	GALV. STEEL SHEET THICK.	UNCOATED STEEL THICK	STAINLESS STEEL STEEL THICK.	TRANSVERSE JOINT TYPE	DIATE REINFOR CEMENT (ANGLE SIZE)
UP TO 750	24	0.70 MM	0.60 MM	0.63 MM	G, I, J, K, L, M, N, O, P, Q, R or S	25 x 25 x 3t
751 TO 1350	22	0.85 MM	0.75 MM	0.79 MM	G, I, J, K, L, M, N, O, P, Q, R or S	40 x 40 x 3t
1351 TO 2100	20	1.00 MM	0.91 MM	0.95 MM	J, K, M, N, O, P, R or S	50 x 50 x 6t
2101 TO OVER	18	1.31 MM	1.21 MM	1.27 MM	M, N, O, P, R or S	65 x 65 x 5t
OTHERWISE SPECIFIED	16	1.61 MM	1.51 MM	1.58 MM	-	-

## c) Duct Support

- Fabricate support according to size at construction workshop.
- Detail support for ducting work shall be appropriate with construction drawing or specification.
- Cut edges shall be finished by suitable disk grinder / tool and primer applied.
- Steel shall be economically used; scraps shall be
- Welded parts made on steel members shall be completely clean and free from slag and all other foreign matter, and be finished with rust inhibiting coat (touch up)
- Steel to be used shall be sized and selected properly so that the fabricated parts and components will have good appearances and sufficient strength.
- AC arc Welder shall be used as a rule
- Welding shall be completely cleaned of oil, paints oxides, water and all other Foreign materials.
- d) Duct Fabrication
  - Sizing and cutting galvanized steel sheet according to duct size layout as shown in construction drawing.
  - Cutting edges shall be finished by suitable tool properly.
  - The edge of galvanized steel sheet shall be folded by lock machine and joint each side to form a duct.
  - Companion flange for jointing duct shall be follow as per standard detail and project specification
  - The fabricated ducting must be sealed in every edges connection by duct Sealant / silicone.
  - After inspection, fabricated ducting shall be clean up to remove the dust before insulation and install spindle pin on the duct surface with adhesive rubber
  - The fabricated ducting shall be insulated with glass wool blanket to all surface and tighten it by spindle pin or as follow project specification
  - The insulation ducting shall be wrapped by aluminium foil and stick by aluminium tape or as follow project specification
- e) Duct Installation
  - Prepare equipment, tool and personnel protective equipment (PPE) being used and shall be meet safety standard requirements before starting the work.
  - All of necessary work permits (hot and cold permit), gate pass, etc, shall be obtained prior to start the work.
  - Scaffolding shall be available and installed below ducting layout. Make sure that scaffolding have been checked by safety and declare in safe condition
  - Install support firstly according to the construction drawing
  - Install ducting by put and lay it down on the support and connect companion flange one by one and sealed by rubber packing then tighten by bolts & nuts.
  - The connection will be insulate after inspection by WEN QC Inspector and Client Notified.
  - Dampers (motorized damper & Volume damper) shall be installed follows the drawing plan to know about position and direction and it's placed between companion flange and sealed by rubber packing, tightened by bolt & nut.

- Diffuser and Grille shall be installed follow the HVAC drawing lay out, fixed exactly follow ceiling plan properly.

# f) Duct Testing

<Table 7.4-3.>Duct Testing Procedure

<ul> <li>Permit shall be provide prior to start the work and attached HVAC Ducting layout drawing.</li> <li>The ducting line that will be tested shall be complete and inspected (all equipment are completely installed).</li> <li>Ensure that every duct connection are tightened and already given sealed with proper sealant.</li> <li>The internal ductwork will be test section by section. This is to identify easier the smoke leaking location.</li> <li>Ensure to fix the caps or other types of temporary seal at the end of duct before performing the smoke leak test.</li> <li>Prepare the mobile scaffolding under ducting line and make sure if the worker reach enough to catch the duct. wear a body harness to work at height</li> <li>Provide fire extinguisher and a fire watcher must be mandatory standby at testing area</li> <li>The instructions must be read carefully and the equipment handled in correct manner.</li> <li>The unit of duct leakage tester shall be placed and connecting to duct in the correct manner and as close as possible to the duct.</li> <li>Prepare test sheet and drawing layout.</li> <li>Left one hole not sealed at the end of duct line, and another hole connect to test apparatus with flexible round duct.</li> <li>Smoke Leak Test</li> <li>Smoke leak test will be carried section by section (per zone), and the test shall be maintain during about 15 minutes.</li> <li>Need to pay attention to take care of not to over delivering smoke from smoke generator to tester apparatus.</li> <li>The smoke from smoke generator will be delivered by inline fan drive trough flexible round duct</li> </ul>	ltem	Procedure
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Preparation          • The internal ductwork will be test section by section. This is to identify easier the smoke leaking location.         • Ensure to fix the caps or other types of temporary seal at the end of duct before performing the smoke leak test.         • Prepare the mobile scaffolding under ducting line and make sure if the worker reach enough to catch the duct. wear a body harness to work at height         • Provide fire extinguisher and a fire watcher must be mandatory standby at testing area         • The instructions must be read carefully and the equipment handled in correct manner.         • The unit of duct leakage tester shall be placed and connecting to duct in the correct manner and as close as possible to the duct.         • Prepare test sheet and drawing layout.         • Left one hole not sealed at the end of duct line, and another hole connect to test apparatus with flexible round duct.         • Smoke leak test will be carried section by section (per zone), and the test shall be maintain during about 15 minutes.         • Need to pay attention to take care of not to over delivering smoke from smoke generator to tester apparatus.         • The smoke from smoke generator will be delivered by inline fan drive trough flexible round duct         • The smoke from smoke generator will be delivered by inline fan drive trough flexible         round duct         • The smoke from smoke generator will be delivered by inline fan drive trough flexible         round duct	Preparation	Ensure that every duct connection are tightened and already given sealed with proper sealant.
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<ul> <li>Smoke Leak Test</li> <li>maintain during about 15 minutes.</li> <li>Need to pay attention to take care of not to over delivering smoke from smoke generator to tester apparatus.</li> <li>The smoke from smoke generator will be delivered by inline fan drive trough flexible round duct</li> </ul>		Smoke leak test will be carried section by section (per zone), and the test shall be
<ul> <li>Need to pay attention to take care of not to over delivering smoke from smoke generator to tester apparatus.</li> <li>The smoke from smoke generator will be delivered by inline fan drive trough flexible round duct</li> </ul>	Smoke Leak Test	maintain during about 15 minutes.
<ul> <li>to tester apparatus.</li> <li>The smoke from smoke generator will be delivered by inline fan drive trough flexible round duct</li> </ul>		• Need to pay attention to take care of not to over delivering smoke from smoke generator
• The smoke from smoke generator will be delivered by inline fan drive trough flexible round duct		to tester apparatus.
		I ne smoke from smoke generator will be delivered by inline fan drive trough flexible round duet
Closed & Sealing the hole after smoke reach the end of duct then observe and check		Closed & Sealing the hole after smoke reach the end of duct then observe and check
around at every duct connection.		around at every duct connection.
<ul> <li>In case of found any smoke appears from duct connection, must be marked and then</li> </ul>		• In case of found any smoke appears from duct connection, must be marked and then
cure & reseal (allow time to cure).		cure & reseal (allow time to cure).
Marked the leakage with colored paint obviously.		Marked the leakage with colored paint obviously.
Repairing shall be done after finding any leakage at flange connection	Repairing	Repairing shall be done after finding any leakage at flange connection
Usually leakage is found at flange connection and drive slip connection.		Usually leakage is found at flange connection and drive slip connection.
tighten holt & nut		tighten holt & nut
<ul> <li>In case of any leakage found at drive slip connection, check seal and then cure with seal</li> </ul>		<ul> <li>In case of any leakage found at drive slip connection, check seal and then cure with seal</li> </ul>
properly.		properly.
After successfully smoke test, insulation of duct connection shall be proceed immediately.		• After successfully smoke test, insulation of duct connection shall be proceed immediately.
• The smoke shall be emptied from the duct tester with exhaust fan by flowing out side		• The smoke shall be emptied from the duct tester with exhaust fan by flowing out side
Post Test building	Post Test	building
Cleaning around testing area and ensure ducting line was clean and tree from dust or     other foreign material		• Greaning around testing area and ensure ducting line was clean and tree from dust or
Ensure that no material or foreign material left in the duct		• Ensure that no material or foreign material left in the duct



General arrangement of smoke leak test will be arranged as shown in the illustration drawing

<Figure 7.4-2> arrangement of smoke leak test

## 2) Piping Work

- a) General
  - All materials, design and construction details of piping for HVAC system, its connections, valves, accessories and welding shall be in accordance with ASHRAE recommendations.
  - All piping shall be properly supported or suspended on stands, clamps, hangers & etc. of approved design that permit free expansion and contraction while minimizing vibrations.
  - All pipes passing through floors, walls, and partitions or hung to the ceilings shall be provided with sleeves (galvanized carbon steel) of approved design.
  - Refrigerant piping for air conditioning systems shall be of copper tube assembled with wrought copper fittings.
  - The piping size shall be recommended by the equipment manufacturer / supplier.
- b) Piping Material & Insulation
  - Materials and insulation used for pipe work are as follows.:

### <Table 7.4-4.>Piping Material & Insulation

Ріре	Piping Material	Insulation
Refrigerant Pipe	<ul> <li>Copper Pipe.</li> <li>ASTM B88 or Equivalent.</li> </ul>	Preformed Flexible Elastomeric     Cellular Thermal Insulation in
Condensate Drain Pipe	PVC Pipe.     ASTM D2665 or Equivalent.	accordance with C534, Minimum 25 mm thk.

Note: All piping outdoor environments shall be vapour sealed with aluminum cladding 0.4mm thickness

### 3) Pipe Sleeve

- Fabricate pipe sleeve according to size at construction workshop.
- Detail pipe sleeve for piping work shall be appropriate with construction drawing or specification.
- Cut edges shall be finished by suitable disk grinder / tool.
- Pipe to be used shall be sized and selected properly so that the fabricated parts and components will have good appearances and sufficient strength.
- c) Pipe Support
  - Detail support for piping work shall be appropriate with construction drawing or specification
  - Cut edges shall be finished by suitable disk grinder / tool and primer applied.
  - Steel shall be economically used; scraps shall be minimized.
  - Welded parts made on steel members shall be completely clean and free from slag and all other foreign matter, and be finished with rust inhibiting coat (touch up)
  - Steel to be used shall be sized and selected properly so that the fabricated parts and components will have good appearances and sufficient strength.
  - AC arc Welder shall be used as a rule.
  - Welding shall be completely cleaned of oil, paints oxides, water and all other foreign materials
- d) Pipe Fabrication
  - Prepare all Construction Drawing to be used in these works.
  - Check and prepare all tool, equipment and material to be used. New pipe material shall be used and deformed or rusted pipe material shall not be used.



<Figure 7.4-3> Oxygen Acetylene set

- PVC pipe, fitting, and the insulation material (for drain AC) shall be meet requirement as follow project specification.
- Copper pipe, fitting and the insulation material shall be meet requirement as follow project specification.
- Sizing and cutting all material according to Construction drawing.
- Cutting edges shall be finished by suitable tool properly.
- Insert copper pipe and PVC pipe into insulation tube according to each size.
- Use the material as economically as possible.
- Welded points made on copper pipe connection shall be completely clean and free from slag and all other foreign matter.
- e) Pipe Installation
  - All of necessary work permits (hot and cold permit) shall be obtained prior to start the work
  - To secure the fabricated materials safely while transporting to working area and to avoid any damaged and accident.
  - Install pipe support before installing the pipe to the wall or slab floor tightly.
  - Space between support shall be adjust or depending to the length of pipe and follow construction drawing, and standard drawing (approved).
  - Install copper pipe / PVC Pipe by jointing part by part according to pipe layout as shown in construction drawing.
  - Pipeline shall be tighten up to support by U bolt firmly
  - Brazed joints for copper pipe shall be completely clean and free from slag and all other foreign matter.
  - Solvent joints for PVC pipe shall be completely clean and free from slag and all other

## f) Piping Test

Step by step execution for leakage test for refrigerant pip as below :

- Ensure that the welds on joint pipe was finished and completed.
- Area of welds that will applied the leaks test must be clean, free from any dirt and other test material, welding that is sticking.
- Install a pressure gauge which is calibrated on the nipple that had been prepared in the pipe and make sure that it has been installed properly, and fasten so as not to leak.
- Input the Nitrogen by inject and control the pressure up to 302.5 Psi or 1.1 x 275 Psi (working pressure)
- Hold the pressure in 1 hours (for maximum checking of smooth leak) at the test pressure and during this time checking of welding line by means of providing liquid soap on the surface of the weld outer part of pipe.
- If there are indications of a leak at the weld, it will be seen the presence of air bubbles, then give the sign with metal marker to promptly corrected/repaired according to the repair procedure.
- Prepared reports and ask for approval and the designated supervisor.
- Acceptance Criteria : Leak testing with Nitrogen is acceptable if not found the presence of air bubbles and a decrease in the pressure gauge during an interval at the time of testing.

Repair Pipe : For the test results that are marked with the repair, repair is performed according to the welding / brazing repair procedures, which must then be carried out repeated pressure test.



<Figure 7.4-4> Sketch of Leak Test Installation

# 7.3.4. Main Equipment Installation

1) AC Split Duct Installation

- a) Indoor Unit
  - Electrical supply and installation is to confirm to local authority's (e.g. National Electricity Board) codes and regulations.
  - Voltage supply fluctuation must not exceed +/- 10% of rated voltage. Electricity supply line must be independent of welding transformers which can cause supply fluctuation.
  - Ensure that the location is convenient for wiring and piping.
  - For ceiling mounted models, locate a position where piping and ducting work can be kept to a minimum.Ensure that overhead supports are strong enough to hold the unit's weight. Position hanger rods and check for alignment with the unit. Check that hangers are secure and that the base of fan-coil unit is level in two horizontal directions.
  - Pipings : Do not use contaminated or damaged copper tubings. If pipings, evaporator or condenser are exposed or had been opened for 15 seconds or more, vacuum and purge with field supplied refrigerant. Generally, do not remove plastic/rubber plugs/caps from fittings, tubings and coils until ready to connect suction or liquid line into fittings.
  - Operational Check : After all electrical wiring is completed and the system is charged with refrigerant, make sure unit is operating properly.
  - Electrical Connection : As wiring regulations differ from country to country, please refer to your LOCAL ELECTRICAL CODES for field wiring regulations and ensure that these are complied with.

b) Location For Installation Of The Condensing Units

As condensing temperature rises, evaporating temperature rises and cooling capacity drops. In order to achieve maximum cooling capacity, the location selected should fulfill the following requirements:-

- Install the condensing (outdoor) unit in a way such that hot air distributed by the outdoor condensing unit cannot be drawn in again (as in the case of short circuit of hot discharge air). Allow sufficient space for maintenance around the unit
- Ensure that there is no obstruction of air flow into or out of the unit. Remove obstacle which block air intake or discharge.
- The location must be well ventilated, so that the unit can draw and distribute plenty of air thus lowering the condensing emperature.
- A place capable of bearing the weight of the outdoor unit and isolating noise and vibration.
- A place protected from direct sunlight. Otherwise use an awning for protection, if necessary.
- A place where the hot air discharge and operating sound level will not annoy the neighbours.
- The location must not be susceptible to dust or oil mist.
- c) Field Piping

To ensure satisfactory operation and performance, the following points should be noted for the field piping arrangements of the complete refrigerant cycle.

- Liquid loops or oil traps must be provided according to the position of the outdoor and the indoor units (depending on whether the indoor unit is above or below the outdoor unit).
- Field supplied filter dryer should be provided as close to the expansion valve(s) of the indoor unit (evaporator) as possible.
- Field supplied sight glass must be assembled and mounted next to filter dryer.
- 2) AC Floor Standing Installation
  - a) Indoor AC Unit
    - Electrical supply and installation is to confirm to local authority's (e.g. National Electricity Board) codes and regulations.
    - Voltage supply fluctuation must not exceed +/- 10% of rated voltage. Electricity supply line must be independent of welding transformers which can cause supply fluctuation.
    - Ensure that the location is convenient for wiring and piping.
    - Piping : Do not use contaminated or damaged copper tubing. If piping, evaporator or condenser are exposed or had been opened for 15 seconds or more, vacuum and purge with field supplied refrigerant. Generally, do not remove plastic/rubber plugs/caps from fittings, tubing and coils until ready to connect suction or liquid line into fittings.
    - Operational Check : After all electrical wiring is completed and system is charged with refrigerant, make sure unit is operating properly.
    - Electrical Connection : As wiring regulations differ from country to country, please refer to your LOCAL ELECTRICAL CODES for field wiring regulations and ensure that these are complied with.
  - b) Location For Installation Of The Condensing Units

As condensing temperature rises, evaporating temperature rises and cooling capacity drops. In order to achieve maximum cooling capacity, the location selected should fulfill the following requirements:-

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- The location must be well ventilated, so that the unit can draw and distribute plenty of air thus lowering the condensing temperature.
- A place capable of bearing the weight of the outdoor unit and isolating noise and vibration.
- A place protected from direct sunlight. Otherwise use an awning for protection, if necessary.
- A place where the hot air discharge and operating sound level will not annoy the neighbours.
- The location must not be susceptible to dust or oil mist.
- c) Field Piping

To ensure satisfactory operation and performance, the following points should be noted for the field piping arrangements of the complete refrigerant cycle.

- Liquid loops or oil traps must be provided according to the position of the outdoor and the indoor units (depending on whether the indoor unit is above or below the outdoor unit).
- Field supplied filter dryer should be provided as close to the expansion valve(s) of the indoor unit (evaporator) as possible.
- Field supplied sight glass must be assembled and mounted next to filter dryer.
- 3) Fan Unit Installation
  - a) Preliminary Site Survey
    - Electrical supply and installation is to confirm to local authority's (e.g. National Electricity Board) codes and regulations.
    - Voltage supply fluctuation must not exceed +/- 10% of rated voltage. Electricity supply line must be independent of welding transformers which can cause supply fluctuation.
    - Ensure that the location is convenient for wiring and piping
  - b) INSTALLATION OF WALL FAN / CABINET FAN
    - Cut and frame the appropriate wall opening. Fans mounted to a wall require a different wall opening than fans mounted in cabinets or sleeves. For specific dimensions, refer to the submittal drawing for the specific fan configuration.
    - Mount the fan in the opening with the fan panel directly over the load bearing support and if this is not practical angle supports must be provided to transfer the fan weight to the load bearing structure.
    - Caution: The fan contains rotating parts and requires electrical service. Appropriate safety precautions should be taken during installation, operation and maintenance.
    - A damper, if used, should be securely mounted in a manner that allows free and unobstructed operation.
    - Prior to wiring ensure the power supply is locked in the OFF position and that the motor nameplate voltage and the supply voltage match.
    - Be sure to keep all wiring clear of any rotating parts.

- Before starting the fan, ensure that the wheel rotates freely.
- Tighten all nuts, bolts and setscrews prior to fan start up (as some may have loosened during shipping).
- On belt driven fans make sure that the belts are tensioned and aligned correctly.
- Ensure that all protective guards and other safety devices are installed properly prior to fan start up.



<Figure 7.4-5> WALL FAN and CABINET FAN

## c) INSTALLATION OF CENTRIFUGAL FAN

The best means of floor mounting a fan is on a well-designed, flat, level concrete foundation. The foundation should have a mass of at least three times that of the supported assembly.

The mounting surface of the foundation should be smooth for good shim contact. When deciding the thickness of the foundation, approximately 25 to 40mm height should be allowed for shimming,

grouting, levelling, washers, nuts, etc. If a structural steel base or platform is to be used, the structure must be designed for the weight of the fan, live loads imposed by rotation of the rotor and driver, and any external live loads.

Isolating the fan from ductwork with flex connections eliminates transmission of vibration. When possible, ductwork shall be located where there is least risk of personnel tripping, walking into or falling

over the ductwork. If not possible, warnings shall identify this hazard.

Fans should be installed where they are readily accessible to maintenance personnel, so that such

personnel are not required to stoop or crawl to access fans

The centrifugal fan installation method is as follows.

- Move the fan to the final mounting position.
- Remove skid, crates and packing materials carefully.
- If vibration isolation is to be used, place isolation base on mounting bolts. Line up holes in fan base with bolts as indicated on the foundation plan of the customer submittal drawing.
- Consult each specific fan's submittal drawing for proper installation arrangement and mounting dimensions. Place the fan on mounting structure. Carefully level the unit (checking the level on the shaft) on the foundation and shim as necessary using stainless steel shims on both sides of each anchor bolt. Anchor bolts are to be pre-tensioned, check with bolt manufacturer for the proper torque.

- Check the alignment of the bearings. Shim or reposition the bearings if necessary. In many split housing roller bearings, the gap between the seal carrier and housing can be measured with a feeler gage. The variation in this gap should be less than half of the maximum gap measured. In roller bearings where this gap is not visible, alignment can be verified by verifying the bearing is square with the pedestal top
- Check face alignment of sheaves on belt driven fans. Parallel alignment should be within 5mm per meter of centre distance. Angular Misalignment should be less than 1 degree. Check and record tension of belts to see if it is sufficient. Proper belt tension is specified on the included datasheet
- Check alignment of factory mounted couplings, as they are subject to misalignment during shipment. Realign if necessary in accordance with the instructions.
- Check alignment of factory mounted couplings, as they are subject to misalignment during shipment. Realign if necessary in accordance with the instructions,
- Make sure there is no rubbing or binding and that the wheel-inlet cone or wheel to fan housing clearances and overlap are correct.
- Check the tightness of the wheel on the shaft. See taperlock data sheet. The measured torque should be recorded.
- Check the tightness of foundation bolts, motor mounting bolts, and bearing mounting bolts.
- Check that bearings are fully lubricated.
- Install any accessories shipped loose from the factory.
- d) Pre Start Inspection

Pre Start Inspection is conducted as follows

- Lock out all power sources
- Inspect all fasteners and set screws and tighten as required
- Inspect belt alignment and tension
- Confirm power source voltage and motor voltage are the same and that the motor is wired correctly
- Rotate the fan blade to ensure that neither the fan blade nor the belts come into contact with the housing
- Inspect the fan and the ductwork to ensure they are free of debris
- Check to ensure that all guards and accessories are securely mounted
- Check to be sure the propeller rotation is correct
- e) Start Up

Turn the fan on and inspect for the following.

- Direction of rotation
- Improper motor amperage
- Excessive Vibration
- Unusual Noise
- Improper belt tension or alignment If a problem is discovered shut off the fan and refer to the section on troubleshooting to discover the cause of the problem. The fan should be inspected after 30 minutes, 8 hours and 24 hours of operation to ensure all fasteners are tight and belts are properly tensioned and aligned.

### 4) HVAC Control System

The following HVAC equipment shall be monitored (on/off status & common fault) by SCADA System (By C&I work)

- Split type air conditioning units for electrical rooms & battery room of power house.
- Split type air conditioning units for rack room of control & administration building.
- Variable refrigerant flow type air conditioning units for control room of control & administration building.

## 5) Sanitary Plumbing System

The requirements of the Sanitary Plumbing System are as follow:

- Potable & Hot water pipe shall be applied to CPVC (ASTM F441) pipe or Equivalent.
- The connection method of CPVC pipe and/or fitting shall be applied with solvent cement and thermal (heat) welding.
- Drain and soil pipe work shall be applied to polyvinyl chloride (PVC, ASTM D2665) material Also, drain & soil pipes shall be provided uniform pitch of 1/100 to 1/150 slope for horizontal pipe lines.
- Vent pipe work shall be applied to polyvinyl chloride (PVC, ASTM D2665) material
- All pipes passing through floors, walls, and partitions or hung to the ceilings shall be provided with sleeves (galvanized carbon steel) of approved design.
- Water Closet should be applied to white-glazed vitreous china with solid plastic seat, complete with deodorizer and drain trap & flushing facility.
- Urinal should be of wall mounted type, single unit, white-glazed vitreous china, complete with flushing valve, drain trap and flushing facility.
- Lavatory should be applied to white-glazed vitreous china, front overflow with integral soap dish. It should be provided with drain trap, chromium plated faucet / tap and rubber stopper.
- Eye Wash should be applied to Movable eye wash type (Self-Contained Gravity Fed Unit) for proper operation to ensure compliance to ANSI Z 358.1 standard. Also, units are designed for mounted on a transport cart, as well as a stand-alone unit on shelf.

# 7.4. Fire Fighting

## 7.4.1. General

This method statement is as a guidance for Fire Protection System installation. All the activities shall be carried out in a safe manner during the whole working period according to construction drawings, work specification and schedule.

The scope of work is as described bellowing.

- Hydrant system
- Water Spray System.
- HFC System.
- Fire Extinguisher System.
- Detection system.

The Fire Fighting System will be installed in the following buildings:

- Power House
- Control & Administration Building
- Switchyard Control Building
- Measuring & Gate Control House

- Guard House
- Water Pump Shelter
- Parking Shed

## 7.4.2. Manpower

The following personnel will be involved to carry out the works;

- Site Manager : 1 Person
- Mechanical Supervisor : 1 Person
- Electrical Supervisor : 1 Person
- Fitter : 30 Person
- Welder : 1 Person
- Safety Coordinator : 1 Person

# 7.4.3. Equipment List

## <Table 7.5-1.> Equipment List

ltem	Equipment & Tools
Equipment	Light Truck Mitsubishi Fuso Cap. 5 Ton     Mobile Crane 25 Ton
Rigging Tools.	<ul> <li>Webbing sling 100mm x 4m (4 Ton)</li> <li>Webbing sling 50mm x 4m (2 Ton)</li> <li>Chain Block Cap. 2 Ton</li> <li>Chain Block Cap. 3 Ton</li> </ul>
	• Shackle 3/4
Fitter Tools	<ul> <li>Hydraulic Jack 5 Ton.</li> <li>Grinding Machine 4".</li> <li>Cutting Machine 7".</li> <li>Shims Plate.</li> <li>Welding Tools.</li> <li>Combination Wrench.</li> </ul>

## 7.4.4. Main building Equipment Location & piping scheme

1) Power House



<Figure 7.5-1> Fire fighting Equipment Location for ground floor



<Figure 7.5-2> Fire fighting piping scheme for ground floor

a) Control & Administration Building



<Figure 7.5-3> Fire fighting Equipment Location for ground floor



<Figure 7.5-3> > Fire fighting piping scheme for ground floor

## 7.4.5. Work Procedure

- 1) Hydrant System (Indoor/Outdoor)
  - a) Pipe installation procedure
    - Installation of sleeper support
      - Install the previously printed sleeper support at the center point of the work floor. Sleeper support size 40x40x20cm.
      - Check the flatness of the sleeper sitting position against the work floor using a water pass.
      - Position the packed rubber packing into the first pipe flange to the next pipe flange.
      - Connect the flange between the first pipe to the next pipe with the nut and bolt tighten using a pipe lock.
      - Before the pipe is installed, make sure the pipe is coated with bitumen. And when the process of moving and lifting the pipe should be noted that the bitumen layer of the pipe is not scratched because the factor is scratched foreign objects. Pipes are removed manually (± 6 8 workers). Or with the help of heavy equipment using a ceiling cord tied to the ends of the pipe.
    - Mounting Bracket Support Installation
      - Make a dyna bolt hole with a concrete drill on the side pile to fit that size specified in the technical drawings.

- Position the hole in the bracket against the dyna bolt holes that have been made.
- Install the bracket with myrrh and dyna bolt to the side pile wall.
- Fasten with wrench and assisted screwdriver.
- Lift the pipe manually then put the pipe and positioned on the center U Bolt.
- Put U Bolt with nut and bolt using spanner.
- Install the next mounting bracket support and put the distance between mounting brackets 2.5 meters.
- Position the packed rubber packing into the first pipe flange to the next pipe flange.
- Connect the first pipe flange to the next pipe with nut and bolt. Tighten it using a pipe lock.
- Pipe Installation
  - Pipes are removed manually (± 6 8 workers). Or with the help of heavy equipment with ceiling cord tied to the side of the pipe.
  - Before joint the pipes, ensure that the elevation of pipes is center.
- b) Underground Pipe Installation Procedure
- Preparation of Elevation and Work Floor
  - Perform the measurement of pipe installation coordinate points based on the image per excavation segment.
  - Make sure the depth of the excavation has reached the pipe elevation height of the pipe is 1, 2 meters, measured from the elevation 0 ground to the center point of the pipe.
- Land Improvement and Flooring to work.
  - Construct and smooth the excavated soil using a stamper.
  - Layered soil with sand 1cm thick, length x width = 50x50 cm.
  - Cover again with mortar (sand, cement) as thick as 4cm, length x width = 50x50 cm.
  - Marking the height of the center level of the pipe to the level 0 of the ground and the center point of the work floor is measured from the working floor surface with weighing and weighing hose patterns.
  - Make sure the marking results are in accordance with the pipe depth size. Minimum drying time of working floor half day with bright weather factor.
- Plant Pipe Hoarding

After the mold is trust block / encased concrete dry. Apply a 5cm thick layer of sand to the support area. Then close the digging pits with heavy equipment

- c) Hydrant Pillar Hydrostatic Test
  - General

These are the following conditions that will be applied and achieved in the pressure test procedure: The pressure test procedure will be performed as a test of the above & underground pipe. Procedures pressure test will be conducted to ensure that the pipes and fittings are in good condition before installing. The pressure test procedures are followed ASME B31.1 pipe hydro test standard. There for the pressure test must be conducted in 1.5 x 10 bar (design pressure)= 15 bar.

- Equipments Needed
  - Here is a list of equipment needed for fulfilling pressure test on the hydrant
  - installation:
  - 15 bar test pump
  - Timer
  - Mechanical Tools Kit (wrench, adjustable wrench, etc.)
- Testing Procedures

The following pressure test procedures shall perform sequentially and each procedure must be checked:

Phase	Description
	• Install the hydrant pillar with the base flange which connected to the header pipe using bolt and gasket connection (as seen on the drawing
Preparation	below). Tighten it using wrench
	<ul> <li>Install a ½" hole in the both blind flange that will be used for:</li> </ul>
	- Input for pressurized water.
	-Pressure gauge.
Inspection	Perform a visual check for the tested hydrant pillars, and repair if leakage
	found.
	• Install the test pump to the inlet $\mathcal{V}''$ , and the pump inlet to the water
Test Procedure	source.
	• Open the inlet ball valve, turn the pump on, and wait for the pressure to
	reach 15 bar. After the pressure gauge reach 15 bar, close the inlet ball valve, and turn the pump off.
	<ul> <li>Set the timer on. The testing time is 10 minutes.</li> </ul>
	• After reaching 10 minutes and no leakage found, depressurize the hydrant
	pillar until 10 bar (design pressure), and hold the pressure for 30 minutes
	Repair if leakage found.
	• If no leakage after 30 minutes, remove the water inside hydrant pillar by
	opening the ball valve.

## <Table 7.5-2.> Testing Procedure

## 2) Water Spray System

a) Preparation work

Broadly speaking, the preparatory work hydrant installation system is as follows:

- Making the drawing layout.
- Making the drawing isometric.
- Making the flow calculation (when needed).
- Material & drawing approval process.
- Marking area to the installation site.
- Prefabricated job based on the drawing that has been approved.
- Installation support of pipes and pipes according to the drawing on the jobsite.
- Installation of main equipment that will be applied.
- Setting up the system interconnect for fire alarm.
- Hydro test.
- Testing and Commissioning.

Standard references of installation are based on:

- NFPA-13; Standard for The Installation of Sprinkler Systems
- NFPA-14; Standard for The Installation of Standpipe and Hose Systems
- NFPA- 16; Standard for the Installation of Foam-Water Sprinkler and Foam-
- Water Spray Systems
- NFPA-20; Standard for The Installation of Centrifugal Fire Pumps
- SNI 03-1735-2000

SNI 03-1745-2000

1) Installation of sprinkler and water spray

Just like plumbing hydrant in doing this process in several stages:

- Installation of pipe support, support for sprinkler and water spray there are 2 types of support and hanger bracket clamps.
- Install pipe from the side of the base or the main line pipe in sequence until the end of the branch pipe.
- In the process of connecting pipe sprinkler and water spray using screw method requires the installer to use epoxy glue or tape seal to reinforce the connection.
- Before connecting screw must be cleaned of dirt and oil.
- Tighten connections using a stopcock.
- Install sprinkler heads or water spray nozzle.

### 2) HFC System

Pipe Installation Procedure are described bellowed.

a) Painting

To avoid corrosion of the pipe required the following stages:

- Clean the rust on the pipe with sand blast, then apply the primary coat with Jotamastic 80. Dry film thickness not less than 75  $\mu$ m and not more than 200  $\mu$ m. Wet film thickness not less than 90  $\mu$ m and not more than 250  $\mu$ m.
- Apply the final painting (top coat with hardtop XP). Dry film thickness not less than 40  $\mu$ m and not more than 60  $\mu$ m. Wet film thickness not less than 80  $\mu$ m and not more than 120  $\mu$ m.
- Adjust the thickness of the paint with the needed (min 100  $\mu m$  for dry film and 140  $\mu m$  for wet film).
- b) Threaded Making

The process of the connecting pipes with threads:

- Make a threads on the end of the pipe with a length +/- 3 cm.
- Check the thread using fittings.
- Wrap the seal tape on the thread.
- Install the fittings firmly to prevent leakage
- c) Hanger Clamp/Support Installation

Support material in use on the installing pipe:

- Hanger Clamp
- Thread rod + Dyna set
- Angle bar
- Channel P-1000
- Ductor Clamp
- 3) Fire Extinguisher System

It is important to check for electrical cables and pipe work using a suitable detector. When fitting appliances use appropriate wall fixings in conjunction with the manufacturer supplied wall bracket. Additional support may be needed when fitting heavier extinguishers to plasterboard walls. In locations as public halls a "safety bracket" may be beneficial.

## • Mounting Heights

The carrying handle of a portable fire extinguisher with a total gross mass of 4kg and above should be approximately 1 meter from the floor. The carrying handle of a portable fire extinguisher with a total gross mass of less than 4kg should be sited at 1.5 meters from the floor.

• 2 Extinguishers Mounted Side by Side

With one extinguisher total mass above 4kg and the 2nd extinguisher below 4kg, both extinguishers can be mounted on the wall at the heaviest extinguisher handle fixing height of 1 meter.

• Fire Extinguisher Stands

Where fire extinguishers cannot be wall mounted the use of fire extinguisher stands is recommended.

• A Note of Warning on 'Pre-serviced' fire extinguishers

Occasionally, you may come across the practice of online fire extinguisher retailers offering preserviced fire extinguishers. What they offer is the inspection of the extinguisher in their warehouse and the addition of a maintenance label on the extinguisher. Sometimes they even claim that this service is in accordance to BS5306.

However, this practice is NOT in accordance to BS5306 for very good reasons. Damage to extinguishers like loss of pressure, loss of extinguishing medium, bent handles and hoses which make the extinguisher inoperable do not occur whilst the extinguisher is in the warehouse but all of these issues can occur in transit to the customer after the supplier has already declared the extinguisher 'fit for operation'. This puts lives at risk, especially if suppliers do not protect extinguishers adequately for shipment. BSI has therefore changed the standard BS5306 to require an ON SITE commissioning for all extinguishers installed under BS5306. This entails a full check of the extinguishers as they arrive on site and the correct weighing, preparation and certification of the extinguishers. Only then can you use the certification document as proof that you have taken your responsibility in accordance to your fire risk assessment seriously.

Pre-servicing or pre-labelling is therefore not permitted any longer. If you require your extinguishers to be installed in accordance to BS5306 you must have the extinguishers commissioned on site or alternatively you can have them installed and commissioned on site by a servicing company. BS5306 conformity is always required if you are a business or landlord or if you have to carry out a fire risk assessment.

Here are a few guidelines about fire extinguisher installation requirements:

- Install fire extinguishers at an elevated height with the carrying handle around 1 meter from the floor for larger, heavier extinguishers and 1.5 meters from the floor on smaller, lighter units.
- Don't place your fire extinguisher in locations where there are extreme temperatures.
- Extinguishers should be pretty close to an escape door, preferably in a shallow recess where they won't get knocked.
- The relevant extinguisher should be handy for any specific type of fire risk but not too close so that it can't be reached if a fire breaks out.
- Make sure that all extinguishers are labelled for the type of fire they are suitable for.
- Staff should be trained in the use of the fire extinguishers installed. Try to make sure that any different types of extinguisher you have can be operated in a similar way.

### 4) Detection System

a) Preparation before installation

Some things to consider before starting work:

- Preparing work equipment that will be in use.
- Preparing the appropriate safety equipment for the area conditions.
- Shop Drawing & Schedule.
- Man Power that as needed.
- Operating Costs
#### b) Conduit installation and accessories

Conduit installation procedure:

- Prepare 3 pipe conduit, two-way box and coupling.
- Prepare Clamp/saddle, Fischer and screw.
- Set the clamp saddle distance every 1200 mm (look at Shop Drawing).

#### 1) FIRE ALARM CABLE INSTALLATION

#### <Table 7.5-3.> Fire Alarm Cable specification

Division	Cable Type	Size	Color	Polarity
Cabla Loop	Shielded Pair	FRC-AWG 16	White	Positive (+)
			Black	Negative (-)
Increation	FRC-NYA	1.5 mm	Red	Positive (+)
Inspection	FRC-NYA	1.5 mm	Black	Negative (- )
Cable Dower Medule	FRC-NYA	1.5 mm	Red	Positive (+)
	FRC-NYA	1.5 mm	Black	Negative (- )

Note:

Maximum power cable installation for module size 1.5 is 1000 meter/core.

The Maximum recommended Installation of cable NYA 1.5 mm into conduit 20 mm is 4 core.

#### 7.4.6. Safety Provision

In the installation work must consider the risk of accident on workers, guest, and equipment in the work area.

The type of work accident:

- Electric shock.
- Heat effect of the installation.
- Advantages or disadvantages of electric current flows.
- Falling from a height or falling the object.

To prevent the occurrence of accidents it is necessary to protect against such hazards according to the procedure of risk control. Any occupational hazard identified according to the installation procedure, if using a new of equipment, it must be done JSA (Job Safety Analysis). JSA (Job Safety Analysis) done by supervisor and technician and then request approval from costumer. Personal

safety equipment for workers: Helmet, Safety shoes, gloves cotton, and other equipment following the JSA.

Provide special marks for the work area with an electric hazard and given the limit to not be entered by anyone. Check the electrical cable equipment in use must be good condition.

# 8. Quality Control of RCC

- 8.1 General
- 8.2 Trial Mix Program
- 8.3 Full Scale Trial
- 8.4 Quality Control of Stockpiles and Silo Storage
- 8.5 Quality Control of Manufacturing Facility
- 8.6 Activities during RCC Placement
- 8.7 Activities after RCC Placement

# 8. Quality Control of RCC

#### 8.1. General

The purpose of concrete quality control is to maintain uniformity (minimizing variation) of all constituents and operations entering into the final product such that the final product will have predictable properties and behaviour, and will satisfy the design requirement.

Quality control of concrete is commonly measured by the variation in compressive strength results as calculated by statistical method. Other properties are related to strength through correlations which may be project specific or generalized.

Effective quality control requires the following:

- A good management structure is essential. Responsibilities have to be well defined. There should be no inherent conflicts of interest.
- The quality control team requires powers to control the quality of the work. This may include powers to reject and remove deficient materials and products.
- The personnel in the QC team have to be suitably qualified and trained for the activities.
- Appropriate and sufficient office, laboratory and field facilities have to be provided.
- An effective system of document control is required.

#### 8.2. Trial Mix Program

The trial mix program will be designed to test and select the mix proportions, which will give concrete of the desired fresh and hardened properties. The program made in the design phase should be subject to quality control and the specification may include requirements on:

- Procedures used to develop the mix design
- Design strength of the concrete at a given maturity
- Maximum size of aggregate (MSA)
- The number of aggregate sizes to be batched for each MSA
- · Limits on the combined aggregate grading for each MSA
- Maximum water-cement ratios
- Air entrainment
- Minimum cement or cementitious contents (in relation to durability, water-tightness of other factors)
- Minimum proportion of pozzolan required in the mix in order to mitigate the risk of alkali-silica reaction (ACR)
- Minimum density of RCC, typically as a percentage of theoretical air-free density (TAFD)
- Workability, such as VeBe Time
- The method of determining the target strength of the concrete as a function of the design strength and expected statistical variations in strength
- Temperature at the time of placement or completion of mixing
- The maturities at which specimens are to be tested

#### 8.3. Full Scale Trial

The trial can have several objectives, amongst these can be:

- The training of personnel, both those working on the dam and also those supervising and inspecting
- The optimization of the workability and mixture proportions of the concrete

- The optimization of the construction procedures during the transportation, dumping, compaction and curing of the concrete and also the procedures for placing the concrete against the upstream and downstream formwork and against a rock abutment
- The review of the various joint treatment to be used between the layers for various exposure times
- The optimization of the testing methods for workability and fresh density and for in-situ density

#### 8.4. Quality Control of Stockpiles and Silo Storage

Given aggregate and cementitious materials that conform to specification, large stockpiles aid quality. Good stockpile management will reduce the effects of segregation. The time-lag between production and incorporation into concrete allows corrections to be made, such as removal of unsuitable material generated by equipment failure or other causes. Stockpiles of fine aggregate allow these to drain before use.

For RCC, continuous concrete production is necessary in order to achieve a good quality of end product. Large stockpiles provide a buffer in the event of problems with the aggregate production or supply.

Contamination from adjacent material, surfaces, processes and cooling water has to be avoided.

Quantities of all materials in stockpiles should be monitored as part of the quality control. Also, sufficient material of acceptable grading and uniform moisture content should be tested and stockpiled prior to starting RCC.

#### 8.5. Quality Control of Manufacturing Facility

Good control is contingent upon having concrete manufacturing facilities of high quality with proven capability of giving consistent constituent materials, batching and mixing. The cost of providing the equipment to achieve this is high, but this cost may be recouped through savings in cement and pozzolan consumption and more effective and predictable concrete placement. Therefore, the equipment should be subject to approval prior to installation.

Typical quality control activities at the concrete mixing plant are as follows.

- Mixer efficiency tests
- Mixing times
- Workability
- Verification of preventive maintenance
- Cleaning and maintenance

#### 8.6. Activities during RCC Placement

Quality control during RCC placement involves two operations: inspection and testing. Inspection is the first opportunity to observe an RCC problem and institute measures to correct it. In addition to inspection activities, a comprehensive RCC testing program should monitor the aggregate properties, RCC mixture proportions, fresh concrete properties, hardened concrete properties, and in-place compaction.

#### 8.7. Activities after RCC Placement

Quality control after placement should include periodic inspections to ensure that the RCC is being continuously moist cured and properly protected from damage.

# 9. Transportation and Logistics

- 9.1 General
- 9.2 Shipping and Transportation Plan
- 9.3 Logistic Controller
- 9.4 Order Plan for Equipment and Materials

## 9. Transportation and Logistics

#### 9.1. General

The Contractor is responsible for arrangement and coordination of shipping and transportation of all equipment and materials (hereinafter called "the cargo") procured from all over the world, until its delivery on Site in the EPC works of TINA Project.

The Contractor is also responsible for necessary arrangements for forwarding, insurance and other necessary services. The Contractor will estimate the overall volume of cargoes and plan their deliveries based on the most feasible ways in accordance with the project schedule.

#### 9.2. Shipping and Transportation Plan

The shipping and transportation plan will be implemented to the shipping and transportation of the cargo coming from all over the world to Site in consistent with the project schedule, sound transportation and economical methods covering:

- Geographical location of the cargo sources
- Types of cargo to move
- Types of shipments and their schedules
- Managing method of special equipment to be handled, i.e., electronic equipment, heavy equipment and fragile, vulnerable components such as pipes, castings, etc.
- The interface among the management of cargo, local agencies, customs and other functions of procurement in order that goods are controlled from the delivery points to the site in conformity with the terms of the purchase order and contractual cargo strategy.

All transportation activities and procedures will be oriented toward these objectives.

#### 9.3. Logistic Controller

The logistic controller will manage and coordinate the shipping and transportation activities of vendors, freight forwarders, shipping lines and/or other public services.

#### 9.3.1. Routing and Carrier Selection

Items to be considered for carrier selection are

- Required date by construction Site / Particulars of the cargoes
- Dimension, weight, packing, hazardousness etc.
- Total freight estimation by each carrier and routing
- Conditions of loading/unloading ports/airports
- Total freight estimation by each carrier and routing

Types of transportation are:

- Truck freight
- Air freight
- Ocean freight

As soon as the carrier and the routing are selected, such reservation of space should be followed.

#### 9.3.2. Shipping Requirements

1) General Shipping Requirements

The logistic controller should prepare general shipping requirements as outlined hereunder and distribute to the vendors, packers, freight forwarders and other concerned parties as required.

- Shipping instruction containing number and type of package, gross weight and cube, origination carrier, shipping marks, name and address of consignee/shipper, shipping and discharging port, etc.
- · Invoice and packing list requirements / Distribution of documents
- Packing instructions / Other information
- 2) Shipping Advice

After shipment of the cargo, the logistic controller will send the shipping advice to the local forwarder and the transportation officer simultaneously in order that they can receive the cargo in time at port of discharging and at Site.

3) Shipping Status and Forecast

The shipping status and forecast have to be firmly understood by the logistic controller who keeps close liaison with the expediter who expedites and controls the manufacturing for timely delivery of the cargo to the port of export. The logistic controller will prepare the monthly shipping status report to check the information of shipping status and forecast.

4) Packing and Marking

• General packing and marking specification

The Contractor will ensure that the packing and marking of the cargoes will be in accordance with Instruction for shipping and marking.

• General preservations and specific protection

The Contractor will establish the specific requirements into the instruction for export protection and packaging, essentials for transportation and storage under the weather conditions at site. The general preservation and specific protection of the cargo will also be specified in the same instruction.

- 5) Customs Clearance
  - Declaration of the importation

Customs clearance will be the responsibility of the logistic controller, customs broker, and other concerned parties as required. Customs declaration for import can be submitted not only under the name of the customs broker, juristic person for customs clearance but also under the name of the Employer.

• Procedure for import clearance

Declarations must be made on an import declaration form stating the description of goods as well as quantity, value and other particulars required. Customs duty will be levied on the basis of the quantity and value of goods at the time of import declaration. The documents to be submitted to customs office with the import declaration form are as follows:

- Commercial invoice and price declaration
- Packing list
- Bill of Lading
- License, Certificates, etc. provided in accordance with laws and regulations other than the Customs Act.



<Figure 9.3-1> Marine Transportation Route (Pusan, Korea - Honiara Port)

#### 9.3.3. Inland Transportation

The freight forwarder's responsibilities will include supervision of labor, equipment, tools, and supplies required to provide services from the point of entry into Honiara port to the job site.

Before off-loading, a visual inspection will be carried out by the Contractor or designee of the Contractor as far as possible to inspect materials/packages in the consignment are correct in regard to quantity and description of the materials and to determine any obvious damage to all or part of the consignment.

The "obvious damage" is defined as bent/broken or poorly scratched/scuffed paint on the equipment or damaged packing. If there are discrepancies between actual receipt and the shipping documents, an OS&D (overage, shortage and damage) report will be completed.

The freight forwarder on behalf of Contractor will be responsible for arranging stevedores and lifting equipment to accomplish the transition. In case it is not possible to directly forward cargo, the freight forwarder will be responsible for safe temporary storage.

The freight forwarder will be responsible for reviewing and distributing all customs documents required by the laws and will arrange for authorized customs inspectors. On occasion it may be necessary to return materials or equipment to offshore locations and in such cases, the freight forwarder will obtain, prepare, and distribute documentation and arrange for export crating, transportation and loading.



<Figure 9.3-2> Inland Transportation Route to Dam Site from Honiara Port

1) Specification of Honiara Port

#### <Table 9.3-1> Major specification of turbine and generator

Item	General information
Channel	Open approach
Distance from pilot station to anchorage	0.5 nautical miles
Minimum depth of tuning basin	11 m
Diameter of tuning basin	300 m
Port established maximum vessel draft	#1 Berth : 9.5m, #2 Berth : 10.5m
Port size	#1 Berth : L110m x D10.5m(depth) #2 Berth : L150m x D10.5m(depth)





<Figure 9.3-3> Reference Photo for the Inland Transportation

#### 2) Notice Requirements

The Freight Forwarder will notify the Contractor by facsimile or e-mail, the following information regarding incoming cargo:

- Name of the ship and voyage number or airline flight number
- Date of shipment or flight departure from port of embarkation
- Expected and actual time of arrival
- · Packing list information including quantity, weight, and volume
- Purchase order number and tag or line items shipped
- Ocean bill of lading number or airway bill number

The freight forwarder will be required to immediately report any suspected or actual damage and should take photographs if it seems necessary and appropriate.

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#### 9.4. Order Plan for Equipment and Materials

<Figure 9.4-1> Summary Procurement plan for equipment and materials

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	[PO] Emergency Diesel Generator		1		-		F			No. 1 Contraction									11							
	[VPA] Emergency Diesel Generator		1		1																					

Activity Name	2020 2021 2022 2023 JIFMAMJJASIGNI JIFMAMJJASIGNI JIFMAMJJASIGNI JIASIGNI JIFMAMJJASIGNI JIFMAMJJASIGNI JIFMAMJJASIGNI JIFMAMJJASIGNI
[FAT] Emergency Diesel Generator	
[FOB] Emergency Diesel Generator	
[DTS] Emergency Diesel Generator	
[MR] UPS and DC System with Battery	
[TBE] UPS and DC System with Battery	
[PO] UPS and DC System with Battery	
[VPA] UPS and DC System with Battery	
[FAT] UPS and DC System with Battery	
[FOB] UPS and DC System with Battery	
[DTS] UPS and DC System with Battery	
HVAC	
[MR] HVAC Equipment	
[TBF] HVAC Equipment	
[PO] HVAC Equipment	
[VPA] HVAC Equipment	
IFAT1 HVAC Equipment	
[FOB] HVAC Equipment	
[DTS] HVAC Equipment	
Firefighting	
Firefighting Equipment	
[MR] Firefighting Pump System	
[TBE] Firefighting Pump System	
[PO] Firefighting Pump System	
[VPA] Firefighting Pump System	
[FAT] Firefighting Pump System	
[FOB] Firefighting Pump System	
[DTS] Firefighting Pump System	
[MR] Firefighting Protection System	
[IBE] Firefighting Protection System	
[PO] Firefighting Protection System	
[VPA] Firefighting Protection System	
[FAI] Firefighting Protection System	
[FOB] Firefighting Protection System	
LUISJFIRETIGNTING Protection System	
Switchyard	
Electrical	
IMR1 Air-Insulated Switchvard Equipment(AIS)	
ITRE1 Air-Insulated Switchvard Equipment(AIS)	
[PO] Air-Insulated Switchyard Equipment(AIS)	
[VPA] Air-Insulated Switchvard Equipment(AlS)	
[FAT] Air-Insulated Switchyard Equipment(AIS)	
[FOB] Air-Insulated Switchyard Equipment(AIS)	
[DTS] Air-Insulated Switchyard Equipment(AIS)	
Main Transformer	
Electrical	
ITBEI Main Transformer	
[PO] Main Transformer	
[VPA] Main Transformer	
IFATI Main Transformer	
IFORI Main Transformer	
	━━╋╘╘┶┶╘╘┶╘╘┶┶╘┶┶╘┶┶╘┶┶╘┶┶╘┶┶╘┶┶╘┶┶╘

<Figure 9.4-2> Detailed order plan for equipment and materials

# ANNEX P-1-III CONSTRUCTION SCHEDULE

#### [TRHDP] Tina River Hydropower Development Project\_Impacted Programme\_Master Schedule

Description	2019			202	0					2021	- r - r				2022					2023						2024				2025					2026			_	Remark
NTP (2019)	Nov Dec	Jan Feb I	Aar Apr	May Jun .	Jul Aug	Sep Oct N	lov Dec Finaliza	Jan Feb Man	r Apr May	y Jun Jul J	Aug Sep O	Approval	Jan Feb M	ar Apr May	Jun Jul A	ug Sep C	Approval of	Jan Feb ESMP for Hy	Mar Apr M propower Plant	flay Jun J	ul Aug Sep	Oct Nov	Dec Jan	Feb Mar A	Apr May Ju	n Jul Aug	Sep Oct N	lov Dec Ja	n Feb Mar Ap	r May Jun J	ul Aug Sep	Oct Nov De	ec Jan Fe	eb Mar Apr	May Jun J	ul Aug Sep	Oct Nov	Dec	
Milestone		121		Submission	of Pasia Day		P. Aminaid	a of Datailed Datai			Commencemer	t of ground wor	is for the Lot2, I	Lot3 Access Ro	ad 🔶			ad Davies																					
Engineering	Lo2-2, 2-3L	03															- moral of Detai																						
Basic Design	ÎП	Hydro	power Plant		++																																		
Detailed Design			ľ		Hydn	opower Plant																_																	
Procurement					80	•	MR Issue													MEG/ EAT				DTS_	Turbine and Ge	nerator 🔷			600 0TS										
Metal					~	•														MPG PAI																			
Electrical			MR		PD															MFG/ FAT																			
Turbine and Generator		-		0	+															MFG/ RAT								FOB D	s										
Construction																																							
Temporary Facility	Nov Dec	Jan Feb I	Mar Apr	May Jun	Jul Aug	Sep Oct N	lov Dec	Jan Feb Mar	r Apr May	Jun Jul	Aug Sep O	t Nov Dec	Jan Feb N	lar Apr May	Jun Jul A	ug Sep (	Oct Nov Dec	Jan Feb	Mar Apr M	/lay Jun J	ul Aug Sep	Oct Nov	Dec Jan	Feb Mar A	Apr May Ju	n Jul Aug	Sep Oct N	lov Dec Ja	Feb Mar Ap	r May Jun J	ul Aug Sep	Oct Nov De	ec Jan Fe	eb Mar Apr	May Jun J	ul Aug Sep	Oct Nov	Dec	
Base Camp	* <sub>eat</sub>	Work	Structu	•	o inte	nor							ewage Treatment Fi	aciity																									
Site Office		C Bat	Work												Structure &	Interior																							
Batcher and Crusher Plant	~	Mobilization	0												BP 60 CP Intal & 1	ist																							
Batcher Plant for Dam																						bilization	BP 12	0 Conveyor	9														
Access Road	Nov Dec	Jan Feb I	Mar Apr	May Jun	Jul Aug	Sep Oct N	lov Dec	Jan Feb Mar	r Apr May	Jun Jul	Aug Sep O	t Nov Dec	Jan Feb N	lar Apr May	Jun Jul A	ug Sep (	Oct Nov Dec	Jan Feb	Mar Apr M	/lay Jun J	ul Aug Sep	Oct Nov	Dec Jan	Feb Mar A	Apr May Ju	Jul Aug	Sep Oct N	lov Dec Ja	Feb Mar Ap	r May Jun J	ul Aug Sep	Oct Nov De	ec Jan Fe	eb Mar Apr	May Jun J	ul Aug Sep	Oct Nov	Dec	
Lot1(Existing)							П		•	Sta.7+600			Earth Works		s	a 12+000					Drainage V	orks & Earth Works							P	vement					ting & Repairing				
Lot2-1(Mtn.Crest)							+								Sta. 1+040		Earth & Drainage	Works	Sta 2+504		•														Pavement				
Lot2-2(to Intake)															Sla 2	000-2+080	•	arth & Disinana I	links 1		•••••													Pavement	,				
Lot2-3/to Dam Base)					++		+		+									5-00 Days			<b>-</b>													malt					
			+		++		+-		+						Sta.	+080		Earth & Drain	ige Wons														avenent		++	+			
Lot3 2/to Turnet Ordan	+++	++	+	++	+	++	+	++	++	$\left  \right $	++	++	++	++	Ck	-mg & Grubbing	-	Eadh & Dra	age Warks	++	++	$\left  + \right $	+	+	++	+	$\vdash$	++	+++	+++	++	+++	++	++	++	++	+		
Lot3-2(to Tunnel Outlet)																	Earth Wor	6 & Pavement																					
River Diversion	Nov Dec	Jan Feb I	war Apr	nnaiy Jún -	Jui Aug	Sep Oct N	dv Dec	Jan Feb Mar	Apr May	Jun Jul	wug Sep O	a Nov Dec	Jan Feb N	ar Apr May	Jun Jul A	ug Sep (	oct Nov Dec	Jan Feb	Mar Apr 1	nay Jun J	ur Aug Sep Earth Wo	oct Nov	2Revs Box 0	rieb Mar /	mpr May Ju	Jul Aug	Sep Oct N	iov Dec Ja	reb Mar Ap	r May Jun J	u Aug Sep	Oct Nov De	ed Jan Fe Dive	eto Mar Apr insion Closure	may Jun J	an Aug Sep	Uct Nov	LIEC	
Box Culvert	$\left  \right $	++	+	++	+	++	+		$\left  \right $			++	++	++		++		$\square$		-  îT														Plugi	ing Carls	+ $+$	+	_	
Primary Cofferdam	$\downarrow \downarrow \downarrow$	++	+	$\parallel$	+	++	+	++	$\square$			+	++	++		++	++	$\square$			++	$\square$	$\parallel$		Foundation R <sup>4</sup>	imbankment C Wall		++	+++		++		++		++	+			
Upstream Cofferdam		$\parallel$	+	$\downarrow \downarrow$	++	$\square$	+		$\square$			++	$\downarrow \downarrow$			++		$\square$					$\parallel$		* Enbankment	1	$\mid \mid \mid \mid$	++	$\square$	$\square$	++	$\square$	$\parallel$		$\parallel$		+	_	
Downstream Cofferdam																																							
RCC Dam	Nov Dec	Jan Feb	Mar Apr	May Jun	Jul Aug	Sep Oct N	lov Dec	Jan Feb Mar	r Apr May	Jun Jul	Aug Sep O	t Nov Dec	Jan Feb N	lar Apr May	Jun Jul A	ug Sep (	Oct Nov Dec	Jan Feb	Mar Apr I	/lay Jun J	ul Aug Sep	Oct Nov	Dec Jan	Feb Mar /	Apr May Ju	Jul Aug	Sep Oct N	lov Dec Ja	Feb Mar Ap	May Jun J	ul Aug Sep	Oct Nov De	ec Jan Fe Paralost Works	eb Mar Apr	May Jun J	ul Aug Sep	Oct Nov	Dec	
Dam Wall																			Eart	h Works_Left Side	Earth V	aks_Right		OO	indation L/R	Land Hole To	Foundation	BL 132			EL1	85.9m(R) Drain Hole	1						
Gallery																													Main Gallery(El	(35.7m)	Riparian (	Outlet/ Leit Gallery							
Scouroutlet																													Foundation	Gate Wall Conduit	Gate Wat	Scou	ur Gutiet Gale	Ŷ					
Spillway																														Alip Bucket	Chute Slab & We	al Ogee Crest I	Bigge						
Intake	Nov Dec	Jan Feb	Mar Apr	May Jun	Jul Aug	Sep Oct N	lov Dec	Jan Feb Mar	r Apr May	Jun Jul	Aug Sep O	t Nov Dec	Jan Feb N	lar Apr May	Jun Jul A	ug Sep (	Oct Nov Dec	Jan Feb	Mar Apr M	/lay Jun J	ul Aug Sep	Oct Nov	Dec Jan	Feb Mar	Apr May Ju	Jul Aug	Sep Oct M	lov Dec Ja	Feb Mar Ap	r May Jun J	ul Aug Sep	Oct Nov De	ec Jan Fe	eb Mar Apr	May Jun J	ul Aug Sep	Oct Nov	Dec	
Intake Gate																		Lat 2-2		->	arth Works	o						••• 0 EL. 160.0m	EL 186.§m late Wall	Basckfil	éxe (Jato	EM W	Note						
Intake Control House																														Structure Works	EM Works								
Headrace	Nov Dec	Jan Feb	Mar Apr	May Jun	Jul Aug	Sep Oct N	lov Dec	Jan Feb Mar	r Apr May	Jun Jul	Aug Sep O	t Nov Dec	Jan Feb N	lar Apr May	Jun Jul A	ug Sep (	Oct Nov Dec	Jan Feb	Mar Apr M	/lay Jun J	ul Aug Sep	Oct Nov	Dec Jan	Feb Mar	Apr May Ju	Jul Aug	Sep Oct N	lov Dec Ja	Feb Mar Ap	r May Jun J	ul Aug Sep	Oct Nov De	ec Jan Fe	et Mar Apr	May Jun J	ul Aug Sep	Oct Nov	Dec	
Headrace Tunnel							П										Lot 3	D	S-TB/	A Launching Yard	S-TBM DTS	····· e	Sta. 3-1 Shield TE	172 BM 1		Shield TBM		-	S-TBN Disassembly	Transition Outlet Inlet Pe	o natock								
Surge Tank																					Vard V	rk Earth	Works	UIG Linin	ng Coelic All& Linir	g Confe													
Penstock																				Earth Work & Slop	Protection		Ste	el Pipe-Trifurcation	•••••••						Stael Pipe-Slo								
Powerhouse	Nov Dec	Jan Feb I	Mar Apr	May Jun	Jul Aug	Sep Oct N	lov Dec	Jan Feb Mar	r Apr May	Jun Jul	Aug Sep O	t Nov Dec	Jan Feb N	lar Apr May	Jun Jul A	ug Sep (	Oct Nov Dec	Jan Feb	Mar Apr 1	/lay Jun J	ul Aug Sep	Oct Nov	Dec Jan	Feb Mar	Apr May Ju	Jul Aug	Sep Oct N	lov Dec Ja	Feb Mar Ar	r May Jun J	ul Aug Sep	Oct Nov De	ec Jan Fe	eb Mar Apr	May Jun J	ul Aug Sep	Oct Nov	Dec	
Structure					u. rog						ing oup o					og oop i	Lot 3-1			Eath Work		83 Slab & Wall	B2 Slab	& Wall	B1 Sia6 & W	4 GL Sh	b Backfil			Palem	ent and Fende					. rug oop			
Steel Structure					++		+-													1							dumn & Fruss	Wat											
Station Cinder Crane		++	+		++		+		+																	+	Hoof as	& Cartificate	Masoffy	+++	++				++				
Adapte Building						_					_																1 Intaliatio	n asonly Works	Classing Wall	•									
							-														Training	Vel_2/3		Tu	aining Wal_10		state La	9	Interi	·	•								
Tailrace				_			+		+										Cate	rdam	Foundation	Retaining Wall	_Left Rub	aining Wat_Right	$\rightarrow$	Ba	extil thing and Grounding		Electrical Equipme	Col L Cable Pulling and Ter	ferdem Removal ministion								
Electrical Works				_					+		_																	_	HVAC Equipme	2									
HVAC Works			+		++																							H	Equipment & Piping										
Firefighting Works									$\square$				$\rightarrow$														Sevage Pide		Ě		++				$\rightarrow$				
Water Works		$\parallel$	+	++	+	$\square$	+		$\square$				$\downarrow \downarrow$			++		$\square$	$\square$	++						Septio	tank W	later Pipe	E	fation Test & C-	rifidate	$\square$	$\parallel$		$\parallel$			_	
Main Transformer		$\parallel$	+	$\downarrow \downarrow$	$\square$	$\square$	$\downarrow \downarrow$		$\square$		++		$\square$			++		$\square$	$\square$	$\parallel$			$\parallel$		$\downarrow$		$\mid$	++		Installation Pole C	ablePulling	$\square$	$\parallel$		$\downarrow \downarrow$		$\parallel$	_	
Distribution Line																																							
Turbine and Generator	Nov Dec	Jan Feb	Mar Apr	May Jun	Jul Aug	Sep Oct N	lov Dec	Jan Feb Mar	r Apr May	Jun Jul	Aug Sep O	t Nov Dec	Jan Feb N	lar Apr May	Jun Jul A	ug Sep (	Oct Nov Dec	Jan Feb	Mar Apr M	/lay Jun J	ul Aug Sep	Oct Nov	Dec Jan	Feb Mar /	Apr May Ju	Jul Aug	Sep Oct N	lov Dec Ja	Feb Mar Ap	r May Jun J	ul Aug Sep	Oct Nov De	ec Jan Fe	et Mar Apr	May Jun J	ul Aug Sep	Oct Nov	Dec	
Turbine(Unit #1, #2, #3)		$\parallel$		$\square$		$\parallel$	$\downarrow$		$\square$				$\parallel$	++		$\parallel$	$\parallel$	$\square$	$\square$	$\parallel$		_   °	DTL, Ri	ings, Spiral Casing.	Pit Liner			1			++		$\square$		$\parallel$			_	
Generator(Unit #1, #2, #3)					$\square$		$\square$		$\square$							$\parallel$			$\square$							FND for Stator &	Rotor S	ator & Rotor	Rah-out Check a	d Exoler	o dal Benton		$\square$						
BOPm		$\square$							$\square$										$\square$								$\square \square$	e de	, a c, c analge pools	and a cuteration			$\square$						
BOPe	$\square$		$\square$	$\square$			$\square$			$\square$																		(	BDPe(Au) TR, Control I	ystern)									
Piping Works																						Embeded	ipe					BOI	Pipes(Drainage,Water 1	arbine, Measuring, Dewa	tering, HPU, Cooling,	Air,Sealing)							
Switchyard	Nov Dec	Jan Feb	Mar Apr	May Jun	Jul Aug	Sep Oct N	lov Dec	Jan Feb Mar	r Apr May	Jun Jul	Aug Sep O	t Nov Dec	Jan Feb M	lar Apr May	Jun Jul A	ug Sep (	Oct Nov Dec	Jan Feb	Mar Apr M	/lay Jun J	ul Aug Sep	Oct Nov	Dec Jan	Feb Mar	Apr May Ju	h Jul Aug	Sep Oct N	lov Dec Ja	Feb Mar Ap	r May Jun J	ul Aug Sep	Oct Nov De	ec Jan Fe	et Mar Apr	May Jun J	ul Aug Sep	Oct Nov	Dec	
Foundation Works																					Earth	łoń.				Fos	Cable Tranch & Di	toh											
Steel Tower & HV Apparatus		$\uparrow \uparrow$	$\top$	$\uparrow\uparrow$	$\top$		$\top$									$\uparrow\uparrow$				$\top$						l Å	Tower & Conducts	Calle Pulling & Tr	mination				$\square$						_
Control Building			$\uparrow$						$\square$							$\uparrow\uparrow$											Studie Major	¥0					$\uparrow \uparrow$						
Electrical Works									$\square$					++		$\uparrow\uparrow$												CV,PP,Con,Auct	orBox,Cable Pulling and	Termination	++		$\uparrow \uparrow$		++				
Test and Commissioning																																							
Pre-Commissioning	Nov Dec	Jan Feb	Mar Apr	May Jun	Jul Aug	Sep Oct N	lov Dec	Jan Feb Mar	r Apr May	Jun Jul	Aug Sep O	t Nov Dec	Jan Feb M	lar Apr May	Jun Jul A	ug Sep (	Oct Nov Dec	Jan Feb	Mar Apr M	/lay Jun J	ul Aug Sep	Oct Nov	Dec Jan	Feb Mar	Apr May Ju	Jul Aug	Sep Oct N	lov Dec Ja	Feb Mar Ar	May Jun J	ul Aug Sep	Oct Nov De	ec Jan Fe	eb Mar Apr	May Jun J	ul Aug Sep	Oct Nov	Dec	
Switchyard											T					H									T					Bay Line #1	, #2)8 Bay TR #1, #	2							
Control Building	+++	++	+	++	+	++	+	++	++	+++	++	++	++	++	$\left  \right $	++	++	$\vdash$	$\vdash$	++		$\square$	+	+	++	+	+++	++	+++			+++	++		++		+	+	
Intake	+++	++	+	++	++	++	+	++	++	+++	++	++	++	++	$\left  \right $	++	++	$\vdash$	$\left  \right  $	++	++	$\left  + \right $	+	+	++	++	$\left  \right  $	++	+++	+++	++	+++	Diy Te	vet Test	++	+++	+		
Dam	+++	++	+	++	++	++	+	++	++	$\left  \right $		++	++	++	$\left  \right $	++	++	$\vdash$	$\left  \right  $	++	++	$\square$	+	+	++	++	$\left  \right  $	++	+++	+++	$+ \parallel$	+++	Dry Test			+	+	_	
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Powernouse																																	T					_	
Commissioning	Nov Dec	Jan Feb I	Mar Apr	May Jun	Jul Aug	Sep Oct N	lov Dec	Jan Feb Mar	r Apr May	Jun Jul	Aug Sep O	t Nov Dec	Jan Feb N	lar Apr May	Jun Jul A	ug Sep (	Oct Nov Dec	Jan Feb	Mar Apr M	ilay Jun J	ut Aug Sep	Oct Nov	Dec Jan	Feb Mar /	Apr May Ju	Jul Aug	Sep Oct N	iov Dec Ja	Feb Mar Ap	r May Jun J	ul Aug Sep	Oct Nov De	ec Jan Fe	eb Mar Apr	May Jun J	ul Aug Sep	Oct Nov	Dec	
No Load Test		++	+	++	+	++	+	++			++	++	++			++		$\square$		++			+	-	++	$\left  \right $		++	+++			and New Tra	_ ver-asuri Litté	lotial Fills		+ $+$	+		
Load Test		$\parallel$	+	$\parallel$	$\square$	$\square$	+		$\parallel \mid$		++		$\square$			++		$\square$	$\square$	$\parallel$			$\parallel$		++		$\mid$	++	$\square$		++		++	+	<b>_</b>				
Reliability Test Run																						0.1	24	Fail I														Due	
Calendar	2019	Jan Feb	nar Apr	may Jun 2020	JUI Aug	Sep Oct N	ov Dec	Jan Feb Mar	Apr May	Jun Jul 2021	Nug Sep O	NOV Dec	Jan Feb N	ar Apr May	Jun Jul A 2022	ug Sep (	oct Nov Dec	Jan Feb	Mar Apr I	ady Jun J	ur Aug Sep	Oct Nov	uec Jan	reb Mar /	npr May Ju	Jul Aug	Sep Oct N	iov Dec Ja	reb Mar Ap	May Jun J 2025	u Aug Sep	Uct Nov De	ec Jan Fe	eo Mar Apr	may Jun J 2026	an Aug Sep	Uct Nov	Dec	

# ANNEX P-1-IV SUMMARY OF LAWS AND REGULATIONS OF THE SOLOMON ISLANDS



SUMMARY OF LAWS & REGULATIONS OF SOLOMON

ISLANDS

TINA RIVER HYDROPOWER DEVELOPMENT PROJECT- TRHDP Hyundai Engineering Co., Ltd (HEC)

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1.	Environment Act 1998	<u>'</u>
2.	Environment regulations 2008	;
3.	Labour Act 19967	,
4.	Trade Unions Act (1996 Edition)	-
5.	UNFAIR DISMISAL (Amendment) ACT 199619	)
6.	Environmental Health (Amendment) Act 1996	ł
7.	THE ENVIRONMENTAL HEALTH (PUBLIC HEALTH ACT) REGULATIONS (Reviewed Edition) 1996	)
8.	Wildlife Management (Amendment) Act 2017	;
9.	PROTECTED AREAS ACT 2010	;
10.	Fisheries Management Act 2015	•
11.	Laws of Solomon Islands, Chapter 131. Traffic Act [Cap.131], 1996	j
12.	Laws of Solomon Islands, Chapter 129, Roads [Cap.129], 1996	)
13.	Explosives Act [Cap.79]63	;
14.	Mines and Minerals Act. [Cap.42]67	,
15.	Traffic Act [Cap.131]	;
16.	Safety At Work Act [ CAP.74]70	)
17.	Solomon Islands Provincial Act 199772	
18.	Honiara City Act 1999	┝

## 1. Environment Act 1998

S.I Legislations/ Laws Environment Act 1998	Applicable Article/Clause Title	Section/Sub-section	Remarks/ Comments
Part I: PREMILINARY	<ul> <li>Environmental Terms, Definitions and Interpretation;</li> <li>e.g.</li> <li>Approval, Conservation, Developer, Development, Development consent, Director, Discharge, Environment, Environment audit, Environment Impact Statement, Environmental Inspector, Environmental Protection, Impacts, Landowners, Land, Level, Licence, Minister, Mitigation, Noise, Noise control equipment, Occupier, Offensive noise, Plant, Pollution, Premises, Prescribed development, Proposed development, Public authority, Public environment report and Wastes.</li> </ul>	Interpretation of key Environment " Terms/Words and Phrase". Section 2.	
	Objects of the Act	Section 3(subsection a-d)	

S.I Legislations/ Laws	Applicable Article/Clause Title	Section/Sub-section	Remarks/ Comments
	Effect of this Act on other Acts	Section 4 (subsection 1-2)	
Part II: ADMINISTRATION	Administration of the Act.	Division 1: Establishment of	
	Establishment of the Division and Appointment of the	Environment and	
Division 1:	Director and other Officers.	Conservation Division.	
Establishment of Environment	<ul> <li>Director</li> </ul>		
and Conservation Division.	<ul> <li>Environmental Inspectors</li> </ul>	Section 5 (subsection 1-2)	
	Other Officers		
	Functions and Power of Director	Section 7 (subsection a-i)	
	Environment Report	Section 8	
	Power of Entry of Inspectors	Section 11	
Division 2.			
Establishment, functions and	Establishment of Advisory Committee	Section 13	
powers of the Environmental	Functions and Powers of the Adivory Committee	Section 14	
Advisory Committee			
	General duty to consider environmental impact	Section 15	
	Declaration of prescribed Development	Section 16	
	Applications for Approval	Section 17 (subsection 1-5)	
	Requirements for Information concerning existing	Section 18	
Part III	prescribed development		
DEVELOPMENT CONTROL,	Consent required for development	Section 19 (subsection 1-2)	
ENVIRONMENTAL IMPACT	Content of Public Environment Report (PER)	Section 20 (subsection a-i)	
ASSESSMENT, REVIEW AND	Requirement for further information	Section 21	
MONITORING	Publication of PER and Procedure in respect of	Section 22 (subsection 1-4)	
	Objections and Appeal		
	Content of EIA / EIS	Section 23 (subsection a – v)	
	Publication of EIA/EIS and Procedure in respect of	Section 24	
	Objections and Appeal		
	Development to be carried out in accordance with	Section 25	
	development consent		

S.I Legislations/ Laws	Applicable Article/Clause Title	Section/Sub-section	Remarks/ Comments
	Offence of providing false or misleading information	Section 26	
	Responsibility for public EIA/EIS report	Section 30	
	Monitoring environmental aspects of the Development	Section 31	
	Appeal to Advisory Committee	Section 32	
	Development consents non-transferable	Section 33	
	Causing pollution and noxious discharge	Section 34	
Part IV	Discharge of Waste in circumstances in which it is likely	Section 35	
CONTROL OF POLLUTION	to cause Pollution		
	Occupiers of premises to take certain measures	Section 36	
	Penalties for breach of Section 34 & 35	Section 37	
	Occupiers of prescribed premises to obtain a licence for		
	discharge of waste or emissions of noise, odour or	Section 38	
	radiation		
	Application for licence (refer to permit in our case)	Section 39	Apply to our subcontractor
			in our case (Permit in HEC
			case).
	Revocation, suspension or amendment of licences by	Section 40	In HEC case we refer to
	Director		Permit
	Duty of persons becoming occupiers of prescribed	Section 41	
	premises		
	Conditions of licence	Section 42	Permit in HEC case
	Pollution abatement notice	Section 43	
	Outgoing owner or occupier to notify the Director and	Section 44	
	successor in ownership or occupation		
	Environment Inspector may serve stop notice	Section 45	
	Powers concerning discharge of waste and creation of	Section 47	
	pollution		
	Defences to certain proceedings	Section 48	
	Discharges from vehicles or vessels	Section 49	

S.I Legislations/ Laws	Applicable Article/Clause Title	Section/Sub-section	Remarks/ Comments
	Interference with anti-pollution devices on vehicles or vessels	Section 50	
	Installation of equipment emitting unreasonable noise	Section 51	
	General penalty	Section 54	
FIRST SCHEDULE (Section 13)	Constitution of the Advisory Committee	Section 1 - 11	
SECOND SCHEDULE (Section 16)	Prescribed Developments		

# 2. Environment regulations 2008

Law	Clause	Subclause	Abstract	Remarks
Environment Regulation 2008	Part 2. Preparing PER or EIS	4. Only person authorised by Director can conduct PER/EIS	The Environment Regulations 2008 covers detailed requirements for EIA or PER.A EIA/PER s timeframe approval is monthsAn EIA/PER is mandatory for a prescribed development. 	A EIA/PER standard timeframe before approval is ~2 months
		5. A guideline for conducting PER/EIS shall be given by the Director		a. 15 days review of Development
	Part 3. Application for Prescribed development	6. Developer shall submit an development proposal application		Proposal Application b. 15 days review of EIA/PER c. 30 days public notice and consultation
		7. Director will determine if proposed development requires a PER or EIS, according to development proposal application		
		8. Director will decide if the PER/EIS complies with the Act.		

	<ul><li>11. Director will publish the PER/EIS and put out a notice for a public consultation hearing.</li><li>14. Direct my issue a Development Consent if there was no objections raised by the public against the proposed development.</li></ul>	PER/EIA or exempted. The Developer compiles a PER/EIA and submit to the Director. Upon receiving the PER/EIA the Director shall decide whether it complies with the Act. The	d.	Grant of Approval
Part 4. Appeals Procedure	<ul> <li>18.1.a. Development consent could be appeal against if it is inconsistent with any provisions of the Act</li> <li>1.b. inconsistent findings of PER/EIS</li> <li>1.c. inconsistent with international treaties</li> <li>1.d. Development taken on customary land is being disputed by landowners</li> </ul>	Director will then publish a notice about PER/EIA and calls for a public hearing. If there is no public objections, the Director will issue the Licence/approval/Development Consent.		
Part 5. Control of Pollution	<ul> <li>20.1. A developer occupying a prescribed development must apply for an approval from Director to discharge waste, emit noise, air pollution/odour</li> <li>20.2. details for application</li> <li>20.3. Director reviews application for 30 days and decide whether application complies with Act</li> <li>20.4. The Director shall publish a notice of the application in the Gazette setting out the particulars of the application and inviting the public to submit in writing whether the application should be approved.</li> <li>21.1. Applicant/Developer to finance the PER/EIA</li> <li>22. Upon receiving the PER/EIA the Director shall convene a meeting to discuss the subject matter of the application</li> </ul>	Consent.		

2	23. The Director shall issue an approval/licence	
ā	after 10 working days if no there is no	
C	objection	

### 3. Labour Act 1996

Law Clause/Part Subclause/Section Abstract Remarks	
Law       Clause/Part       Subclause/Section       Abstract       Remarks         Labour Act 1996       Part 1       1. Short title       1. Labour Act.       2. Interpretation       3. Term of contract       2. Commissioner means: Commissioner of Labour (Col)       2. Supply of certificate to worker on termination of employment       2. Industrial undertaking means (b) engaged in construction of (building, tunnels, water-works and quarries)       5. Rules relating to holiday leave       f. Worker means anyone who enter a workplace under a written contract       3. Term of contract - every employment contract shall be deemed from month to month         4. A worker whose contract has been expired or been terminated his employer shall give them a certificate indicating dates of commencing and leaving work, and nature of work in which they       3. Term of work in which they	

		5- Every employment contract must include provision of annual holiday, payment of leave passage, sick leave and sickness benefit.	
Part 2 Administration	<ol> <li>Commissioner of labour and other officers</li> <li>Inspections, enquiries, etc</li> <li>Returns by employers, inspection of documents, etc</li> <li>Power of summons and institution of proceedings</li> <li>Offenses</li> </ol>	<ul> <li>6- Minister will appoint a Commissioner of Labour (CoL)</li> <li>6.3- if employer is not agree with a decision given by the CoL, may require a confirmation from the Minister</li> <li>7- CoL have the right to inspect a workplace at all times, under consent and prior notice to employer</li> <li>8 – CoL have the right to examine all contracts, accounts and documents of employer</li> <li>9- CoL have the right to summon an employer or worker to answer questions relating to suspicion of misconduct</li> <li>10 – Any person who hinders/obstructs any officer acting in execution of his duty under this Act is liable to fine of \$ 1,000 or imprisonment for 6 months</li> </ul>	
Part 3 Wages and Hours of Work	<ul> <li>11. Liability of workers for advances and loans</li> <li>12. Permissible deductions from wages</li> <li>13. Days and hours of work</li> <li>14. Overtime</li> <li>15. Records to be kept by employers</li> <li>16. Payment of wages</li> <li>24- deductions for fines</li> <li>25- Remuneration other than wages</li> <li>28- Penalties</li> </ul>	<ul> <li>11 – the employer can only give loan or advance to worker an amount not exceeding their monthly wage</li> <li>12- Maximum amount of wages which may be deducted from the worker shall not exceed 1/3 of total wages for a pay period</li> <li>13 .1a. Normal weekly working hours shall not exceed 45 hrs.</li> <li>13.1b – Normal daily working hours shall not exceed 9 hrs</li> <li>13.1c – workers whose work hours exceed 6hrs must be given at least 30mins break</li> <li>13.1d – no worker is allowed to work on gazetted public holiday, unless worker of Essential services</li> <li>13.2 – shift workers shall be given at least 24hrs rest weekly</li> </ul>	

		<ul> <li>14 - Over time <ul> <li>g. Daily OT - 1.5 of hourly rate</li> <li>h. Saturday/Sunday 1.5 of hourly rate</li> <li>i. Gazetted public holiday - 2 x hourly rate</li> </ul> </li> <li>15 - employer must keep all records/contracts of all workers <ul> <li>16 - payment of wages shall be paid no later than 7days due date</li> <li>16.1- payment of wages to a terminated worker must be on the date of termination</li> <li>24 - Employer shall make No deductions of fines to a worker for a negligent of work/injury to work materials, unless due to wilful misconduct of worker</li> <li>25 - Provision of food and housing to workers for their services shall be in monetary terms</li> <li>28 - employer fails to pay wages is liable to fine of \$1000 or 6 months imprisonment</li> </ul> </li> </ul>	
Part 4 Minimum wage	<ul> <li>29 – Interpretation</li> <li>30 – Fixing of minimum wage</li> <li>31 – Penalty for not paying wages</li> <li>in accordance with minimum rate</li> </ul>	<ul> <li>29 – minimum wage means the minimum rate of fixed wages</li> <li>30 – Minister may by order fix the minimum wage</li> <li>31 –Employer shall pay the workers not less than the minimum wage</li> </ul>	
Part 5 Written contracts of Employment	37 – Work permit requirements for non-indigenous workers and penalties	37 – Non indigenous workers shall not work unless they have work permit	
Part 6 Employment of women	39 – Prohibition of employment of women at night 42 – Maternity Leave 44 - Penalty	<ul> <li>39 – women are not allowed to work during night except in emergency, or they are a nurse</li> <li>42- Female fulltime worker entitled to 12 weeks of maternity leave</li> <li>44 - any person who fails to comply with this Act is liable to a fine of \$500 dollars</li> </ul>	

Part 7 Employment of children and young persons	<ul> <li>46 – employment of children</li> <li>under 12</li> <li>47 – employment of persons</li> <li>under 15</li> <li>49 – employment of persons</li> <li>under 18</li> <li>52 - penalty</li> </ul>	<ul> <li>46 – No child under age of 12 shall be employed under no circumstance what so ever.</li> <li>47 – No child under the age of 15 shall work in an industrial undertaking</li> <li>49 – No person under age of 18 shall work at an industrial undertaking during the night</li> <li>52- Any person who fails to comply with this Act is liable to a fine of \$ 500</li> </ul>	
Part 8 Apprentices	54 – contracts of apprentice or persons over 14 and under 16 56 – contracts of apprenticeship of persons over 16	54 – A guardian of a person age between 14-16 can apprentice him to be trained by employer 56 –An person above 16 can apprentice themselves to be trained by employer	
Part 9 Care of Workers	<ul> <li>66 – Protection of workers from malaria</li> <li>69 – Provision of housing</li> <li>70 – medical care and treatment</li> <li>71 – Hospital maintained by employers</li> <li>72 – directions in regard to housing and sanitation</li> <li>74 – penalty</li> </ul>	<ul> <li>66 – Employers must take measures to make sure all workers are safe from malaria</li> <li>69 – Where an employer's undertakings is located that a worker cannot reasonably returned to his home at the end of daily work, the employer shall provide a proper housing or paid housing allowance</li> <li>70 – At a place of employment the employer shall provide medical treatment of medicines, first aid, or appliance for transportation of sick or injured workers.</li> <li>71 – A employer shall provide a sickroom with accommodation for not less than 10% of their workers</li> <li>72 – Employer shall observe all reasonable directions given by CoL in regard to housing of workers and sanitation of the buildings and provide medical facilities and attendance.</li> <li>74 – Any person who does not comply with this Act is liable to fine of \$1000 or 6 months imprisonment or both.</li> </ul>	
Part 10 General	<ul> <li>75 – criminal proceedings</li> <li>76 – civil proceedings</li> <li>79 – power to exempt persons</li> <li>from provisions of this Act</li> </ul>	<ul> <li>75 – CoL shall prosecute the proceedings of offences against this act</li> <li>76 – any civil proceedings between employer and worker, the CoL shall appear on behalf of the worker</li> </ul>	

Party 11	80 – the Minister may make rules	Minimum wage order - \$ 1.50 per hour.	
Rules	The labour minimum wagers	Labour Housing Standards Rules.	
	Order	<ul> <li>Housing of single workers there must be no more than</li> </ul>	
	Labour Housing Standards Rules	6 workers to live in one room	
	Holiday, Sickleave and Passage	– No	
	Rules	j. communal sleeping platforms shall be provided	
	Work Permit Rules	for single workers	
		Holiday, Sick leave and Passage Rules	
		k. these rules shall not apply to immigrant workers	
		I. Each worker is entitled to a holiday at a rate not	
		less than 1.25 working days for each complete	
		calendar month of employment.	
		m. A paid holiday worker shall be entitled for once a	
		year a cost of return journey to be paid by	
		employer from home to place employment	
		n. A worker entitled to minimum of 26 days sick	
		leave	
		Work Permit Rules	
		o. Application for a work permit shall be made in	
		Form 1 of schedule 1	
		p. Work permit is valid for a duration specified by	
		CoL	

# 4. Trade Unions Act (1996 Edition)

Law	Clause/Part	Subclause/Section	Abstract
Trade Unions Act (Amendment) 1996	Part 1 Preliminary	<ol> <li>Short Title</li> <li>Interpretation and Application</li> </ol>	<ol> <li>This Act is cited as <b>Trade Unions Act</b></li> <li>(g)- "<b>employee</b>" means any person who has entered into works under contract with an employer         "<b>employer</b>" includes the Government of Solomon Islands;</li> <li>(q. "executive committee" means the body, by whatever name called, to which the management of the affairs of a trade union is entrusted by the members</li> <li><b>r</b>. <b>"officer</b>" when used with reference to a trade union, includes any member of the executive committee</li> <li><b>"Registrar</b>" means the person for the time being appointed pursuant to the provisions of section 3 by name or by office to be or to act as Registrar of Trade Unions</li> <li><b>"trade dispute</b>" means any dispute or difference between employers and employees or between employees and employees, connected with the employment</li> <li><b>"trade union</b>" means any combination, whether temporary or permanent, of more than six persons, the principal objects of which are, under its constitution and rules, the regulation of the relations between employees and employees</li> <li><b>2.2</b> - This Act does not apply to persons in a disciplined force of Solomon Islands, but otherwise it applies to employees of the Crown in the same manner as if the employees were employed by or under a private person.</li> <li><b>2.3</b> - No employee employed by or under the Crown shall join a trade union which a person not so employed may join, and no trade union shall represent or accept as members both persons who are and persons who are not so employed:</li> </ol>
	Part 2	3. Appointment of Register	3Appointed a person to be a Registrar of Trade Unions and responsible for performance of the duties and functions assigned under this Act.

Appointment of Register	<ol> <li>Appointment of Assistant Registrars and other officers</li> <li>Protection of officers</li> </ol>	<ol> <li>Appointed an Assistant Registrars of Trade Unions and from time to time be required for the purposes of this Act.</li> <li>No suit shall lie against any officer appointed under sections 3 or 4 for anything done or omitted to be done by him in good faith and without negligence and in the exercise or intended exercise of any power or in the performance or intended performance of any duty conferred or imposed by this Act.</li> </ol>
	<ul> <li>6. Registration of Trade Union</li> <li>7. Necessity for registration</li> <li>8. Application for registration</li> <li>9. Registration</li> <li>10. Certificate of Registration</li> <li>11. Power of Registrar to call for further particulars</li> <li>12. Power of registrar to call for further particulars</li> <li>13. Refusal of registration</li> <li>14. Cancelation or suspension of registration</li> <li>15. Appeal from decision of registrar</li> <li>16. Consequences of suspension of registration</li> <li>17. Effect of cancellation of registration</li> <li>18. Appointment of Liquidator and Powers</li> </ul>	<ul> <li>6 (1) The Registrar shall keep and maintain in such form as may be prescribed, a register of trade unions</li> <li>7(1) Every trade union formed after the commencement of this Act shall apply to be registered as a trade union under this Act within one month of the date of its formation.</li> <li>(2) A trade union is deemed to be formed on the first date on which more than the six employees or employers, as the case may be, agree in writing to become or to form a trade union.</li> <li>8 (1) Every application for registration as a trade union shall be made to the Registrar in the prescribed form and shall be signed by at least seven members of the body applying for registration, any of whom may be officers thereof.</li> <li>10. The Registrar, on registering a trade union under section 9, shall issue to the trade union a certificate of registration in the prescribed form</li> <li>13(1) The Registrar may, in his discretion, refuse to register any trade union if he is satisfied that- <ul> <li>(a) the trade union has not complied with the provisions of this Act or of any regulations made thereunder; or</li> </ul> </li> <li>14 (1) The registration and the certificate of registration of a registered trade union may be cancelled by the Registrar in the queues of the trade union upon its dissolution</li> <li>(2)(a) -the registration was obtained by fraud or misrepresentation;</li> <li>(b) any of the objects of the trade union has become unlawful;</li> <li>18(1) Where the registration of a trade union is cancelled the Registrar may, appoint one or more persons to be liquidators thereof.</li> <li>19 (a) all of the funds (including welfare funds, if any) and assets of whatsoever description belonging to the trade union shall be realised and converted into money and shall be applied first to the cost of the dissolution, then to the discharge of the liabilities of the trade union 20(1) No trade union shall operate unless application has been made for registration in accordance with the provisions of sec</li></ul>

	Of Liquidator and registrar in winding up of Affairs of a Trade Union 19. Distribution of funds and assets of trade unions on dissolution of liquidator 20. Unregistered trade unions prohibited from carrying on business	
Part 4 Rights and liabilities	<ul> <li>21. Unregistered trade unions and officers and members not to enjoy rights, immunities or privileges</li> <li>22. Liability in relation to criminal prosecutions</li> <li>23. Trade union not unlawful</li> <li>24. Immunity from civil suit in certain cases</li> <li>25. Liability in tort</li> <li>26. Liability in contract</li> <li>27. Proceedings by and against trade unions</li> </ul>	<ul> <li>21 -No trade union shall enjoy any of the rights, immunities or privileges of a registered trade union until it is registered as a trade union under this Act,</li> <li>22 - The purposes of any registered trade union shall not, by reason merely that they are in restraint of trade, be deemed to be unlawful liable to criminal prosecution for conspiracy</li> <li>23 The purposes of any registered trade union shall not, by reason merely that they are in restraint of trade, be unlawful so as to render void or voidable any agreement or trust</li> <li>24 No suit or other legal proceeding shall be maintainable in any civil court against any registered trade union or any officer or member thereof in respect of any act done in contemplation or in furtherance of a trade dispute on the ground only that such act induces some other person to break a contract of employment,</li> <li>25 A suit against a registered trade union or against any member or officer thereof on behalf of themselves and all other members of such a registered trade union in respect of any totious act alleged to have been committed by or on behalf of such trade union shall not be entertained by any court.</li> <li>26 - (1) Every trade union shall be liable on any contract entered into by it or by an agent acting on its behalf: Provided that a trade union shall not be so liable on any contract which is void or unenforceable at law.</li> <li>(2) Nothing in this Act shall enable any court to entertain any legal proceeding instituted with the object of directly enforcing or recovering damages for the breach of any of the following agreements, namely         <ul> <li>(a) any agreement between members of a trade union as such, concerning the conditions on which any members for the time being of such trade union shall or shall not sell their goods, transact business, employ or be employed;</li> </ul> </li> </ul>

Part 5	28. Membership of minors	<ul><li>(2) A trade union which has not been registered under this Act, may sue and be sued and be prosecuted under the name by which it has been operating or is generally known.</li><li>28. A person under the age of twenty-one years may be a member of a registered trade union</li></ul>
Constitution and rules	<ol> <li>Officers of a trade union</li> <li>Voting members of trade union</li> <li>Change of name</li> <li>Notice of change of name</li> <li>Effect of change of name</li> <li>Registered office and postal address</li> <li>Rules</li> <li>Copies of constitution and rules</li> <li>Notification of officers, etc</li> <li>Right of inspection of registrar's records</li> <li>Delegation of powers of trade union</li> <li>Trustees</li> <li>All property vested in trustees</li> </ol>	<ul> <li>unless provision be made in the constitution and rules thereof to the contrary unless he is under the age of sixteen years</li> <li>(29)(1) No person shall hold the post of secretary or treasurer of a registered trade union who, in the Registrar's opinion, has not acquired a sufficiently high standard of literacy so as to enable him to perform his duties effectively.</li> <li>(2) No person who has been convicted of any crime involving fraud, dishonesty or extortion shall be an officer of a registered trade union</li> <li>(3)All officers of every trade union shall be persons who have been for a period of not less than one year and still are engaged or occupied in an industry, trade or occupation with which the union is directly concerned</li> <li>34(1) Every trade union shall have a registered office and registered postal address to which all communications and notices may be addressed.</li> <li>35(1) (a) The rules of every trade union shall provide for all the matters specified in the Schedule to this Act.</li> </ul>
		(b) It shall be lawful for the Minister from time to time, by order, to amend the Schedule to this Act.
		<ul> <li>36(1) A copy of the constitution and rules of a registered trade union shall be prominently displayed in the registered office of such trade union and in every branch office thereof</li> <li>37(1) A notice giving the names of all officers and their titles shall be prominently exhibited in the registered office of every trade union and in every branch office thereof.</li> </ul>

		<ul> <li>38. Any member of the public may inspect the constitution and rules, and the list of officers of a trade union at the office of the Registrar on payment of such fee as may from time to time be prescribed.</li> <li>39. The functions vested by the constitution or rules of a trade union in its officers or any committee appointed by it shall be exercised only by such officers or committee</li> <li>40(1) The rules of a trade union shall provide for the appointment or the election of trustees and for the filling of any vacancy in the office of a trustee so that, as far as may be, there shall always be at least three trustees of the union</li> <li>41(1) All property, movable or immovable, of a registered trade union shall be under the control of the trustees.</li> </ul>
Part 6 Amalgamation and dissolution	<ul> <li>42. Consent of registrar required to amalgamation of trade unions</li> <li>43. Application for consent to amalgamation</li> <li>44. Vote on application for consent to amalgamation</li> <li>45. Grounds for refusal to consent to amalgamation and procedure in such cases</li> <li>46. Notice in writing to be given to amalgamation, and saving of power of registrar in relation to registration of trade union formed by amalgamation</li> <li>47. Procedure for amalgamation, etc</li> <li>48. Transfe r of liabilities,</li> </ul>	<ul> <li>42. Save with the consent of the Registrar, no registered trade unions shall amalgamate as one trade union</li> <li>43(1) Where two or more registered trade unions desire to amalgamate as one trade union, an application shall be made to the Registrar for his consent to the amalgamation.</li> <li>44. No application under section 43 for the consent of the Registrar to the amalgamation of any registered trade unions shall be made unless in the case of each trade union desiring amalgamation - <ul> <li>(a) A ballot is taken</li> <li>(b) Vites of atleast half of members entitled to vote are cast and recorded</li> <li>(c) of such votes cast and recorded, those in favour of the proposal exceed by one-fifth or more the votes against the proposal</li> </ul> </li> <li>45. The Registrar may refuse to give his consent to an intended amalgamation of registered trade unions where- <ul> <li>(a) any of the provisions of this Act in respect of the making of the application for his consent have not been complied with</li> </ul> </li> <li>(2) Where, under subsection (1), the Registrar refuses to give his consent to the amalgamation of any registered trade unions, he shall, in writing, notify each of the trade unions concerned of his refusal and shall specify therein the grounds for his refusal.</li> <li>46(1) Where the Registrar gives his consent to the amalgamation of any registered trade unions concerned anotice in writing thereof and shall supply to each of the trade unions concerned such additional copies of such notice as may be necessary to enable the trade union to comply with section 47 (1).</li> <li>47(1) No registered trade unions shall be amalgamated as one trade union unless the notice in writing of the consent of the Registrar to the amalgamation has been posted at the registered of no text and unions party to the amalgamation and in every branch thereof for a neriod of not text and unions party to the amalgamation and in every branch thereof for a neriod of not text.</li> </ul>

	etc., to trade union formed by amalgamati on 49. Notification of dissolution	<b>49.</b> When a registered trade union is dissolved, notice in writing of the dissolution thereof, signed by the secretary of the trade union and seven persons who were voting members thereof at the date of the dissolution, shall, within fourteen days of the dissolution, be sent to the Registrar and shall be registered by him if he is satisfied that the dissolution has been effected in accordance with the rules of the trade union or, where a liquidator has been appointed under section 18, with the provisions of this Act; and the dissolution shall have effect from the date of such registration.
Part 7 Application of funds	<ul> <li>50. Prohibition of payment of fines or penalties</li> <li>51. Injunction to restrain misuse of funds</li> <li>52. Books to be kept</li> <li>53. Safeguarding of union funds and property</li> <li>54. Annual returns</li> <li>55. Inspection of accounts and documents</li> <li>56. Obstructing inspection by registrar</li> <li>57. Power to call for detailed accounts</li> </ul>	<ul> <li>50. The funds of a trade union shall not be applied either directly or indirectly in payment of the whole or any part of any fine or penalty imposed upon any person by sentence or order of a court of justice, other than a fine or penalty imposed upon the trade union under this Act.</li> <li>51 - An injunction restraining any unauthorized or unlawful expenditure of the funds of a trade union may be granted on the application of five or more persons having a sufficient interest in the relief sought, or of the Registrar the court, in the case of the dissolution of any trade union upon the cancellation of its registration, may order that the funds of that trade union be paid into court for disposal in accordance with the rules of that trade union.</li> <li>52. The officers of every registered trade union shall cause to be kept such books of account as may be prescribed.</li> <li>53. (5) any officer or member of a trade union shall, upon resigning or vacating his office or membership hand over to the trustees of the trade union all bonds, securities, effects, books, papers and property of the trade union in his hands or custody or otherwise under his control.</li> <li>54(1) The secretary of every registered trade union shall furnish annually to the Registrar on a prescribed date each year an audited general statement of the assets and liabilities of the trade union at such times as may be provided for in the rules of the trade union, and by the Registrar</li> <li>55. The account books, receipt books and receipts for expenditure of a trade union and a list of the members thereof shall be open to inspection by any officer or member of the trade union at such times as may be provided for in the rules of the trade union, and by the Registrar</li> <li>56. Any person who opposes, obstructs or impedes the Registrar or any person authorised by him under section 55 in the carrying out of an inspection under the provisions of that section shall be guilty of an offence and shall be liable to a fine</li> </ul>

		<b>57.</b> -(1) In addition to any other provisions of this Act relating to the rendering of accounts, the Registrar may, at any time by notice in writing, require the treasurer show in particular such information as the Registrar may require
Part 8 Picketing and intimidation and other matters relating to Disputes	<ul> <li>58. Peaceful picketing</li> <li>59. Conspiracy in trade disputes</li> <li>60. Freedom of association of employees</li> </ul>	<ul> <li>58. it shall be lawful for one or more persons acting on their own behalf or on behalf of a registered trade union in contemplation or furtherance of a trade dispute to attend at or near a place where a person works or carries on business or happens to be, if they so attend merely for the purpose of peacefully obtaining or communicating information, or of peacefully persuading any person to work or abstain from working.</li> <li>59(1) An agreement or combination by two or more persons to do or procure to be done any act in contemplation or furtherance of a trade dispute shall not be punishable as a conspiracy if such act committed by one person would not be punishable as a crime.</li> <li>60(1) No employer shall make it a condition of employment of any employee that such employee shall neither be nor become a member of any or a particular trade union or other organisation representing employees in any trade or industry, and any such condition in any contract of employment entered into before or after the commencement of this Act shall be void.</li> </ul>
Part 9 Regulations	61. Regulations	<b>61.</b> -(1) The Minister may make regulations for the purpose of carrying out or giving effect to the provisions of this Act.
Part 10 Offences and penalties	<ul> <li>62. Penalty for misuse of money or property of a trade union</li> <li>63. Penalty for failure to give notice or produce document</li> <li>64. Limitation of prosecutions</li> <li>65. Jurisdiction</li> </ul>	<ul> <li>62(1) Where, on complaint made by a member of a trade union or the Registrar, it is shown to the satisfaction of a court that any person has in his possession or control any property of the trade union except in accordance with the constitution and rules of the trade union the court shall, if it considers the justice of the case so requires, order such person to deliver all such property to the trustees of the trade union and to pay to them the money so unlawfully expended or withheld.</li> <li>63. A trade union which fails to give any notice or to send or to produce any document which it is required by this Act or any regulations made thereunder to give shall be guilty of an offence and shall be liable to a fine of one hundred dollars unless some other punishment is provided for such offence by this Act.</li> <li>64. No prosecution shall be instituted under Part VIII of this Act except by, or at the instance, of or with the written consent of, the Director of Public Prosecutions.</li> <li>65. Notwithstanding any provision to the contrary in any other Act, all offences and penalties under this Act may be prosecuted and recovered before a Magistrate's Court.</li> </ul>

Part 11 Miscellaneous	<ul> <li>66. Nomination</li> <li>67. Service of legal process</li> <li>68. Notification of certain matters by the registrar</li> <li>69. Inapplicability of certain laws</li> </ul>	<ul> <li>66(1) A member of a trade union not being under the age of sixteen years may, by writing under his hand, delivered at or sent to the principal office of the trade union, nominate a person, not being an officer or servant of the trade union (unless such officer or servant is the husband, wife, father, mother, child, brother, sister, nephew or niece of the nominator), to whom any moneys payable (not exceeding such amount as may from time to time be prescribed) on the death of such member shall be paid at his decease</li> <li>67.Every summons, notice or other document required to be served on a trade union in any civil or criminal proceeding shall be deemed to be duly served if it is delivered at the registered office of the trade union or posted to its registered postal address by registered post,</li> <li>68 - The Registrar shall, by notice published in such manner as he may determine, notify the following matters within twenty-eight days of the occurrence thereof-</li> <li>a. that a trade union has applied for registration;</li> <li>b. that any trade union has been registered or that registration has been cancelled or suspended;</li> <li>69- The Companies Act and the Cooperative Societies Act shall not apply to any trade union and the registration of a trade union under either of those Acts shall be void and of no effect.</li> </ul>
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# 5. UNFAIR DISMISAL (Amendment) ACT 1996

Law	Clause/Part	Subclause/Section	Abstract	Remarks
Unfair Dismissal Act	Part 1 Introduction	1. Short Title and commencement	<ol> <li>This Act may be Cited as the Unfair Dismissal Act 1982</li> <li>"An act to provide a remedy for employees who are unfairly dismissed; for questions about redundancy payments to be referred to the trade disputes panel; for the enforcement of money awards of the panel; to extend the power to make rules about the panel and for connected purposes"</li> </ol>	
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	Part 2 Unfair Dismissal	<ol> <li>Right not to be unfairly dismissed</li> <li>Meaning of "Dismissal"</li> <li>"Fair" and "Unfair" dismissal</li> <li>Excluded cases</li> <li>Compliant of unfair dismissal</li> <li>Amount of compensation</li> </ol>	<ul> <li>2. Every employee has the right not to be unfairly dismissed by their employer</li> <li>2.1. The remedy for an employee dismissed in breach of that right is that provided by section 6.</li> <li>3. An employee is dismissed by their employee if and only if; <ul> <li>(a). the employment contract is terminated by notice of employer</li> <li>(b). a fixed term contract is expired without renewal</li> <li>(c) the employee terminates their contract with/without notice in circumstances in which, by reason of the employer's conduct</li> </ul> </li> <li>4. (1) An employee who is dismissed is not unfairly dismissed if-</li> <li>(a) he is dismissed for a substantial reason of a kind such as to justify the dismissal of an employee holding his position; and</li> <li>(b) in all the circumstances, the employer acted reasonably in treating that reason as sufficient for dismissing the employee.</li> </ul> <li>(2) An employee who is dismissed is not unfairly dismissed if he is dismissed because of redundancy.</li> <li>(3) An employee who is dismissed is not unfairly dismissed if the reason for his dismissal is that he could not continue to work in the position which he held without contravention (either on his part or on that of his employer) of a duty or restriction imposed by or under written law.</li>	

(4) In deciding whether the dismissal of an employee was fair or unfair, there may be taken into consideration the period of time for which he has worked in the employer's undertaking; but an employee who is dismissed is not unfairly dismissed if-
(a) he is dismissed within the period of 26 weeks beginning when his employment in the employer's undertaking began; and
(b) before his dismissal he has agreed in writing to exclude any claim for unfair dismissal arising within that period.
<b>5.</b> (1) Section 2 does not confer a right on any person employed under a contract of employment for a fixed term (whether or not the term might be renewed) unless he is a citizen of Solomon Islands.
(2) That section does not confer a right on any person if, under, his contract of employment, he ordinarily works outside Solomon Islands.
<b>6.</b> (1) An employee ("the complainant") may present a complaint to the Trade Disputes Panel against his employer that he has been unfairly dismissed by the employer.
<ul><li>(2) In the case of an employee dismissed in connection with a trade dispute that is referred to the Panel, no complaint by the employee under this section may be considered by the Panel while the dispute stands referred to them</li><li>(3) A complaint may not be made after the end of three months beginning with the date of dismissal.</li></ul>
<ul> <li>(4) If the Panel –</li> <li>(a) find that the complaint is well-founded;</li> <li>(b) consider that it would be both practicable and fair for the complainant to be re-engaged by the employer,</li> <li>the Panel must make a recommendation to that effect, stating the terms on which they consider that it would be reasonable for the complainant to be re-engaged.</li> </ul>

		(5) If the Panel find that the complaint is well-founded but either-	
		<ul> <li>(a) do not make a recommendation under subsection</li> <li>(4); or</li> <li>(b) having made such a recommendation, it is not complied with,</li> <li>The Panel must make an award of compensation to be paid by the employer to the complainant in respect of the dismissal, unless the complainant has been re-engaged by the employer on terms which the Panel consider reasonable.</li> <li>(6) If, on a complaint under this section, it is shown that the complainant was dismissed, it is for the employer to show what was the reason for the dismissal.</li> <li>(7) In this section, "trade dispute" has the same meaning as in the Trade Disputes Act; and "re-engaged" includes "re-instated".</li> </ul>	
		7 (1) The amount of compensation that may be awarded by the Trade Disputes Panel under section 6 is such amount as the Panel consider fair and reasonable in all the circumstances, taking account (among other things) of the conduct of the employer and the complainant both before and after the date of dismissal.	
		<ul> <li>(2) But that amount may not exceed the amount which, in the complainant's case, represents 52 x BW, where "BW" is the basic weekly wage of the complainant on the date of his dismissal.</li> <li>(3) Where any party is aggrieved by the amount of compensation awarded by the Trade Dispute Panel under section 6 he may within one month of the date of the award appeal to a Court.</li> </ul>	
Part 3 Redundancy	Payments8. Complaints about redundancy payments	8 (1) Any question arising under Part II of the Employment Act as to the right of any person to a redundancy payment, or as to the amount of the payment, shall be referred to the Trade Disputes Panel	

			<ul> <li>by a complaint under this section and determined by the panel.</li> <li>*(2) Accordingly, that Act is amended as follows-</li> <li>(a) in section 4(2), for "Commissioner of Labour" substitute "Trade Disputes Panel";</li> <li>(b) in section 9(1) (c), for "Commissioner of Labour" substitute "Trade Disputes Panel"; and</li> <li>(c) omit sections 10 and 11;</li> <li>but sections 10 and 11 of that Act continue to have effect for the purposes of Part III of that Act (long service benefit) and in respect of any question referred to the Commissioner of Labour under section 10 of that Act before the commencement of this section.</li> <li>(3) The hearing of a complaint under this section may be combined with the hearing of a complaint under section 4(2) of the Employment Act (presumption of redundancy) does not apply.</li> <li>*The amendments to the Employment Act set out in this subsection have been given effect to.</li> </ul>	
Part Gen	t 4 neral	<ul> <li>9 Enforcements of money awards of trade disputes panel</li> <li>10 Applications of Provisions of Employment Act 1982</li> <li>11 Application and Extension of</li> </ul>	<ul> <li>9. Where- <ul> <li>(a) the Trade Disputes Panel has</li> <li>determined that an employer is liable to</li> <li>make a redundancy payment of a</li> <li>specified amount to an employee or is</li> <li>to pay compensation under section</li> <li>6(5); and</li> <li>(b) the payment has not been made,</li> </ul> </li> <li>The payment may be recovered as a debt and, accordingly, any</li> <li>magistrate's court (irrespective of the financial limits on its jurisdiction) may on a complaint by or on behalf of the employee order the payment of that sum.</li> </ul> 10. (1) In this Act-	

Disputes Act "employer"; "redundancy payment"; and "renewal"; Have the same meaning as in Part II of the Employment Act.	Disputes Act	<ul> <li>"employer"; "redundancy payment"; and "renewal";</li> <li>Have the same meaning as in Part II of the Employment Act.</li> <li>(2) Sections 4 (meaning of dismissal "because of redundancy"), 5(3) (date of dismissal), 23(1) (Government employment), 24 (regulations) and 25(1) (supplementary provisions) of the Employment Act apply for the purposes of this Act as they apply for the purposes of Part II of that Act.</li> <li>(3) But section 25(1) of that Act applies subject to section 4(4) of this Act.</li> <li>11. (1) Sections 3(3) (rules for Trade Disputes Panel), 7(1) (award to show reasons), 8(1) (Panel may give majority award) and 13 (appeals) of the Trade Disputes Act apply in relation to any award or other decision of the Trade Disputes Panel under this Act as they apply in relation to awards or decisions under the Trade Disputes Act.</li> <li>(2) The Panel has the same power to order parties to a complaint under this Act to contribute towards the expenses of the panel as it has under section 11 of the Trade Disputes Act to order parties to a trade dispute to do so.</li> </ul>	
		(2) Sections 4 (meaning of dismissal "because of redundancy"), 5(3) (date of dismissal), 23(1) (Government employment), 24 (regulations) and 25(1) (supplementary provisions) of the Employment Act apply for the purposes of this Act as they apply for the purposes of Part II of that Act.	
<ul> <li>(2) Sections 4 (meaning of dismissal "because of redundancy"), 5(3) (date of dismissal), 23(1) (Government employment), 24 (regulations) and 25(1) (supplementary provisions) of the Employment Act apply for the purposes of this Act as they apply for the purposes of Part II of that Act.</li> </ul>		<ul> <li>(3) But section 25(1) of that Act applies subject to section 4(4) of this Act.</li> </ul>	
<ul> <li>(2) Sections 4 (meaning of dismissal "because of redundancy"), 5(3) (date of dismissal), 23(1) (Government employment), 24 (regulations) and 25(1) (supplementary provisions) of the Employment Act apply for the purposes of this Act as they apply for the purposes of Part II of that Act.</li> <li>(3) But section 25(1) of that Act applies subject to section 4(4) of this Act.</li> </ul>		<b>11.</b> (1) Sections 3(3) (rules for Trade Disputes Panel), 7(1) (award to show reasons), 8(1) (Panel may give majority award) and 13 (appeals) of the Trade Disputes Act apply in relation to any award or other decision of the Trade Disputes Panel under this Act as they apply in relation to awards or decisions under the Trade Disputes Act.	
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# 6. Environmental Health (Amendment) Act 1996

Law	Clause/Part	Subclause/Section	Abstract
Environment Health		1. SHORT TITLE 2. INTERPRETATION	<ol> <li>-This Act may be cited as the Environmental Health Act.</li> <li>-In this Act, unless the context otherwise requires -</li> </ol>
			"Authorised Officer" means an officer appointed under sections 4 or 6(1);

(Amendment) Act 1996		<ul> <li>"Enforcement Authority" means an authority included in those specified in section 6(1);</li> <li>"Minister" means the Minister from time to time assigned responsibility for environmental health matters, and "Ministry" shall be construed accordingly;</li> <li>"Permanent Secretary" means the Permanent Secretary to the Minister responsible for environmental health matters.</li> </ul>
	<ol> <li>3. DUTIES OF THE MINISTER</li> <li>4. APPOINTMENT OF STAFF</li> <li>5. DELEGATION BY THE MINISTER</li> <li>6. ENFORCEMENT AUTHORITIES</li> <li>7. DEFAULT BY ENFORCEMENT AUTHORITY</li> <li>8. POWERS OF ENFORCEMENT AUTHORITY</li> <li>9. RIGHT OF ENTRY OF AUTHORISED OFFICERS</li> <li>10. PROTECTION OF AUTHORISED OFFICERS</li> </ol>	<ol> <li>Minister shall be responsible for the administration of the environmental health services in Solomon Islands.</li> <li>the services of a Ministry headed by a Permanent Secretary and may appoint such persons (to be known as "Authorised Officers")</li> <li>- (1) The Minister may by Order delegate any matters falling to be administered by the Ministry under this Act to an Enforcement Authority</li> <li>The Enforcement Authorities to which the Minister may delegate matters in accordance with section 5(1) are the Provincial Assemblies and the Honiara Town Council.</li> <li>Whenever a complaint is made to the Minister shall make an Order directing the Enforcement Authority to perform its duty in respect of the matter of such complaint and shall prescribe a time for such exercise or performance.</li> <li>Any person appointed under subsection (2) to perform the duty of a defaulting Enforcement Authority shall, in the performance and for the purpose of such duty, have all the powers exercisable by such Enforcement Authority under this Act or any regulations made hereunder.</li> <li>Any Enforcement Authority may, in respect of such matters as may have been delegated to it under this Act by the Minister, make by-laws to</li> </ol>

facilitate the efficient operation of services provided and actions carried out by it in connection with such matters.
<b>9</b> (1) Any Authorised Officer shall on producing, if required, some duly authenticated document showing his authority, have the right to enter any premises at all reasonable times -
(a) for the purpose of ascertaining whether there is or has been on or in connection with the premises any contravention of this Act or regulations made hereunder;
(b) for the purpose of ascertaining whether or not circumstances exist which would authorise or require the Enforcement Authority to take action or execute any work under this Act or regulations made hereunder;
(c) for the purpose of taking any action or executing any work authorised or required under this Act or any regulations made hereunder, to be taken or executed by the Enforcement Authority;
(d) generally for the performance by the Enforcement Authority of matters assigned or delegated to it under this Act:
Provided that admission to any premises not being a factory, workshop or workplace shall not be demanded as a right unless twenty-four hours notice of intended entry has been given to the occupier.
(2) If it is shown to the satisfaction of a Magistrate that-
<ul><li>(a) admission to any premises has been refused or that the premises are unoccupied or the occupier is temporarily absent or that the case is one of emergency or that an application for admission would defeat the object of entry; and</li></ul>
(b) there are reasonable grounds for entry into the premises as aforesaid,
The Magistrate may by warrant authorise any Authorised Officer to enter the premises, if need be, by force. (3) Any person who wilfully obstructs any Authorised Officer acting in execution of
this Act shall be liable to a fine of two hundred dollars.

		<ul><li>10(1) No Authorised Officer shall be generally liable in respect of any act done by him in the execution or purported execution of this Act and within the scope of his employment, if he did such act in the honest belief that his duty under the Act required him or entitled him to do it:</li><li>Provided that nothing in this section shall be construed as relieving an Enforcement Authority from any liability in respect of the acts of Authorised Officers employed by it.</li></ul>
	11. REGULATIONS	<ul> <li>11(1) The Minister may make Regulations for the better carrying out of the purposes and provisions of this Act and regulating the activities of any person (including the Government or any statutory authority) in relation to the maintenance or improvement of environmental health generally.</li> <li>(2) Such regulations may create offences and prescribe penalties in respect thereof not exceeding a fine of one thousand dollars or imprisonment for one year or for both such fine and imprisonment, and such penalty may provide for fines to be imposed on a daily basis in respect of a continuing offence.</li> <li>(3) Offences against regulations made under subsection (1) may be dealt with in the manner prescribed therein or as prescribed in section 12.</li> </ul>
	<ol> <li>SUMMARY PROCEEDINGS FOR OFFENCES</li> <li>SERVICE OF NOTICES</li> <li>LIABILITY OF SECRETARY, MANAGER OR DIRECTOR OF A COMPANY</li> </ol>	<ul> <li>12 Proceedings for enforcement of regulations made under this Act may, where the Enforcement Authority considers it desirable that the person it considers to be in breach of any such regulation shall first have the opportunity to remedy such breach, be taken in accordance with the provisions of this section</li> <li>13. Unless otherwise expressly provided, any order, notice, demand, certificate or other document required to be served under the provisions of this Act or regulations made hereunder may be served either - <ul> <li>(a) by delivering it to the person on whom it is to be served; or</li> <li>(b) by sending it by registered post addressed to the last known place of business or residence of the person to be served; or</li> <li>(c) by leaving it with an adult occupier of the premises or place to which the notice relates or by posting it upon a conspicuous part of such premises or place.</li> </ul> </li> <li>14. Where a contravention of any of the provisions of this Act or regulations made hereunder is committed by any company or corporation,</li> </ul>

		the secretary, manager or any director thereof may be summoned and shall be held liable for such contravention and the consequences thereof
	15. PROSECUTIONS	<ul> <li>15(1) An Enforcement Authority (which for this purpose shall include the Ministry) may, by any Authorised Officer, or by any person generally or specially authorised by it in writing, institute and conduct proceedings for any contravention of, or offence against, or default in complying with, any provision of this Act or regulations or by-laws made hereunder if the contravention, offence or default is alleged to have been committed within its boundaries.</li> <li>(2) All fines secured under the provisions of this Act by or on behalf of an Enforcement Authority other than the Ministry shall be paid into the general revenue of that Authority.</li> <li>(3) Nothing in this section shall be deemed to derogate from the powers of the Director of Public Prosecutions in relation to the prosecution of criminal offences.</li> </ul>
	<ul><li>16. REFERENCE TO OWNER OF PREMISES</li><li>17. RECOVERY OF COSTS AND EXPENSES</li></ul>	16. Whenever in any proceedings whether written or otherwise under this Act or any regulations made hereunder, it becomes necessary to refer to the owner of any premises, it shall be sufficient to designate him as the owner of those premises without name or further description. 17. Where any Enforcement Authority (including the Ministry) has incurred expenses for the repayment whereof the owner of the premises for or in respect of which the same are incurred is made liable under this Act or by an agreement with the Enforcement Authority, those expenses may be recovered, together with interest at a rate not exceeding five <i>per centum</i> per annum from the date of service of a demand for the same until payment thereof, from any person who is the owner of the premises when the works are completed for which the same shall be a charge on the premises in respect of which they were incurred.
	18. FINANCIAL PROVISIONS	<ul> <li>18(1) Any expenses incurred by the Ministry in the exercise of its functions under this Act shall be defrayed out of monies provided by Parliament.</li> <li>(2) All fees levied or charges collected by the Ministry or fines secured by or on behalf of the Ministry under the provisions of this Act or regulations made hereunder or regular visits made hereunder shall be paid into the Consolidated Fund.</li> <li>(3) Where fees are charged in accordance with Regulations made under this Act, the conditions under which any remission of such fees may be granted by the person or authority responsible for the collection thereof shall be prescribed by the Minister.</li> </ul>

	(4) Any fee or charge payable under or by virtue of this Act or regulations made hereunder and remaining unpaid after the due date for payment, may in addition to any other lawful method of recovery, be recovered as a debt due to the Crown.
19. REPEAL AND SAVINGS	<b>19.</b> Subject to the provisions of section 11, the Public Health Act, 1970 is hereby repealed: Provided that all subsidiary legislation made thereunder in force immediately prior to the coming into operation of this Act, shall continue in force until such time as the Minister may by Order, revoke or rescind such subsidiary legislation or any part thereof, or otherwise replace the same.

## 7. THE ENVIRONMENTAL HEALTH (PUBLIC HEALTH ACT) REGULATIONS (Reviewed Edition) 1996

Law	Clause/Part	Subclause/Section	Abstract	Remarks
THE ENVIRONMENTAL HEALTH (PUBLIC HEALTH ACT) REGULATIONS 1996	Part I Preliminary	<ol> <li>Citation</li> <li>Interpretation</li> </ol>	<ol> <li>These Regulations may be cited as the Environmental Health (Public Health Act) Regulations</li> <li>Interpretation</li> <li>"building" includes any structure whatsoever for whatever purpose used;</li> <li>"business" means any commercial undertaking includes</li> <li>"drainage" means the conveyance of sewage, rain and surface water from buildings and premises, and includes the conveyance by means of a sink and any other necessary appliance of waste water, and the conveyance of rain water from roofs;</li> <li>"drainage works" means the construction, installation, laying, connecting, fixing, repair or</li> </ol>	
			removal of any pipe, drain, gully, cesspool,	

		soakaway, septic tank, sewage filter installation or other works for the discharge, reception or disposal of sewage in connection with any premises, or of any waste-pipe, soil-pipe trap, urinal, water-closet, slop-hopper, sink, bath, lavatory basin, ventilation pipe or anti- syphonage pipe, or any drain fitting or water- flushing cistern, or any works connected with the discharge of liquid or soiled matter into any drain, sewer, cesspool soakaway, septic tank, sewage filter installation, or other like receptacle for drainage, or otherwise connected with the drainage of any premises; "sewage" means soil water, waste water, and manufacturing or trade effluent; "waste water" means discharge of a non- excremental character from baths, lavatory basins, sinks, wash-tubs, and similar fittings;	
Part II	[*Part II of the repeal Public Health Act omitted - vide section 11 of the Environmental Health Act.]		
Part III PREVENTION AND SUPPRESSION OF NOTIFIABLE DISEASES	<ul> <li>7 Provisions regarding notification of notifiable diseases</li> <li>8 Powers of Minister, Director, local authorities, etc</li> </ul>	<ul> <li>7(1) Where any person is suffering from any notifiable disease - <ul> <li>(a) the person in charge of or in attendance on the patient, and in default of any such person the occupier of any building in which the patient may be lodged shall, as soon as he becomes aware, or has reason to suspect that the patient is suffering from any notifiable disease, send</li> </ul></li></ul>	

[*Sections 9-20notice thereof to the nearest medical practitioner, or to the nearest nurse registered under the Nursing Council Act or, in default of any such person, to the nearest health inspector, health officer or sanitary officer;110/1970] <b>21</b> Powers to amend First Schedule and to <b>8.</b> -(1) For the purposes of preventing the occurrence or of checking the spread of any notifiable disease in Solomon. Island, and generally for carrying out the provisions of this Part, the Minister acting in his discretion shall	
restrict application of Part have power- (a) to cause to be provided in such parts of Solomon Islands as he may deem fit permanent or temporary hospitals, camps and stations for- (i) the isolation, treatment and disinfection of persons suffering from a notifiable disease and of persons who, as a result of contact with infected persons or otherwise, may be or become a source of infection; (ii) the isolation, cleansing and disinfection of infected articles and goods; (2) The Under Secretary (Health) Ministry of Health and Medical Services shall, for the dirorsaid purposes, have power - *(f) to forbid the discharge of sewage, drianage or insanitary matter of any description into any	

		<ul> <li>watercourse stream, lake or source of water supply;</li> <li>21. The Minister may by notice-</li> <li>(a) amend the First Schedule; and</li> <li>(b) Direct that all or any of the provisions of this Part shall not apply in relation to any notifiable disease specified in such notice.</li> </ul>	
PART IV NUISANCES	<ul> <li>22 Nuisance prohibited</li> <li>23 Local authorities to maintain cleanliness and prevent nuisances</li> <li>24 What constitutes nuisance</li> <li>25 Notice to remove nuisance</li> <li>26 Procedure if owner fails to comply with notice</li> <li>27 Penalty respecting nuisances</li> <li>28 Proceedings where nuisance caused by acts</li> </ul>	<ul> <li>22. No person shall cause a nuisance or shall suffer to exist on any land or premises owned or occupied by him or of which he is in charge any nuisance or other condition liable to be injurious or dangerous to health.</li> <li>23. It shall be the duty of every local authority to take all lawful, necessary and reasonably practicable measures for maintaining its district at all times in a clean and sanitary condition</li> <li>24 The following shall be deemed to be nuisances liable to be dealt with in the manner provided in this Part: - <ul> <li>(a) any dwelling or premises or part thereof which is or are of such construction or in such a state or so situated or so dirty or so verminous as to be injurious or dangerous health or which is or are liable to favour the spread of a infectious disease;</li> <li>(c) any well, river, stream, spring or other source of water supply, or any tank, cistern or other receptacle for water, whether public or private, the water from which is used or is likely to</li> </ul> </li> </ul>	

	or defaults of two or more persons 29 Proceedings where nuisance caused by acts or defaults of two or more persons 30 Power of entry 31 Meaning of "court"	be used by man for drinking or domestic purposes, or in connection with any dairy, or in connection with the manufacture or preparation of any article of food intended for human consumption, which is in the opinion of a health inspector or health officer polluted or otherwise liable to render any such water injurious or dangerous to health; (d) any noxious matter or waste water flowing or discharged from any premises, wherever situated, into any street, or into	
		the gutter, side channel or surface water drain of any street, or into any watercourse, irrigation channel of bed thereof not approved for the reception of such discharge;	
		<ul> <li>(h) any dwelling or premises which is or are so over- crowded as to be injurious or dangerous to the health of the inmates;</li> <li>(a) Any set omission or thing which is or</li> </ul>	
		(o) Any act, omission or thing which is, or may be, dangerous to life, or injurious to health.	
		<b>25.</b> A local authority or health inspector, if satisfied of the existence of a nuisance, shall serve a notice on the author of the nuisance Provided that -	
		(a) where the nuisance arises from any want or defect of a structural character, or where the dwelling or premises is or are unoccupied, the notice shall be served on the owner;	

	<ul> <li>(b) where the author of the nuisance cannot be found and it is clear that the nuisance does not arise or continue by the act or default or sufferance of the occupier or owner of the dwelling or premises, the local authority or health inspector may remove or cause the same to be removed and may do what is necessary to prevent the recurrence thereof.</li> <li>26(1) If the person on whom a notice to remove a nuisance has been served as aforesaid fails to comply with any of the requirements thereof within the time specified, the local authority or a health inspector shall cause a complaint relating to such nuisance to be made before a court and the court shall thereupon issue a summons requiring the person on whom the notice was served to appear before it</li> </ul>	
	(2) If the court is satisfied that the alleged nuisance exists, the court shall make an order on the author thereof, or the occupier or owner of the dwelling or premises, as the case may be, requiring him to comply with all or any of the requirements of the notice or otherwise to remove the nuisance within a time specified	
	<b>27</b> (1) Any person who fails to obey an order to comply with the requirements of the local authority or health inspector, or otherwise to remove the nuisance, shall, unless he satisfies the court that he has used all diligence to carry out such order, be guilty of an offence and liable to a fine of forty dollars and to a further fine of ten dollars for every day or part of a day during which the non-compliance continues.	
	<b>28</b> . Whenever it appears to the satisfaction of a Magistrate that the person by whose act or default a nuisance arises, or that the owner or occupier of the premises, is not known or cannot be found, he may order the local authority to execute the	

	works thereby directed, and the cost of executing the same shall be a charge on the property on which the said nuisance exists.	
	<b>29</b> . Where a nuisance appears to be wholly or partly caused by the acts or defaults of two or more persons, proceedings may be instituted under the foregoing provisions of this Part against any one of them, or all or any two or more of them may be included in the same proceedings and, subject to those provisions, any one or more of the persons proceeded against may be ordered to abate the nuisance,	
	<b>30</b> (1) A local authority or any of its health officers, or medical officer or health inspector or, on the request of the health officer, medical officer, or health inspector and on the order of a Magistrate, any police officer of or above the rank of Inspector, shall have the right to enter any building or premises-	
	(a) for the purpose of examining as to the existence thereon of any nuisance liable to be dealt with summarily under this Part at any hour by day and, in the case of a nuisance referred to in regulation $24(h)$ at any hour by day or by night, or, in the case of a nuisance arising in respect of any trade or business, at any time when that trade or business is in progress or is usually carried on;	
	<ul> <li>(b) where a nuisance has been ascertained to exist or a nuisance order has been made under this Part, at any such hour as aforesaid until the nuisance is abated or the works ordered to be done are completed; and</li> <li>31. In this Part, "court" means a Magistrate's Court, or a local court constituted under the Local Courts Act.</li> </ul>	
	Local Courts Act.	

PART VI Prevention and Destruction of Mosquitoes	<ul> <li>34 Breeding places to be nuisances</li> <li>35 Premises to be kept free from long grass and receptacles likely to facilitate breeding of mosquitoes</li> <li>36 Water tanks, etc. to be covered and screened</li> <li>37 Septic tanks, soakaways, etc. to be screened</li> <li>39 Mere presence of mosquito larvae an offence</li> </ul>	<ul> <li>34. All collections of water, sewage, rubbish, which permit or facilitate the breeding or multiplication of animal or vegetable parasites of men or domestic animals or of mosquitoes shall be nuisances liable to be dealt with in the manner provided in Part IV.</li> <li>35(1) No person shall permit any premises or lands owed or occupied by him or over which he has control and which are situated within twenty yards of any dwelling, public building, school, store, workshop or workplace to become overgrown with long grass of such a nature as to be likely to harbour mosquitoes.</li> <li>36(1) It shall not be lawful for any person to keep, or for the owner or occupier of any premises to allow to be kept thereon, any collection of water in any barrel, tub, bucket, tank or other vessel intended for the storage of water unless such barrel, tub, bucket, tank or other vessel is fitted with a sufficient cover and is properly protected or screened to the satisfaction of a health inspector or health officer so as to prevent the ingress of mosquitoes into the same.</li> <li>37. The owner or occupier of any premises upon or attached to which is any cesspit, cesspool, septic tank or soak away shall cause such cesspit, cesspool, septic tank or soak away shall cause such cesspit, he shall be guilty of an offence and liable to a fine of forty dollars.</li> <li>39. Notwithstanding any provision of these Regulations, the owner or occupier of any house or premises, or the owner or person having the charge of any vessel, or other article or receptacle in or about which there is any collection of water found by a health inspector, health officer or sanitary officer to contain any of the immature stages of the</li> </ul>	

		mosquito shall be guilty of an offence and liable in respect of each and every such collection of water to a fine of ten dollars.	
PART VIII PROVISION AND PROTECTION OF WATER SUPPLIES	<ul> <li>43 Houses to be provided with water supply</li> <li>45 Powers of sampling</li> <li>47 Power to close or restrict use of water from polluted source of supply</li> <li>48 Tanks, etc. to be kept clean</li> <li>49 Pollution of water supply</li> </ul>	<ul> <li>43 every building intended for human habitation shall be provided within its cartilage with a proper and sufficient supply of wholesome water</li> <li>45. A health inspector or health officer may enter upon any land or premises at any time during the day for the purpose of taking water samples for examination from any well, stream, reservoir, spring, tap, faucet, pump, storage tank</li> <li>47 If a local authority is satisfied upon a report from a heal inspector or health officer that the water in or obtained from any well, spring, stream, reservoir, tank so polluted as to be prejudicial to health the local authority may direct the owner of the premises to use for certain purposes only to reduce harm</li> <li>48 any tank, cistern or other receptacle for the collection or storage of water used to be maintained at all times in a clean condition and protected from contamination</li> <li>49(1) Every person who knowingly and wilfully in any way defiles or pollutes any water-course, stream, lake, pond, or reservoir shall be guilty of an offence and liable to a fine of forty dollars.</li> </ul>	
PART X BUILDINGS AND HOUSING	<b>56</b> Local authorities to prevent or remedy danger to health from unsuitable dwellings	<b>56</b> It shall be the duty of every local authority to take all lawful, necessary and reasonably practicable measures for preventing or causing to be prevented or remedied all conditions liable to be injurious or dangerous to health arising from the erection or occupation of unhealthy dwellings or buildings	

	<ul> <li>57 Building lots to be filled in and drained</li> <li>58 Notice to be given and plans furnished</li> <li>59 Buildings constructed of materials which are short-lived or otherwise unsuitable for use in permanent buildings</li> <li>60 Building sites not to be filled in with refuse matter</li> <li>64 Notice of closing order</li> </ul>	57 No dwelling or building shall be erected on any area of land unless and it has been filled in and levelled the area to the satisfaction of the local authority and construct drainage of the area <b>58</b> (1) Any owner intending to utilise any area of land for the erection of a building shall give notice in writing to the local authority and shall, together with the notice, furnish a plan of the propose dwelling or building <b>59</b> (1) Where, plans are deposited with a local authority, showing that it is proposed to construct a dwelling or building of materials which are, in the absence of special care, liable to rapid deterioration, or are otherwise, in the opinion of the local authority, unsuitable for use in the construction of permanent buildings, the local authority may - reject the plans; or	
	<ul> <li>66 Demolition order</li> <li>67 Execution of work by owner</li> <li>68 Removal of buildings</li> <li>69 Appeal against order</li> <li>70 Abatement of overcrowding</li> <li>71 Regulations in relation to overcrowding.</li> <li>73 Nuisances</li> </ul>	<ul> <li>in passing the plans, fix a period on the expiration of which the building must be removed and impose, with respect to the use of the building, such reasonable conditions, if any, as, having regard to the nature of the materials used in its construction, it deems appropriate.</li> <li>(3) The owner of any building in respect of which a period has been fixed under this section shall, on the expiration of that period, remove the building, and, if he fails to do so, the local authority may remove it and may recover from him the expenses reasonably incurred by it in so doing, and, without prejudice to the right of the local authority to exercise that</li> </ul>	

	<ul> <li>power, he shall be guilty of an offence and liable to a fine of fifty dollars.</li> <li>(4) Any person who uses a building in contravention of any condition imposed under this regulation, or who permits such building to be so used, shall be guilty of an offence and liable to a fine of fifty dollars.</li> <li>60(1) Except with the written permission of a local authority, it shall not be lawful in any urban sanitary district to fill up or to raise the level of any land to be used as a building site with refuse matter containing or impregnated with faecal animal or vegetable matter.</li> <li>(2) It shall not be lawful to erect any new building on any ground which has been filled up with any such refuse matter</li> <li>61(1) Where plans for the erection or extension of a building are, in accordance with regulation 58, deposited with a local authority, the local authority shall reject the plans, unless it is shown to it that satisfactory means of access from the house to a street for the purpose of the removal of refuse will be provided.</li> </ul>	
	(3) It shall be unlawful for any person, except with the consent of the local authority, to close or obstruct the means of access by which refuse is removed from any house, and the local authority, in giving its consent, may impose such conditions as it thinks fit with respect to the improvement of any alternative means of access, or the substitution of other means of access.	
	(4)Any person who contravenes the provisions of paragraph (3) shall be guilty of an offence and liable to a fine of fifty dollars.	
	<b>62</b> The local authority or any of its officers, or a health inspector may enter any building or	

premises for the purpose of examining as to the existence of any nuisance therein at all reasonable times, 63.-(1) where a medical officer, health inspector serves notice in writing on a local authority that any building is unfit or unsafe for human habitation, such local authority may by an order in writing, hereinafter referred to as a closing order, declare that such dwelling or building or part thereof is not fit for human habitation (5) Such order may provide that such direction shall not have effect if the repairs or alterations specified therein are made in the dwelling or building so as to render it fit for human habitation or occupation to the satisfaction of the local authority. 64 Where a closing order has been made in respect of a building, the local authority shall serve a notice of the order on every occupying tenant of the building and within such period as is specified in the notice, not being less than 7days after the service of the notice, the order shall be obeyed by him and shall cease to inhabit the dwelling or building, and in default he shall be guilty of an offence and liable to a fine of \$50

**65**. Where a closing order has been made in respect of any building and has not been determined by any subsequent order, then the local authority, if of opinion that the dwelling or building has not been rendered fit for human habitation or occupation and if the necessary steps are not being taken to render it so fit, shall cause notice to be served on the owner of the dwelling or building that it considers it expedient to order the demolition of the dwelling or building or any part thereof, and such notice shall specify a time and place appointed by the local authority for further consideration of the matter, not being less than one month after service of the notice, and any owner of the dwelling or building shall be at liberty to attend and state his objections to the demolition.

66. If upon consideration of any objections made under regulation 65, the local authority decides it is expedient so to do, then, unless the owner undertakes forthwith to execute the work necessary to render the dwelling or building fit for human habitation or occupation, the local authority shall order the demolition of the dwelling or building or any part thereof.

**67** If the owner undertakes to execute the works necessary render the dwelling or building fit for human habitation, the local authority may order the execution of the works within such reasonable time as is specified in the order and if the works are not completed within the time or any extended time allowed by the local authority, the local authority shall order the demolition of the said dwelling or building or any part thereof.

	<ul> <li>68 Where an order for the demolition of a dwelling or building or any part thereof has been given, the owner thereof shall, within three months after service of the order, proceed to take down and remove the said dwelling or building</li> <li>69. Any person aggrieved by an order of the local authority under the provisions of regulations 66 or 67 may within ten days of the service of such order require by summons the local authority to appear before a Magistrate to show cause why the order should not be set aside.</li> <li>70(1) Any dwelling or premises used for the purpose of human habitation or any part of any such dwelling or premises which is or are so overcrowded as to be dangerous or injuries to the health of the inmates thereof, whether members of the same family or not, shall be a nuisance which may be dealt with under the provisions of Part IV.</li> </ul>	
	<ul> <li>71. Without prejudice to the provisions of regulation 70, the Minister may make regulations in relation to overcrowding or protection of health prescribing or providing for-</li> <li>(a) the control of the number of persons who may at one time occupy, work in or use any premises or any part of any premises;</li> <li>(b) the separation of the sexes occupying the same premises or the same part of any premises for the purpose of habitation;</li> </ul>	
	(c) the control (including prohibition) of the use of any	

		<ul> <li>specified purposes of any premises or any part of any premises;</li> <li>(d) the proper access of light and ventilation to premises or any part of any premises;</li> <li>(e) the control (including prohibition) of the erection, alteration or maintenance of verandas, balconies, cubicles, partitions, bunks, beds or other facilities provided for the accommodation of persons in any premises or part of any premises used for human habitation.</li> <li>73. Any dwelling or premises which is or are so defective, damp or dilapidated, or so deficient in lighting or ventilation as to be, in the opinion of a medical officer, health inspector, or officer, injurious or dangerous to health, in any urban sanitary district, shall be deemed to be a nuisance liable to be dealt with in the manner provided in Part IV.</li> </ul>	
PART XI DRAINAGE AND SANITATION	<ul> <li>76 Power of local authority to agree to adopt sewer or drain or sewage disposal works at future date</li> <li>81 Application by owners or occupiers to drain into public sewers</li> <li>84 New buildings to be provided with latrines,</li> </ul>	<ul> <li>76(1) A local authority may agree with any person constructing, or proposing to construct, a sewer or sewage disposal works that, if the sewer or works is or are constructed in accordance with the terms of the agreement, the local authority will upon the completion of the work, or at some specified date, or on the happening of some future event, declare the sewer or works to be vested in it, and any such agreement shall be enforceable against the local authority by the owner or occupier for the time being of any premises served by the sewer or works.</li> <li>81 -(1) The owner or occupier of any premises, or the owner of any private sewer, within the district</li> </ul>	

	<ul><li>85 When latrine or dustbin sufficient</li><li>89 Removal or alteration of septic tanks, etc</li></ul>	of a local authority, may apply to the local authority for permission to have his drains or sewer made to communicate with a public sewer of that local authority, and thereby to discharge foul water and surface water from those premises or that private sewer.	
	<ul> <li>90 Examination of septic tanks etc. by local authority</li> <li>94 Refuse, etc. not to be deposited in watercourses in urban sanitary districts</li> <li>95 Sewage not to be discharged into watercourse</li> <li>97 Penalty</li> </ul>	<ul> <li>84. In every urban sanitary district, every such building erected or re-built or any building converted into a dwelling house shall be provided with a sufficient latrine and dustbin and with proper drains for the efficient carrying off of storm water and slop water to the satisfaction of the local authority.</li> <li>85. A latrine or dustbin shall not be deemed to be sufficient within the meaning of these Regulations unless it be of such type or description and be furnished with such coverings, fittings and connections as may be required by these Regulation</li> <li>89 if any septic tankso constructed to be, a nuisance or offensive to public decency the local authority may cause a notice to be served upon the owner, within curb time as may be</li> </ul>	
		<ul> <li>upon the owner within such time as may be specified in the notice, to remove, reconstruct, screen or otherwise alter such septic tank</li> <li>90(1) The local authority may examine any of the following works, that is to say, any septic tank, or any water supply, apparatus, pipe or work connected therewith, upon any premises, and for that purpose may cause the ground to be opened in any place which may appear to the local authority necessary, doing as little damage as may be.</li> </ul>	
		94 No person shall throw, empty or deposit, or cause to be thrown, emptied or deposited, into any part of any river, stream, creek or other	

			<ul> <li>watercourse which flows through or into any part of an urban sanitary district, any rubbish, refuse, waste products, raw sewage, or other noxious or offensive matter:</li> <li>95. No person shall erect or cause to be erected any latrine over any river, stream, creek or other watercourse which flows into or through any urban sanitary district, and no person shall empty or discharge or cause to be emptied or discharged any raw sewage in any such watercourse, without the written permission of the local authority.</li> <li>97. Any person who contravenes the provisions of regulations 93, 94, 95 or 96 shall be guilty of an offence and liable to a fine of one hundred dollars.</li> </ul>	
(II) THE PUBLIC HEALTH (MALARIA ERADICATION) RULES LN 6/1979	<ol> <li>Citat</li> <li>Inter</li> <li>Area spra carri</li> <li>Insp spra</li> <li>Notic</li> <li>Actic occu rece</li> <li>Reco Spray</li> </ol>	ion pretation is in which ying may be ed out ection of ying ee of Entry on by pier on ipt of notice rds of ying	<ol> <li>These Rules may be cited as the Public Health (Malaria Eradication) Rules</li> <li>In these Rules unless the context otherwise requires-         <ul> <li>"inspection" means inspection of any premises or of any articles therein with a view to spraying;</li> <li>"Malaria Officer" means a person employed by the Ministry of Health and Medical Services and appointed to the Malaria Eradication Programme by the Permanent Secretary</li> <li>"Permanent Secretary" means the Permanent Secretary of the Ministry of Health and Medical Services;</li> <li>"person in charge of the spray team" means the person in immediate control of the</li> </ul> </li> </ol>	

	operation of spraying any	
	present at the operation;	
	"spraying" means the spraying with insecticides of any premises	
	(whether internally or externally) or	
	any articles thereon;	
	"spray toam" moans one or more	
	persons occupied as a unit in the	
	operation of spraying;	
	3. Spraying may be carried out in such	
	Permanent Secretary may from time to	
	time direct.	
	<b>4.</b> Inspection of spraying shall be carried out on	
	any day between the nours of six o clock in the morning and six o clock in the evening and	
	subject to the provisions of rule 5, any member of	
	a spray team may enter any premises for such	
	purposes:	
	Provided that reasonable measures shall be taken	
	by the person in charge of the spray team to	
	ensure that the premises and any articles thereon	
	are left in a condition not worse than before the inspection or spraving and in particular it shall be	
	his duty to ensure that all steps which the	
	occupier of premises is required to take under	
	rule 6 have been taken and as soon as the	
	course of the inspection or spraying.	
	<ol> <li>-(1) A ividiaria Ufficer or person in charge of a spray team, or any person duly authorised in this</li> </ol>	
	respect by a Malaria Officer, shall give to the	
	occupier of such premises not less than forty-	
	eight hours' notice of his intention to inspect or	

spray the premises and of the time and which the
inspection or spraying is to be carried out.
6. An occupier of premises who has received a
notice in accordance with paragraph (1) of rule 5
or who has consented to the spraying of the
premises without such notice shall before the
spraying commences -
(a) put away all foodstuffs clothing and
other articles likely to be damaged
hy spraving.
7 - (1) The person in charge of the spray team
may issue to the occupier of any premises
which have been sprayed pursuant to these
Rules a notice containing a record of the
spraving of the premises.
(2) The accurate of promises who has received a
(2) The occupier of premises who has received a
notice in accordance with paragraph (1) of this
the request of a Malaria Officer or of the person
in charge of any snray team which subsequently
visits the premises
visito tile premiseo.

# 8. Wildlife Management (Amendment) Act 2017

Law	Clause/Part	Subclause/Section	Abstract
Wildlife Management (Amendment) Act 2017			An Act to Amend The Wildlife Protection and Management Act 1998 to comply with obligations imposed under the conventions on <b>international</b> <b>trade in endangered species</b> of <b>wild flora and fauna</b> , and for related matters. This Act focuses mainly on protection and management of <b>wildlife exports</b> <b>and imports</b> , which is not relevant to TRHDP.

### 9. PROTECTED AREAS ACT 2010

Law	Clause/Part	Subclause/Section	Abstract
Protected Areas Act 2010	PART 1 Preliminary	<ol> <li>Short Title and Commencement</li> <li>Interpretation</li> <li>Objects of the Act</li> </ol>	<ol> <li>Cite as Protected Areas Act 2010</li> <li>Interpretation</li> <li>"Area" means an area of land or water and includes any building, structure or thing;</li> <li>"Biological diversity" means variability among living things from all</li> </ol>
			<ul> <li>w. Biological diversity "means variability among living things normal sources both terrestrial and aquatic/marine</li> <li>x. "Biological resources" includes genetic resources, traditional knowledge, organisms/parts, population of species</li> <li>y. "Director" means Director of Environment and Conservation Division</li> <li>z. "Protected Area" means an area declared under Part 3</li> </ul>

		<ul> <li>aa. "Sustainable use" means the use of components of biological diversity in a way or at a rate that does not lead to long-term loss</li> <li>3. The objectives of this Act: <ul> <li>a. Establish a system of protected areas where special measures need to be taken to conserve biological diversity</li> <li>b. Develop guidelines for selection, establishment and management of protected areas</li> <li>c. Regulate/manage biological resources important for conservation of biological diversity with or within protected areas</li> </ul> </li> </ul>
PART 2 ESTABLISHMENT, FUNTIONS AND POWERS OF THE PROTECTED AREAS ADVISORY COMMITTEE	<ol> <li>Establishment of the Advisory committee</li> <li>Functions of the advisory committee</li> <li>Powers of the advisory committee</li> <li>Delegation of functions and powers</li> </ol>	<ul> <li>4. (1) A Protected Areas Advisory Committee consisting; <ul> <li>a. Chair person</li> <li>b. Deputy chairperson</li> <li>c. 4 non-members to represent non-governmental organisations</li> <li>d. 4 other members</li> </ul> </li> <li>(2) the Minister shall take into account when appointing members, experience and skills in resource and conservation management</li> <li>(3) Permanent security may, in writing, designate a public officer within the Ministry responsible for this Act to the Secretary to the Advisory committee</li> <li>5. Functions of the Advisory committee are:</li> <li>a. Advice the Government on any policy matter in relation to this Act</li> <li>b. Advice on carrying out, implementation and monitoring this Act</li> <li>c. Assist formulate, develop, approve, implement, monitor and review the national biodiversity strategy action plan</li> <li>d. Formulate the conde pf conduct relating to the standards and conduct of non-governmental organisations which deals with matters relating to this Act</li> <li>e. Advise the Minister</li> <li>6. Powers of the Advisory Committee are:</li> </ul>

		<ul> <li>a. Assist Gov't to carry out regular review of the policies of the policies relating to this Act</li> <li>b. Assist in the implementation and enforcement of this Act</li> <li>c. Oversee and supervise the functions of management committee</li> <li>d. Enter and inspect any declared protected area</li> <li>7. The Advisory committee with approval of the Minister, delegate by notice in the Gazette its functions or powers to provincial gov'ts or other organisations or persons</li> </ul>
PART 3 DECLARATION AND PROCTETION OF PROTECTED AREAS		<ul> <li>10. The Minister may, on recommendation of the Director, declare any area as a protected area of biological diversity significance; <ul> <li>a. Possesses significant genetic, cultural, geological or biological resources</li> <li>b. Constitutes the habitat of species of wild fauna and flora or unique national or international importance</li> </ul> </li> <li>11. The Director may establish and maintain a register of protected areas</li> </ul>
PART 5 REGULATIONS OF BIOLOGICAL DIVERSITY RESEARCH AND BIOLOGICAL PROSPECTING	<ul><li>16 Prohibition on biodiversity or bio prospecting research</li><li>17 Power to issue permits</li><li>18 Application for permits</li></ul>	<ul> <li>16 (1) No person shall undertake any biodiversity research except with a permit issued under this act</li> <li>17 (3) the Power under this subsection includes; <ul> <li>a. To refuse the application for the permit</li> <li>b. To vary, suspend or cancel the permit</li> <li>c. To impose, vary, suspend conditions of the permit</li> </ul> </li> <li>(4)Permit shall be issued in the prescribed form</li> </ul>

PART 6 Enforcement and Other Offenses	20 Powers of Inspectors 21 Offence of obstruction 22 Infringement notices	<ul> <li>20. (1) Powers issued by the Advisory committee, to inspectors are;</li> <li>a. To inspect any protected area</li> <li>b. Prepare reports on protected area matters</li> <li>c. Assist management committee</li> <li>d. Stop and search any persons vessel; or vehicle within the protected areas</li> <li>21. A person who obstructs any person when performing any functions or powers under this Act commits an offence and is liable on conviction to a fine not exceeding 10,000 penalty units</li> <li>22. (1) An inspector may issue infringement notices, in the prescribed form, for breach of any offense under this Act</li> </ul>
PART 7 MISCELLANEOUS	<ul><li>23 Appeal</li><li>24 Regulations</li><li>25 Exclusion of Research Act</li></ul>	<ul> <li>23 (1) A person who is aggrieved by the decision of the Advisory Committee under part 5 may appeal to the Minister within 28 days from date of decision. If matter is allowed by the minister, it shall be reconsidered</li> <li>24 The minister may make regulations to give effect to the provisions of or for the purposes of this Act; <ul> <li>a. To prescribe fees</li> <li>b. Prescribe standards and guideline of environment practise</li> <li>c. Prescribe classes of protected areas</li> <li>d. Regulate protection of protected areas</li> <li>e. Prescribe penalties and fines</li> <li>f. Provide procedures for appeal</li> </ul> </li> <li>25 Research Act (Cap.152) does not apply to any biodiversity research</li> </ul>

## 10. Fisheries Management Act 2015

Law	Clause/Part	Subclause/Section	Abstract
Fisheries Management Act 2015	PART 1 Preliminary	<ol> <li>Short Title</li> <li>Interpretation</li> <li>Application</li> </ol>	<ol> <li>Fisheries Management Act 2015</li> <li>Interpretation         <ul> <li>Community Fisheries Management Plan, means a plan drawn up by and for communities</li> <li>Customary fishing, means fishing by indigenous Solomon Islanders</li> <li>Customary rights area, means areas within S.I waters that indigenous people own</li> <li>Director means the Director of Fisheries</li> <li>Endangered means, under threat of extinction</li> <li>Fishing means, searching for, catching, taking and harvesting fish</li> <li>Inland waters, means fresh water like River and lakes</li> </ul> </li> </ol>
	Part 2 Objective and Principles	<ol> <li>Objective</li> <li>Principles</li> </ol>	<ul> <li>4 (a) all natural living resources of S.I and the environment in which they live in, are a natural asset and heritage of all its people, and should be managed and developed for the benefit of the present and future generations</li> <li>(b) The ecosystem as a whole and the general marine environment shall be protected</li> </ul>

		(m) customary rights shall be recognised and acess for customary fishing ensured
Part 3 Administration	<ol> <li>Functions, powers and duties of Minister</li> <li>Functions, powers and duties of Permanent Secretary</li> <li>Functions, powers and duties of Director</li> <li>Responsibilities of Provincial Gov'ts</li> <li>Provincial authorised officer may be appointed</li> </ol>	<ul> <li>6 (1) The minister shall perform functions and powers provided under this Act</li> <li>– shall give directions, control and guidance on fishery matters as well as approving and recommending amendments</li> <li>7 (2) The permanent secretary shall ensure the development of, for transmission to the Minister</li> <li>- Fisheries and marine resources management and development policy</li> <li>- a corporate plan and annual operation plans</li> <li>8 (1) Director shall, with the advice of the Permanent secretary, perform or exercise such functions, powers and duties as are assigned to him under this Act, including <ul> <li>(a) Address matters relating to conservation, management development an d sustainable use of fisheries resources</li> <li>(b) Coordinate and facilitate the implementation of national policy and strategies concerning fisheries conservation, management and sustainable use</li> <li>(h) make decisions relating to licensing</li> </ul> </li> <li>14 (1) Each Provincial government shall have the primary responsibility for the conservation, management, development and sustainable use of fisheries resources</li> <li>(2) A provincial government may make Ordinances regulating fishing after consultation with the Director</li> </ul>

		15 (1) Director or Provincial Executive may by notice, appoint a provincial authorised officer for purpose of enforcing this act
Part 4 Fisheries, Management and Sustainable Use	<ul> <li>Division 1 – Fisheries</li> <li>Management Plan</li> <li>17 Fisheries Management Plan</li> <li>18 Community Fisheries Management Plan</li> </ul>	<ul> <li>17 (3) fisheries management plan may apply to all persons, vessels and fish and to fishing and related activities and aquaculture within the scope of this Act</li> <li>(7)Fisheries Management Plan shall have <ul> <li>management measures</li> <li>licencing, enforcement powers and authorities</li> <li>fines, penalties and functions</li> </ul> </li> </ul>
	Division 2 – Provinces and Communities 20 Agreement with Provincial governments or communities 21 Recognition of Customary rights	Upon publication in Gazette shall have the legal status of regulations made under this Act 18 (1) A community fisheries management plan may be drawn up for communities for customary rights holders for a customary rights area in consultation with the Director and Provincial executive
	<ul> <li>Division 3 – Prohibited</li> <li>Activities</li> <li>22 Fishing and related activities may be subjected to prohibition</li> <li>31 Declaration of and prohibitions respecting protected/endangered species</li> <li>32 Pollution of the fishery waters</li> </ul>	<ul> <li>20. Director may, with approval of Minister enter into agreements with any provincial executive or customary rights holders for coordination of and cooperation in fisheries conservation, management and development</li> <li>21. (1) customary rights shall be fully recognised and respected in all activities under this Act</li> <li>22. (1) this section applies to all persons, vessels, fishing and related activities</li> <li>(3) Any Order made by the Director may wholly or partially prohibit</li> </ul>

		<ul> <li>(a) Fishing – at all times or during a specified period from any specifies area of fisheries waters</li> </ul>	
		31 (1) the Minister may, on the advice of the Director and in consultation with the minister responsible for environment, by order of gazette, declare as protected or endangered fish	
		32 (1) No person shall attempt to introduce any toxic, hazardous materials which may adversely affect the habitat or health of fish	
Part 10 Jurisdiction, Procedure, Fines and Liabilities	<ul><li>97 Jurisdiction and standing</li><li>98 procedure</li><li>99 General offenses</li><li>100 Maximum fines and</li><li>guidelines for minimum fines</li></ul>	<ul> <li>97 (1) any act in contravention of this Act by a person within or outside of the fisheries waters shall be dealt with by the judicial proceedings of High Court</li> <li>98 (1) An offense against this Act shall be dealt with by the High Court</li> <li>99 (1) Every person who fails to comply with this Act,</li> </ul>	
		commits an offense under this section (2) every person who commits an offence under this Act is liable on conviction to a fine not exceeding the maximum amount described in the First Schedule 100 (1) The maximum fines for contraventions of this Act are set out in Part A of the First Schedule and are shown in S L penalty points	
GT			
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SI	Applicable Clause	Section	Remarks
Legislations			
11. Laws of Solomon Islands, Chapter 131. Traffic Act [Ca			p.131], 1996
Part I	Interpretations	6. Classification of motor vehicles	<ul> <li>Except where provided, motor vehicles shall, for the purpose of SI Traffic Act, consist of the following classes;</li> <li>(a) Heavy public service vehicles,</li> <li>(b) Light public service vehicles,</li> <li>(c) Heavy goods vehicles,</li> <li>(d) Light goods vehicles,</li> <li>(e) Motor tractors,</li> <li>(f) Private motor cars,</li> <li>(g) Motor cycles,</li> <li>(h) Invalid carriages,</li> <li>(i) Motor vehicles other than those specified in this section.</li> </ul>
Part II	Licensing and registration of motor vehicles	7. Vehicles to be licensed	All vehicles must be licensed before using on the road
Part III	Driving Licences	20. Drivers to be licensed	<ul> <li>(a) (1). No person shall drive a motor <i>Vehicle of any Class</i> on a road "<i>unless he is the holder of a valid driving licence endorsed in respect of that class of vehicle</i>"</li> <li>(b) (2). No person who owns or who has charge of a motor vehicle of any class cause or permit any person to drive such motor vehicle unless such person is the holder of a</li> </ul>

			<ul> <li>valid driving licence or a valid provisional licence endorsed in respect of that class of motor vehicle.</li> <li>(c) (3). No person shall be entitled to more than one driving licence under this Act but a driving licence may be endorsed to permit the holder to drive one or more classes of motor vehicle</li> <li>(d) (4). any person who contravenes or fail to comply with the provisions of this section shall be guilty of an offence and liable to a fine or to imprisonment.</li> </ul>
Part IV	Offences Connected with Driving and Use of Motor Vehicles	<ul> <li>38. Causing death by reckless or dangerous driving</li> <li>39. Reckless and dangerous driving generally</li> <li>40. Careless and inconsiderate driving</li> <li>41. Speed Limit</li> <li>43. Driving or being in charge, when under the influence of drink or drugs</li> <li>44. Condition of Vehicle</li> <li>45. Limitation of loads</li> </ul>	<ul> <li>38 (1) Any person causing of death of another person by reckless or dangerous driving shall be guilty of an offence and liable to imprisonment for five years</li> <li>39 (1) If any person drives a motor vehicle on a road recklessly or at a speed or in a manner which is dangerous to the public, he shall be guilty of an offence and liable to conviction. In addition to that, if a person drives a motor vehicle on a road without due care and attention or without reasonable consideration for other person using the road, he shall be guilty of an offence and liable to conviction.</li> <li>40 (1) If a person drives a motor vehicle on a road without due care and attention or without reasonable consideration for other persons using the road, he shall be guilty of an offence and liable to a fine or imprisonment.</li> <li>41 (1) If any person who drives a motor vehicle on a road at a speed greater than the speed prescribed shall be guilty of an offence and liable to conviction.</li> <li>43. (2) A person who, drives or attempting to drive a motor vehicle on a road or other public place under the</li> </ul>

			<ul> <li>influence of alcohol or drugs shall be guilty of an offence and liable to conviction.</li> <li>44. (1) No vehicle shall be used on a road unless such vehicle and all parts and equipment including; lights and tyres, comply with the requirements of this Act, and at all times maintained in such a condition that the driving of the vehicle is not likely to be a danger to other users of the road or persons travelling on the vehicle.</li> <li>45. No vehicle shall be used on a road with a load greater than the load specified by the manufacture or the load in such a manner as to make it a danger to other persons using the road.</li> </ul>
Part VII	Accidents	63. Duty to stop and report accidents caused on the road.	<ul> <li>(a) If, in any case, the presence of a motor vehicle on a road, an accident occurs whereby or damage is caused to any person, vehicle, or animal, the driver of the motor vehicle must – <ol> <li>To stop if required to do so</li> <li>Or report to the nearest police station and make report of the accident and for his reason for not stopping.</li> </ol> </li> <li>(b) The owner of a motor vehicle (In our case; HEC) shall supply the police with all information necessary for the identification of a driver involved in an accident.</li> </ul>
Part VIII	Regulation of Traffic	<ul> <li>65. Highway Code</li> <li>66. Powers to regulate traffic</li> <li>67. Traffic signs</li> <li>68. Highway authority may</li> <li>prescribe speed limits</li> </ul>	67 (1). Subject to and in conformity with such general or other directions as may be given by the Minister, the highway authority, after consultation with the Commissioner of Police then can permit traffic signs to be erected, placed or displayed on or near a road in respect of which it is the highway authority.

			<ul> <li>(2). Traffic signs shall be of prescribed size, colour and type except where the commissioner of police authorises the erection or retention of a sign of another character.</li> <li>(3) Traffic signs shall be of the prescribed size, colour and type except where the commissioner of police authorises the erection or retention of a sign of another character.</li> <li>(4). No traffic signs shall be placed on or near any road except under and in accordance with the preceding provisions of this section.</li> <li>68 A highway authority may, with the approval of the minister, by order prescribe speed limits for any area or road in respect of which it is the highway authority.</li> </ul>
Part IX	General	78 Owner to keep lists of drivers employed	78. (1) Any person who employs any other person to drive a motor vehicle shall keep a written record of the name, address and driving licence number of such other person
12. Laws	of Solomon Islands, C	hapter 129, Roads [Cap.12	9], 1996
	Interpretation	<ul> <li>2 Interpretations</li> <li>5 Director may order road to be closed or diverted</li> <li>9 Power to erect buildings</li> <li>11 Power to make temporary roads</li> <li>13 Power to construct fences</li> </ul>	<ul> <li>2 (1). "Public road" means any road, street or thoroughfare heretofore declared or which may hereafter be declared by the minister under section 3 and includes all carriageways, cart ways, bridle tracts and pathways as well as all bridges, drains, dams, embankments, causeways, fences and ditches belonging or appertaining to a public road and also any adjoining</li> </ul>

20 Survey by qualified land

surveyor to be prima facie

evidence

21 Removal of obstruction or encroachments	officer appointed by the minister to superintend the construction, alteration and maintenance of public roads. The director may order that any existing road be closed, diverted or turned and that some shorter or more convenient course be substituted for any road so closed, diverted or turned. The director with the approval of the minister first had and obtained may order that any new road be opened or any road be widened and enlarge. The director may when tracing, measuring, making, working, opening, altering, turning, repairing, clearing, improving, building or excavating any public road make and erect temporary buildings on any land adjacent or near thereto for the accommodation of any officers, servants, workmen, labourers, animals, vehicles or things employed by him during the progress of the work and may keep duly tethered and stabled all such animals as may be employed upon any lands near or adjacent thereto any may continue to keep the said animals on such lands for such time as may be necessary; The Director may make a road through the grounds adjacent or near to any public road during the execution of any work thereon or in any way connected therewith: Provided that such road shall not run over any ground whereon any building stands nor over an enclosed garden or yard.
*	to be signed by a qualified land surveyor in any
	to be signed by a quantied faild surveyor III ally

proceedings under this Act shall be deemed to be prima facie proof of the facts contained therein.

- 21 (1). The Director may give notice in writing to any person obstructing or encroaching on any public road forthwith to remove or abate such obstruction, and if any such person to whom such notice has been given refuses or neglects to comply with the same within a reasonable time, or if there be any doubt as to who is the proper person to whom such notice shall be given, the Director, after due notification of his intention in that behalf by a notice affixed in a conspicuous manner on or adjacent to the said obstruction or encroachment, may cause any such obstruction or encroachment to be forthwith removed or abated and for that purpose the Director or any person thereto authorised in writing by him may enter into any house, garden, enclosure or other premises and may cause to enter therein such persons with such instruments and things and may proceed to do therein or cause to be done all such things as may be necessary for such removal or abatement, and may, in the case of an obstruction or encroachment erected, placed or otherwise howsoever caused after the declaration of the road as a public road, recover the costs thereby occasioned from the person so offending. 21 (2). No compensation shall be payable with respect
- 21 (2). No compensation shall be payable with respect of the removal of any encroachment or obstruction under this section, except in the case of a building, structure or other thing whatsoever of economical value, which both acceded to the land and existed prior to the declaration of the road as a public road.

SI	Applicable Clause	Section	Remarks
Legislations			
13. Explo	osives Act [Cap.7	9]	
Part I	General	2. Interpretation	<ul> <li>"explosives" means – <ul> <li>(a) Gunpowder, nitro-glycerine, dynamite, gun cotton, blasting powders, fulminate of mercury or of other metals, coloured fires and every other substance, whether similar to those mentioned above or not, used or manufactured with a view to producing a practical effect by explosion or pyrotechnic effect, but shall exclude – <ul> <li>1. Commercially manufactured fireworks except where it declared under paragraph (b) below</li> <li>2. Ammunition as defined in the Firearms and Ammunition Act</li> <li>3. Rockets and flares conforming to the requirement of the shipping regulations</li> </ul> </li> <li>(b) Any substance which the prime minister may by notice declare to be an explosive and, without prejudice to generality of the foregoing, the Prime Minister may declare all fireworks or any type of description of fireworks to be explosive for the purpose of this Act generally or for the purpose of such provisions of this Act or any regulations made thereunder as he shall specify.</li> </ul></li></ul>
Part II	Dealer's and User's Licences	<ul> <li>3. User's Licences</li> <li>4. Dealer's Licence</li> <li>5. Licences to be produced on demand</li> <li>6. Explosives not to be used outside area licensed</li> <li>7. Dealer to keep records (Form C and D)</li> </ul>	<ul> <li>(a) Two licences required for possession, import, use of explosives are;</li> <li>1. User's Licence – Issued by MID and valid for one year</li> <li>2. Dealer's Licences – Issued by RSIPF Commissioner</li> <li>(b) The holder of the User's Licence will ONLY use the explosives within the area defined in the licence.</li> </ul>

			(c) The holder of each Dealer's Licence shall cause to be kept in his licenced magazine, books recording the name, address, licence number and particular of person to whom he disposes of explosives and the quantity and variety of explosives disposed of to such persons. Such book shall be in Forms C and D.
Part III	Loading and unloading of Explosives from Vessels	<ul> <li>10. Vessels unloading explosives</li> <li>14. Precaution against accidents</li> <li>15. Hours for unshipping and shipping</li> </ul>	<ul> <li>(a) The master of a vessel which is carrying explosives and which arrives from outside Solomon Islands shall give at least one day clear notice of his time of arrival to the officer of customs. And no discharge or loading of explosives shall take place unless such explosives have been duly entered for customs purposes, or are conveyed directly and without delay into a magazine in a 'custom area' as defined in the Customs and Excise Act.</li> <li>(b) While shipping or unshipping of explosives is being carried out it shall be the duty of the master to see that notices with the words "DANGER EXPLOSIVES" in at least two inch while lettering on a red background are posted on his vessel and all persons engaged in such operations shall take all due precautions for the prevention of accidents by fire, explosion or concussion, and also keep the detonators and explosives other so separated.</li> <li>(c) The shipping or unshipping of explosives shall be carried out only between the hours of 6:00 am and 6:00 pm.</li> </ul>
Part VI	Conveyance of Explosives after Landing	<ul> <li>30. Explosives to be conveyed to magazines</li> <li>31. External protection against fire and moisture</li> <li>32. Regulation of hours for conveying explosives by motor vehicles</li> <li>33. Red flag to be carried by vehicles conveying explosives</li> <li>34. Speed limit for vehicles conveying explosives</li> </ul>	(a) It shall be the duty of the importer of any explosives to ensure that he or his agent shall be present at the place where explosives are being unloaded, unless the warehouseman or authority administering the port or harbour master otherwise directs, all explosives when first imported shall immediately shall immediately after being put to shore be conveyed to an explosive magazine licensed for that purpose under these regulation

35. Exposed iron and steel to be covered	(b) The explosives m	ust be effectively protected from fire
36. Responsible person to be in charge	and moisture.	
37. Smoking prohibited	(c) The explosives ca	an be conveyed in any motor vehicle
38. Precautions against accidents	between the hours	of 6.00 am and 6.00 pm.
39. Carriage of detonators	(d) Provided that if it	n a case of emergency explosives are
41. Progress and unnecessary delay in transit	conveyed in con	travention of the provisions of this
42. Conditions for transporting explosives	regulation the cir	cumstances shall be reported to the
	commissioner of p	police at the first opportunity.
	(e) Every vehicle wh	en conveying explosives must carry a
	red flag at the fron	t and the rear, so affixed as to be clearly
	visible.	-
	(f) The speed limit for	or vehicle carrying explosives will not
	exceed a speed of	twenty miles per hour.
	(g) All the iron and ste	eel portions of a vehicle which are liable
	to come in conta	act with the container in which the
	explosives are ca	arried, must be covered with wood,
	leather, cloth or ot	her suitable material.
	(h) Any person whilst	conveying explosives, or whilst on, in
	or attending to a	ny carriage containing explosives, or
	whilst acting as w	atchman over any explosives must not
	carry matches or	other appliance for producing fire, nor
	shall he smoke.	
	(i) Detonator shall no	ot be conveyed in the same carriage as
	any other explosiv	ves.
	(i) The convevance	of explosives shall proceed with due
	diligence and with	nout unnecessary delay from the place
	from which they	are being moved to their destination.
	Villages and other	inhabited places must be avoided as far
	as possible. Durin	g a thunderstorm, the vehicle must be
	halted at least 2	50 vards from the nearest inhabited
	building.	· · · · · · · · · · · · · · · · · · ·
	(k) No quantity of ex	xplosives exceeding 50 lbs, shall be
	conveved through	any inhabited area of land outside the
	area of any Port.	except with the approval of the senior

			police officer in the province and subject to such conditions as he specify.
Part VII	Storage	<ul> <li>44. Magazines to be licenced</li> <li>45. Limitation on quantity of explosives to be stored</li> <li>46. Conditions of issue of licence</li> <li>47. Issue of User's magazine licence (Form F)</li> <li>48. Storage of explosives and detonators in User's Magazine</li> <li>49. Issue of dealer's magazine licence (Form G)</li> <li>50. Separation of detonators and explosives in dealer's magazine</li> <li>53. Distance of magazine from means of ignition</li> <li>55. Storage of explosives inside magazines</li> </ul>	<ul> <li>(a) The magazine used to store explosives must be licenced [Magazine Licence (Form G) can be given by RSIPF Commissioner after conducting inspection on the magazine]</li> <li>(b) Not more than 112 lbs. of explosives other than detonators, nor 200 detonators shall be stored in a user's magazine, and not more than 2,240 lbs. of explosives other than detonator nor 5,000 detonators shall be stored or kept for sale in a dealer's magazine, except, in either case, upon the written authority of the licensing officer.</li> <li>(c) The detonator must be stored in a separate building which must not be less than 10 yard from the magazine</li> <li>(d) The magazine shall not be built within 100 yards from anything that is liable to cause ignition, nor within 50 yards of any road to which the public has access, nor within 10 yards of any overhead power or transmission cable.</li> <li>(e) No explosives shall be stored within twelve inches of any</li> </ul>
Part VIII	Use of Explosives	<ul> <li>76. Notice of blasting</li> <li>77. Red flags to be exhibited</li> <li>78. Notice to be exhibited</li> <li>79. Removal of flags and notices</li> <li>81. Qualified person to be in charge</li> </ul>	<ul> <li>(a) No blasting operations shall be carried out unless reasonable precautions are first taken to advise all people within the area. And a 24 hour notice is first given to the senior police officer in the area.</li> <li>(b) The blaster must place red flags not less than 3'x 2' in size on all roads tracks and footpath leading to the blasting area.</li> <li>(c) The blaster must also place notice boards by the red flags with the wording in block capitals, "DANGER BLASTING" and the board must not be less than 3' x 2' in size, painted in white with red lettering, such lettering</li> </ul>

			<ul> <li>must not be less than 4" in height and of appropriate width.</li> <li>(d) The flags and notices must be remove at all times after the blasting processes is finished to allow people to proceed along any road, track or footpath.</li> <li>(e) No person shall pass such flags and notice boards without the express permission of the person in charge of blasting operations.</li> <li>(f) The person in charge of the explosives and blasting works must be a competent and qualified and must satisfied the licensing officer.</li> </ul>
14. Mine	es and Minerals A	xct. [Cap.42]	
Part I	Preliminary	3. Interpretation	"Building materials" means clay, gravel, sand and stone used for buildings, roads or other construction purposes.
Part II	Administration	<ul><li>4. Reserved and protected areas</li><li>6. Powers of the minister</li><li>7. Functions and powers of the director</li></ul>	<ul> <li>Reconnaissance, prospecting and mining are prohibited in or on;</li> <li>Any village, or place of burial, tambu or sites of traditional significance.</li> <li>Any cultivated land or land rendered fit for planting and habitually used for planting of crops.</li> </ul>
Part VIII	Building Materials	<ul><li>64. Building Materials Permit</li><li>65. Application for a building material permit</li><li>66. Form and content of building material permit</li></ul>	<ul> <li>(a) The minister may issue building material permits for the mining of building materials in any area of Solomon islands to any person who makes application pursuant to section 65, where the minister is satisfied that the proposed mining will not cause erosion of coastal or river sediments, or otherwise adversely affect, either directly or indirectly, the environment.</li> <li>(b) The applicant of the BMP must specify in a written application to the director –</li> </ul>

			<ol> <li>Company name, address, etc.</li> <li>A plan of the area, which shall not exceed half a square kilometre,</li> <li>A proposed plan for mining the building material,</li> <li>Other related information requested by the Director.</li> <li>A written consent from the landowners in the area in which the application is made</li> <li>Payment of application fees</li> </ol>
15. Traff	ic Act [Cap.131]		
Part I	Interpretations	6. Classification of motor vehicles	Except where provided, motor vehicles shall, for the purpose of SI Traffic Act, consist of the following classes; Heavy public service vehicles, Light public service vehicles, heavy goods vehicles, Light goods vehicles, motor tractors, private motor cars, motor cycles, invalid carriages, motor vehicles other than those specified in this section.
Part II	Licensing and Registration of Motor Vehicles	7. Vehicles to be licensed	All vehicles must be licensed before using on the road
Part III	Driving Licences	20. Drivers to be licensed	<ul> <li>(1). No person shall drive a motor vehicle of any class on a road unless he is the holder of a valid driving licence or a provisional licence endorsed in respect of that class of vehicle</li> <li>(2). No person who owns or who has charge of a motor vehicle of any class cause or permit any person to drive such motor vehicle unless such person is the holder of a valid driving licence or a valid provisional licence endorsed in respect of that class of motor vehicle.</li> </ul>

			<ul><li>(3). No person shall be entitled to more than one driving licence under this Act but a driving licence may be endorsed to permit the holder to drive one or more classes of motor vehicle</li><li>(4). Any person who contravenes or fail to comply with the provisions of this section shall be guilty of an offence and liable to a fine or to imprisonment.</li></ul>
Part IV	Offences connected with driving and use of motor vehicles	<ul> <li>38. Causing death by reckless or dangerous driving</li> <li>39. Reckless and dangerous driving generally</li> <li>40. Careless and inconsiderate driving</li> <li>41. Speed Limit</li> <li>43. Driving or being in charge, when under the influence of drink or drugs</li> <li>45. Limitation of loads</li> </ul>	<ul> <li>(a) Any person causing of death of another person by reckless or dangerous driving shall be guilty of an offence and liable to imprisonment for five years</li> <li>(b) If any person drives a motor vehicle on a road recklessly or at a speed or in a manner which is dangerous to the public, he shall be guilty of an offence and liable to conviction. In addition to that, if a person drives a motor vehicle on a road without due care and attention or without reasonable consideration for other person using the road, he shall be guilty of an offence and liable to conviction.</li> <li>(c) If any person who drives a motor vehicle on a road at a speed greater than the speed prescribed shall be guilty of an offence and liable to conviction.</li> <li>(d) A person who drives under the influence of alcohol or drugs shall be guilty of an offence and liable to conviction.</li> <li>(e) No vehicle shall be used on a road with a load greater than the load specified by the manufacture or the load in such a manner as to make it a danger to other persons using the road.</li> </ul>
Part VII	Accidents	63. Duty to stop and report accidents caused on the road.	<ul> <li>(c) If, in any case, the presence of a motor vehicle on a road, an accident occurs whereby or damage is caused to any person, vehicle, or animal, the driver of the motor vehicle must –</li> <li>3. To stop if required to do so</li> </ul>

			<ol> <li>Or report to the nearest police station and make report of the accident and for his reason for not stopping.</li> </ol>
Part VIII	Regulation of Traffic	<ul> <li>65. Highway Code</li> <li>66. Powers to regulate traffic</li> <li>67. Traffic signs</li> <li>68. Highway authority may prescribe speed limits</li> </ul>	<ul> <li>(a) Upon consultation with the highway authority and Commissioner of Police then traffic signs can be erected, placed or displayed on or near a road.</li> <li>(b) Traffic signs shall be of prescribed size, colour and type except where the commissioner of police authorises the erection or retention of a sign of another character.</li> <li>(c) No traffic signs shall be placed on or near any road except under and in accordance with the preceding provisions of this section.</li> <li>(d) A highway authority may, with the approval of the minister, by order prescribe speed limits for any area or road in respect of which it is the highway authority.</li> </ul>
16. Safe <sup>-</sup>	ty At Work Act [(	CAP.74]	
Part I	Introductory	3. Meaning of "Workplace"	<ul> <li>"workplace" means any premises or other place made available in the course of business – <ul> <li>a) as a place of work</li> <li>b) as a place where persons at work may use plant or substances provided for their use there,</li> </ul> </li> <li>And any place used in connection with such a place and includes any means of entering or leaving such a place.</li> </ul>
Part II	General Duties	<ul><li>4. General duty of employers to their employees</li><li>5. General duty of employers to person other than their employees</li><li>6. General duty of employees at work</li></ul>	<ul> <li>Examples of the duty imposed by section 4;</li> <li>1. It is the employer's duty to provide plant and systems of work that are, so far as is reasonable practicable, safe and without risks to health and to maintain them in that state.</li> </ul>

		<ul> <li>7. General duty of those who control workplaces, etc., to person not their employees</li> <li>12. Strict liability of employer for defective equipment, etc.</li> <li>14. Civil liability and criminal breach of duty</li> </ul>	2. 3. 4. 5.	It is the employer's duty to make arrangement for ensuring, so far as is reasonable practicable, safety and absence of risks to health in connection with the use, handling, storage and transport of articles and substances. It is the employer's duty to provide such information, instruction, training and supervision as is necessary to ensure, so far as is reasonably practicable, the health and safety at work of his employees. It is the employer's duty, so far as is reasonably practicable – a. To provide means of entering and leaving any workplace under his control that are safe and without risks to health b. To maintain any workplace under his control in a condition that is safe and without risks to health. It is the employer's duty to provide and maintain a working environment for his employees that is, so far as is reasonably practicable, safe and without risks to health.
Part III	Specific Duties	<ul> <li>15. Duty of employer to protect persons from harmful dust, fumes, etc.</li> <li>16. Specific limits on exposure to dust, fumes, etc.</li> <li>18. Machinery – Lifting equipment</li> <li>19. Dangerous machinery</li> <li>20. Electrical installations</li> <li>21. Fire and explosion</li> <li>22. Precautions against explosion</li> <li>24. Interfering with safety equipment etc.</li> </ul>	(a) (b) (c) (d) (e)	It is the employer's duty to provide plant and systems of work that are, so far reasonably practicable, safe and without risks to health and to maintain them in that state. It is the duty of employer to make arrangements for ensuring, so far reasonably practicable, safety and absence of risks to health in connection with use, handling, storage and transport of articles and substances. It is the employer's duty to provide such information, instruction, training and supervision as is necessary to ensure, so far as is reasonably practicable, the health and safety at work of his employers It is the employer's duty, so far as is reasonably practicable – To provide means of entering and leaving any work place under his control that are safe and without risks to health;

			<ul> <li>(f) To maintain any workplace under his control in condition that is safe and without risks to health</li> <li>(g) It is the employer's duty to provide and maintain a working environment for his employees that is, so far as is reasonably practicable, safe and without risks to health.</li> <li>(h) When using lifting equipment – the lifting machine or lifting tackle must be of sound construction; in particular, it must be so designed, and must be constructed of such materials that it is safe when properly used.</li> <li>(i) An electrical installation must be of sound construction; in particular, it must be so designed, constructed, installed and protected that it is safe.</li> <li>(j) Every workplace must be provided with such means of escape as are required to enable persons employed there to leave the workplace safely in case of danger from fire or explosion.</li> <li>(k) Flammable substance must NOT be stored in any enclosed workplace unless it is stored in a tank or magazine.</li> <li>(l) A person who intentionally or recklessly interferes with or missuses anything provided in the interest of health or safety in pursuance of any provision made by or under this Act is guilty of an offence.</li> </ul>
17. Solor	non Islands Prov	incial Act 1997	
Part I	Preliminary	2. Interpretation	"Provincial Government Officer" means a person holding or acting in any office of emolument in the service of a provincial government authority.

Part II	Provincial Government	3. Establishment of Provinces	For the administration of provincial government, Solomon Islands (excluding Honiara) shall be divided into areas to be known as Provinces. <i>Guadalcanal Province</i> - Excluding Honiara, the islands comprised in the area bounded by a line Starting at a point in Latitude 9'13' South Longitude 160'30' East and bearing due South to a point in Latitude 9'20' South thence by a line bearing due East to a point in Longitude 161' East thence by a line bearing due South to a point Latitude 10'30' South thence along the common boundary with central province to a point in Longitude 9'13' South and thence along the common boundary with central province to the point of commencement.
Part III	Transfer of Function	26. Functions	<ul> <li>A provincial assembly shall exercise as regards the province, the functions specified in schedules 3 and 4.</li> <li>Schedule 3: Legislative matters (section 26 (3))</li> <li><i>Trade and industry</i> <ul> <li>Local licensing of professions, trades and businesses, local marketing</li> </ul> </li> <li><i>Cultural and Environment Matters</i> <ul> <li>Local crafts, Historical remains, Protection of wild creatures</li> <li>Coastal and lagoon shippings, provision, maintenance and improvement of harbours, roads and bridges</li> </ul> </li> <li><i>Finance</i> <ul> <li>Property tax</li> <li>Fees for services performed or licences issued by or on half of the provincial executive (other than services performed or licences issued by them as agent of another)</li> </ul> </li> </ul>

			<ul> <li>Land and Land Use</li> <li>Codification and amendment of existing customary law about land. Registration of customary rights in respect of land including customary fishing rights. Physical planning except within a local planning area (within the meaning Act No. 22 of the Town and Country Planning Act or an area to which Part IV of that Act 1979) has been applied.</li> <li>Local Matters <ul> <li>Fire services and fire protection, waste disposal and cleansing services, Building standards etc.</li> </ul> </li> <li>Rivers and Waters <ul> <li>Control and use of river waters, pollution of water, provision of water supplies (other than urban water supply in areas, prescribed by under the Solomon Islands Water Authority Act). [Act No. 16 of 1992]</li> </ul> </li> </ul>
18. <b>Honi</b>	ara City Act 1999		
		21. Function of the City Council	(1) The city council may perform all or any of the functions listed in Part I of schedule 5 and may for such purposes imposes fees, rates or charges by ordinance.
			Schedule 5 – Part I: Functions of the City Council
Part V	Function and powers of the city Council		<ul> <li>Trade and Industry</li> <li>To licence trades, businesses, professions and other occupations.</li> </ul>

	on of the environment.
<ul> <li>Finance – Raising</li> <li>Head Tax</li> <li>Property T</li> <li>Business T</li> <li>Vehicle Tat</li> <li>Fees for set behalf of the such other</li> </ul>	revenue by; Basic Rate ax - Land Rate ax x prvices performed or licences issued by or on ne City Council. matters as may be approved for the purposes

# ANNEX P-1-V FIELD OBSERVATION RECORD / NON-CONFORMITY REPORT



#### FIELD OBSERVATION RECORD / NONCONFORMITY REPORT

NCR No.	
Date	
Page	1 of 1

Project Name/Co	de : TRHDP	Employer :		THL				
Company	Company		Issue by	THL				
Discipline	Civil	Rela	ated Doc. No.	TRHDP-O-L-0000				
Subcontractor	HEC		Location	Dam Site				
	Subject: DAM issue NCR							
	Attachment : 🗆 Yes 🗆 No							
Nonconforming Condition	<b>Safeguards</b> non-conformance raised by Employer (THL) and notified to HEC							
	Prepared by : THL / DDMM	ΙΥΥ	Approved by :	HEC E&S manager / DDMMYY				
	(Name/Date)	)		(Name/Sign/Date)				
	🗆 Use-as-is	🗆 Rewoi	∙k 🛛 Repair	□ Reject/Scrap				
Disposition	The proposed disposition is p with HEC E&S Department	prepared by HE	C Civil Manager in cc	Employer (THL) / DDMMYY				
	(Name/Sign/Da	ite)		(Name/Sign/Date)				
	C	Acceptable	□ Not A	cceptable				
Final Verification	Proof of work completed is submitted by HEC E&S Staff							
	Verified by : HEC E&S staff/ DDM	MYY	Approved by :	HEC E&S manager / DDMMYY				
	(Name/Sign/Da	ite)		(Name/Sign/Date)				
	□ No exceptions to final verifica	tion		Remark				
	Date : DDMMYY							
	Signed by : Employer (THL)							

# ANNEX P-1-VI IR-005 HEC EHS MONITORING - GENERAL ESMP CONTROLS SPREADSHEET

	Image: Constraint of the second sec										
De	scription of v	vork being inspected					ESMP Controls				
Str	ucture Name										
Lo	t No.			Station	From				То		
Dr	awing No.					Spec. No.	2B.3 of Employer Requirement 4 of Detailed Design Specification Relevant drawing				
No.			Items to be c	hecked			Acceptance criteria	Vos	Conformanc	e N/A	Remarks
Gener	ral							105	140	IN/A	
1	The site boundary, access point/s, and environmental controls are surveyed and clearly pegged/marked?			<ol> <li>Earthworks site boundary</li> <li>Drains and Sediment basins</li> <li>Watercourse crossings</li> <li>Pegged sites shall be inspected by THL with a NTP</li> <li>Access shall be strictly controlled</li> </ol>							
2	Tambu sites	and "No Go Zones" are fe	enced, pegged	or mapped pr	rior		1. Identified and boundaries clearly marked on site and on map				
3	The site is g	enerally in a tidy condition	n				1. According to P12 - WMPSPP				
4	All material	and equipment are contain	ned within the	project bound	lary		<ol> <li>Project boundary is clearly marked on map</li> </ol>				
5	Designated l	haulage routes and access	points are bei	ng used			1. According to P11 - TMP				
Work	ers Health an	nd Safety (P8-WHSP)							1		
6	General Hea	lth, Safety and Environme	ent induction l	nas been cond	ucted for all v	vorkers on site	1. HSE Induction records are kept				
7	Appropriate	Sanitation facilitities hav	e been provid	ed and regula	rly maintained	l on site	1. According to P12-WMPSPP				
8	Proper PPEs	s have been issued to all w	orkers on site	where approp	oriate		Hearing protection, Dust masks & Hand Gloves				
9	Covid-19 or any epidemic preventive measures are implemented on site			Protocol							
10	Siting and design of hazardous material storage areas relating to the access road (including workshop at camp) will be illustrated on a site plan by HEC; to be approved by THL before storage and use of materials on site.		Site plan for hazardous materials storage area(s) approved by THL								
11	Spill prevent the environn	tion measures and controls nent are in place, in compli	s to limit expo iance with the	sure of hazar SPERP (P14	dous substanc ) and HMMP	es to workers or (P13).	Pre-construction inspection by HEC HSE Manager and THL				
12	Hazardous s list (Annex I	ubstances required for roa B, HMMP), and MSDS ar	ad construction re available	n have been ir	cluded on the	project inventory	An up-to-date inventory list is completed and kept				
Spoil	and Topsoil	Management (C9-STMP	')								
13	Topsoil has exceeding 2.	been kept separate from sp 5m and seeded with cover	poil (subsoil, crop (legume	gravel and oth s, vertiver) if	er materials), retained more	at a hegith not than 3 months	1. According to C9-STMP				
14	Water Spraying for dust suppression has been done during spoil handling			1. Twice a day during dry weather 2. According to P15-AQMDCP							
16	Soil stockpil	les must not exceed 2.5m h	height and are	properly com	pacted		1. According to C9-STMP				
17	Soil stockpil	les are sited in low-hazard	areas away fi	om a defined	drainage line	or stream	1. According to C9-STMP				
Draina	age, Erosion	and Sediment Control Pl	lan (C10-DES	SCP)			1. Cut-off drains installed				
18	Permanent a	nd Temporary drains have	e been installe	d to divert rur	noff from the	site	2. Lined drains installed 3. According to C10-DESCP 1. Drain discharged into sediment				
19	Cross drains Settling basi	s have been installed on site	e to avoid ero n local overla	sion. 1d runoff. only	y subject to di	rect rainfall.	pond, or into a stable and vegetated area				
20	adequately scale, and structurally sound, capable of withstanding saturation and normal rainfall events.		1. According to C9-STMP								
21	Sediment controls have been installed across construction sites to remove sediment before runoff discharges from the site		1. According to C10-DESCP								
22	Erosion and identify any	sediment controls are bein issues and required correc	ng inspected w etive or additio	eekly and afte mal measures	er each major	rainfall event to	1. According to C10-DESCP				
23	Erosion and	sediment controls has been	n maintained	in good worki	ng order.		1. According to C10-DESCP				ļ
24	Sediment ba	sins are accessible by mac	chinery so the	y can be clean	ed		1. According to C10-DESCP				
25 26	Silt fences a Sediment ba	re installed correctly on sit sin volume markers intact	te and clearly v	isible			1. According to C10-DESCP 1. According to C10-DESCP				<u> </u>
27	Accumulate	d sediment within the sedir	ment basin (in	cluding the Fe	orebay) is belo	ow 50% of	1. According to C10-DESCP			L	
28	Sediment ba capacity (if	sins have been emptied sin not, explanation must be p	nce the last he provided)	avy rain event	and restored	to their design	1. According to C10-DESCP				

Air Ou	Quality/Dust Management							
All Qu	anty/Dust iv	anagement			1			
29	Water Truck	spraying is being used to suppress dust on site		1. Water spraying record is kept				
30	Dust masks	have been provided to Workers understaking dust generating activit	1. PPE issuance record is kept					
31	Speed limits	are being strictly imposed on site to minimize dust emissions	1. Speed (20km/hr) limit signs are installed?					
32	Daily visual	dust monitoring has been conducted by HEC E&S Officer		1. Records of visual monitoring kept				
33	Monthly (24 Officer (Plea	hours) Weekly (1 hour) Air quality monitoring have been conducte se note when this was last completed at this site)	d by HEC E&S	1. Records of each monitoring event are kept				
Noise I	Management							
34	All mobile and stationary equipment are equipped with fully functioning noise mufflers and baffles.			1. Mobile plant is set back as far as possible from sensitive receptors				
35	Noise barriers are Installed with no gaps to reduce noise level where appropriate			1. According to C13-NVMP				
36	Construction works in areas close to villages are restricted to the period 7:00am to 6:00pm.			1. According to C13-NVMP				
37	Monthly Noise monitoring has been conducted by HEC E&S Officer at the respective site or at sensitive receptors (Please note when this was last completed near this site)			1. Noise parameters Lmax, Lmin, Leq, L1, L10 and L90 (in dBA) are within IFC EHS Guidelines 2. According to M7 - AQNMP				
Waste	Managemen	t and Storage of Hazardous Materials						
37	Wastes are segregated in designated bins/bags and transported to the Workers Accommodation Camp.			1. Bins for recyclable waste, compostable waste and hazardous waste				
38	Any temporary waste storage areas are located more than 100 metres from any natural sensitive area (including watercourses). All waste storage areas are reviewed and approved by THL prior to construction (NTP issued for each facility).			NTP issued by THL				
39	Fuels/chemicals are stored in bunded areas			1. Bund is atleast 120% of the total fuel storage volume provided				
40	) No oil leaks or spills are visible on site			<ol> <li>Safety procedures for handling hazardous wastes are established and training is conducted</li> </ol>				
41	Refueling in are done at designated areas			1. Designated sites are indicated on map				
42	2 Spill kits available in designated areas			1. Locations of Spill kit are shown on map and have visible signs				
UXO N	Aanagement	(C2-UXOMP)						
43	All workers	on site were inducted/trained on the UXO Chance Find Procedure		Monthly refresher training is conducted by HSE Training Supervisor				
44	Chance Find Procedure is implemented on site during a chance find incident			As per the chance find procedure (C2-UXO-MP)				
I raffic Management								
45	Safety controls (signage, fencing, limited speed zones etc) are installed as per final design and Annex 1 and 2 of the TMP (P11)			Inspection by HEC HSE Manager and THL				
46	6 Daily and weekly inspections are completed to meet the requirements of the TMP (P11) (Refer to ATTACHED audit checklist, Annex 5 of TMP)			Inspection by HEC HSE Manager and THL				
47	47 Mobile plant and equipment and Project vehicles have been checked and maintained in good condition (as per Annex 6 of TMP - Equipment list and maintenance requirements)			Inspection by HEC HSE Manager				
48 Equipment Transportation Plan has been developed <b>where appropriate</b> for movement of heavy/oversized equipment along public roads and access road, and is up to date			Plan approved by THL, reviewed by OE					
Note								
0.	anisation	Subcontractor		HEC			THL	(or OE on behalf)
Org	amsation	Check and Preparation	Che	ck and Preparation / Inspection		W	itness and/o	or Review Documentation
1	Name							
	Sign							
	Date							

# ANNEX P-1-VII ESMP DISCLOSURE FOR MAIN WORKS COMMUNITY CONSULTATION REPORT



# ESMP Disclosure for Main works (DAM, POWERHOUSE, TUNNEL) Community Consultation Report 23.11.2022

09:00 to 12:00 Hours

Prepared By:	Checked By:	Reviewed By:	
Helen	Edmond	I J Shin	Page No: 1
CLO	E & S Supervisor	E & S Manager	



## 1. Communities Participated:

#	Community	Male	Female	Total
1	Mangikiki, ( Verahurua , Camp & Verabongi)	45	20	65
2	Antioch and Valesala	10	2	12
3	Habusi	10	1	11
4	Namopila, Pachuki and Komureo	6	2	8
5	Valekocha and Vatunadi	1	1	2
	Total	72	26	98

# 2. Introduction

A total of 28 Environmental and Social Management Plans (ESMPs) has been updated by Stantec, Australia with inputs from HEC and THL for the main works. These updated ESMPs have incorporated the design elements, construction method statements, plans, and review comments provided by the Government, the World Bank, and the Asian Development Bank.

Approval is currently being sought for the construction of the Main Works (Hydropower Facility-Dam, Tunnel, and Powerhouse). As part of the consultation and disclosure process, the updated ESMPs were posted to the TRHDP website (https://www.tina-hydro.com/project-esmps/) in November 2022. ESMP updates will be approved by the Solomon Islands Government and Lenders prior to any works taking place, and a summary of changes will be provided which outlines additional measures relevant to each approval. The updated plans cleared for subsequent construction activities will be disclosed progressively.

For convenience, the CESMPs are also accessible from the HEC and THL offices as below:

- HEC Worker's Accommodation Camp: Grass Hill, Malango Ward, Guadalcanal Province
- THL Office: AA3, Pacific Ace Plaza, Kukum Highway, Honiara

It is noted that any questions submitted by the date of 24th of November 2022 can be reflected in the CESMP. Questions submitted after the date of 24th of November 2022 shall be reflected in the next schedule for revision.

The comments shall be analysed, and appropriate mitigation measures will be incorporated into the ESMPs.

ESMPs have been previously disclosed by HEC to communities during consultations relating to construction, and there are numerous features of these management plans that communities should be aware of. Disclosure is also being carried out as part of conversations between HEC and complainants regarding grievances. HEC will make

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it a point to keep the local communities updated on the management strategies throughout the construction phase of the project.

## 3. Requirements

As stipulated in Section 7.1 of the P1: CESMP: The CESMP and sub-plans are "living" documents, due to the requirement of constant maintenance to be effective throughout the construction period. Changes in the Project conditions might affect the efficacy of the mitigation measures or protocols in place. In this case, HEC/THL will revise the necessary management plan to guarantee compliance with the applicable standards. The management plans will also be revised at or before agreed Project milestones, to expand the scope of the activities covered by each plan accordingly (e.g. operational phase). This process is described below and establishes Management of Change requirements for any and all necessary changes.

Thus, in order to accommodate the concerns of the communities, all the ESMPs are disclosed before they are cleared by the CFPs. The information disclosure is conducted in line with P3 Stakeholder Engagement Plan. Apart from the above, the Project shall keep the communities regularly informed and updated about the progress of construction, the schedule of construction, and major activities being conducted.

# 4. Purpose of the consultation

The main purpose of this consultation is

- 1. To disclose the updated ESMPs for the construction of the main works **(Dam**, **Powerhouse & Tunnel**) to Project Affected Communities.
- 2. Provide information on Project Salient features, Construction Schedules, brief description of works as well as Management, Monitoring, and mitigation measures that guide these construction activities.
- 3. To provide an opportunity for community members to present their views and feedback regarding the updated ESMPs.
- 4. For HEC and THL to receive community feedback through face-to-face consultation which will contribute to the review, improvement, finalization, and approval of the ESMPs.

Out of the 28 updated ESMPs, the disclosure to communities on 23<sup>rd</sup> November 2022, all the monitoring and mitigation measures entailed in the current version of the ESMPs were discussed. The disclosed ESMPs are:

- 1. P1: Constructions Environment & Social Management Plan
- 2. P3: Stakeholder Engagement Management Plan
- 3. P4: Human Resource and Labour Management Plan.
- 4. P5: Influx Management Plan
- 5. P6: Grievance Redress Mechanism

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#### **ESMP Disclosure Report**

6. P7: Security Management Plan

HYUNDAI

- 7. P8: Workers Health & Safety Plan
- 8. P 9: Workers code of Conduct
- 9. P 10: Community Health and Vector Management Plan
- 10. P11: Traffic Management Plan.
- 11. P12: Waste Management & Point Pollution Plan
- 12. P13: Spill Prevention & Emergency Response Plan
- 13. P15: Air Quality Management and Dust Control Plan.
- 14. C 2: UXO Management Plan
- 15. C3: Forest Management Plan
- 16. C 4: Post-Construction Rehabilitation & Revegetation Plan
- 17. C5: Quarry Management Plan
- 18. C7: Water Supply Replacement Plan
- 19. C8: Water Crossing Management Plan
- 20. C9: Spoil and Topsoil Management Plan.
- 21. C10: Drainage, Erosion and Sediment Control Plan.
- 22. C11: Drill & Blast Management Plan
- 23. M1: Suspended Sediment Monitoring Plan
- 24. M2: Water Quality Monitoring Plan
- 25. M3: Fish, Algae, & Micro- invertebrates
- 26. M5: Flora and Fauna Monitoring Plan.
- 27. M6: Construction Workings Monitoring Plan
- 28. M7: Air Quality and Noise Monitoring Plan.

More detailed discussion was carried out on the management and mitigation measures related to community safety, livelihoods and environmental wellbeing and are linked to other plans which are equally relevant for communities. Most importantly, the 28 ESMPs assure communities that their wellbeing is being prioritised, even on a daily basis (traffic control measures for students to access the road after school, water truck to mitigate dust, sediment ponds, recruitment for casual work etc.) and priority is also given to mitigation of loss or damage to the environment they depend on daily for their livelihoods.

# 5. Strategy for Information Disclosure

- a. Distribution of notices to target communities 5 days before the Consultation clearly stating the consultation purpose, date and time, and venue.
- b. Development of a standard PowerPoint Presentation which is to be used by all presenters during the consultation.
- c. Development of a Consultation Program
- d. Printing of 20 copies of the PowerPoint presentations (Summary of ESMPS presented) and the consultation program for communities.
- e. Sharing disclosure information with PO and THL beforehand and seeking their input.
- f. Briefing meeting with the HEC team on the program and the PowerPoint Slides before the consultation on Wednesday 23<sup>rd</sup> November 2022

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g. Face-to-face presentation with breaks for community comments and feedback

## 6. Formal remarks during the consultation

Formal remarks were presented by the Project Office, CEO of THL and Site Manager for HEC and a community leader from Managikiki.

#### Remarks by the Project Office.

The PO thanked everyone for their time and effort to ensure the planned disclosure happened. Words of thanks are also extended to HEC and THL for organizing the consultation and to all officers from project partners who are present and community chiefs and elders, men, women, youths, and children for their attendance in this important consultation.

#### Remarks by THL

THL CEO thanked the Community for availing themselves for today's meeting, He highlighted the Roles and Responsibilities of each project Partner such as PO through CBSP/THL and HEC to ensure Community Benefits plans such as water supply are implemented under the CBSP components. However, hydropower is a very important development project because through the project Solomon Islands reduce greenhouse gas emissions. Development is important but more importantly, is sustainable development. Hydropower is an example of cheaper, sustainable, and environmentally friendly development which will be helpful to communities and to the whole of Honiara.

Construction activities of the main works (Dam, Powerhouse & Tunnel) will start soon. We want to listen to your voice and reflect on our project based on your opinions. Before the main works start, similar consultations will take place. More job opportunities will be available in the next phase of the project.

#### Remark the by HEC

HEC CLO welcomes all community Leaders from the 10 communities that attend today's consultations. The Purpose of the Consultations is to disclose the 28 ESMP that HEC had submitted, actioned, and approval being sought from the Lenders. HEC always implemented the ESMP Mitigations and Management actions to safeguard our Environments and all social aspects of Communities and the Project activities.

For the new construction of the Main works (Dam, Powerhouse & Tunnel) more Workers will be needed to work which is good for community development. Building relationships with communities is important for the completion of the project.

#### Remarks by Community Leader

The community leader welcomes everyone present in the Consultation on behalf of the community.

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#### **ESMP** Disclosure Report

## 7. Presentation of the ESMPs

The presentation of the 28 ESMPs is based on the prepared standard presentation (refer to Annex 3). The prepared PowerPoint focus on control measures in each respective ESMPs. As implementers of the ESMPs, presenters elaborate on the control measures using examples on the ground that communities are very much familiar with. In this way, community members can map the activities they see on the ground with the ESMPs and appreciate as well as understand current management and control efforts.

Presenters and presentation topics are outlined below.

- 1. Welcome Address Titus and Daniel, Mr. Yonghoon Chang (CEO, THL)
- 2. Background Samuela, THL (slide 2)
- 3. Overview Main works Manas (slides 3-8)
- 4. Environmental and Social Management Plans Edmond (slides 9-10),
- 5. P3-SECP, P4 HRLMP, Helen (slide 10-12)
- 6. P5 IMP, P6 -GRM Titus and Fiona (slides 13-14)
- 7. P7 SMP, P8-WHSP, P9-WCC, P10 CHDVMP, P11-TMP Patrick (Slide 15-19)
- 8. P12-WMPSPP, P13, P14, P15 Edmond (slide 20-23)
- 9. C2-UXO Clement (slide 24)
- 10. C3-FCP & C4-PCRRP- Ryline (slides 25-26)
- 11. C5-QMP Clement (Slide 27)
- 12. C7-WSRP, C8-WCCMP, C9, C10, C11 & C13 Edmond (slide 28-32)
- 13. CBSP update Bala
- 14. M1, M2, M3 Ivory (slides 33-35)
- 15. M5 Mana (slide 36)
- 16. M6 and M7 Ivory (slides 37-38)
- 17. Q&A session
- 18. Closing statement THL and HEC management,
- 19. Words of Thanks Daniel

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### 8. Community perception and feedback

The following table is inclusive of community comments received during the consultation. HEC responded to the issues and concerns raised by community members. However, this table does not include responses since the intention is to focus on community perception which can inform the improvement of existing management and mitigation measures and processes in the ESMPs.

No.	Communities	Comments, issues, concerns, recommendations	Related ESMPs
1	Managikiki	Time and again Managikiki is requesting HEC to provide Transport for students traveling to school and Community people going to town and Clinic.	P11 Traffic Management Plan
2	Managikiki	The Managikiki community requested HEC to connect the water supply from the Office site Borehole to their communities.	C7 Water Supply Replacement Plan
3	Managikiki Antioch	The Managikiki community would like to have some options for providing Catering services for HEC Construction Team onsite. Thus, the community requests HEC to meet the costs.	P4 Human Resources and Labour Management Plan
4	Managikiki	Since Solomon Island is likely experiencing Earthquakes, How safe is the Dam Construction against the Natural disaster or Power of Nature?	P13 Spill Prevention & Emergency Response Plan
5	Kaimomosa	My community and other Malango Communities may have an impact due the Disposal 2 & 3 sites activities which causes their streams to water turbidity. He requested HEC to do monitoring on these two sites and give feedback to his communities.	C10 Drainage, Erosion, and Sediment Control Plan C9 Spoil and Topsoil Management Plan

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# 9. Conclusion

Disclosure of the ESMPs to communities for the construction of the Main works (Dam, Power House & Tunnel) has been successfully facilitated by HEC and THL on 23<sup>rd</sup> November 2022 (1 site), The consultations have resulted in feedback that can sufficiently inform the review and improvement of ESMPs to capture community context as is relevant. The consultation on 23<sup>rd</sup> November 2022 packaged the ESMPs together and provided a linked and structured tour of the ESMPs.

## Annex 1: Photographs of the community consultation

### Annex 2: Attendance Record

### **Annex 3: Presentation Materials**

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