No.

BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR REHABILITATION
OF
BETIO PORT
IN
THE REPUBLIC OF KIRIBATI

FINAL REPORT

FEBRUARY 2005

JAPAN INTERNATIONAL COOPERATION AGENCY
NIPPON KOEI CO., LTD.

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PREFACE

In response to a request from the Government of the Republic of Kiribati, the Government of Japan decided to conduct a basic design study on the Project for Rehabilitation of Betio Port in Kiribati and entrusted the study to Japan International Cooperation Agency (JICA).

JICA sent to Kiribati a study team from August 17 to September 22, 2004.

The team held discussions with the officials concerned of the Government of the Republic of Kiribati, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Kiribati in order to discuss a draft basic design, and as this result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Kiribati for their close cooperation extended to the teams.

February 2005

Seiji Kojima
Vice-President

Japan International Cooperation Agency

February 2005

Letter of Transmittal

We are pleased to submit to you the basic design study report on the Project for Rehabilitation of Betio Port in Kiribati.

This study was conducted by Nippon Koei Co., Ltd., under a contract to JICA, during the period from August, 2004 to February, 2005. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Kiribati and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

Finally, we hope that this report will contribute to further promotion of the project.

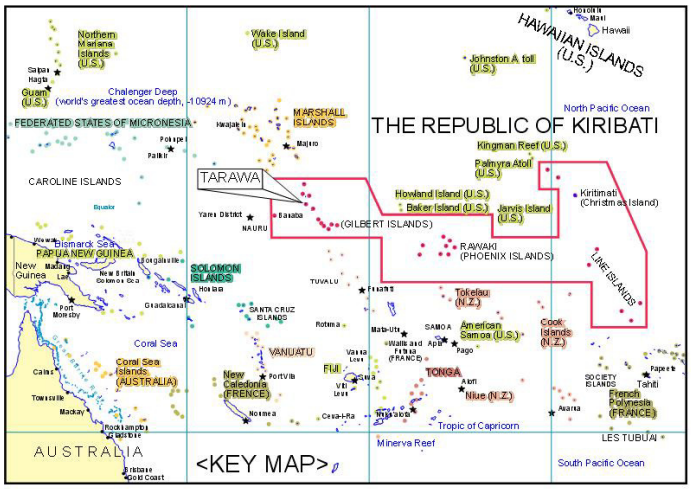
Very truly yours,

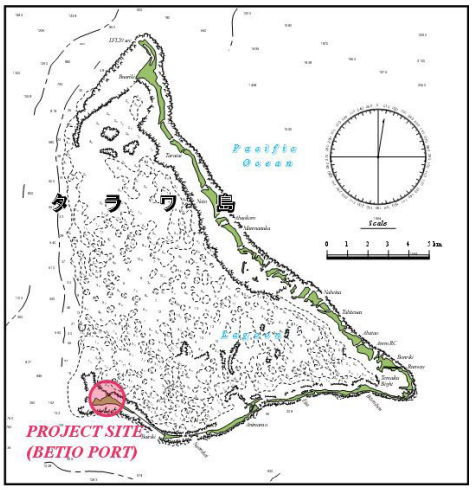
Ryoichi Nishimura

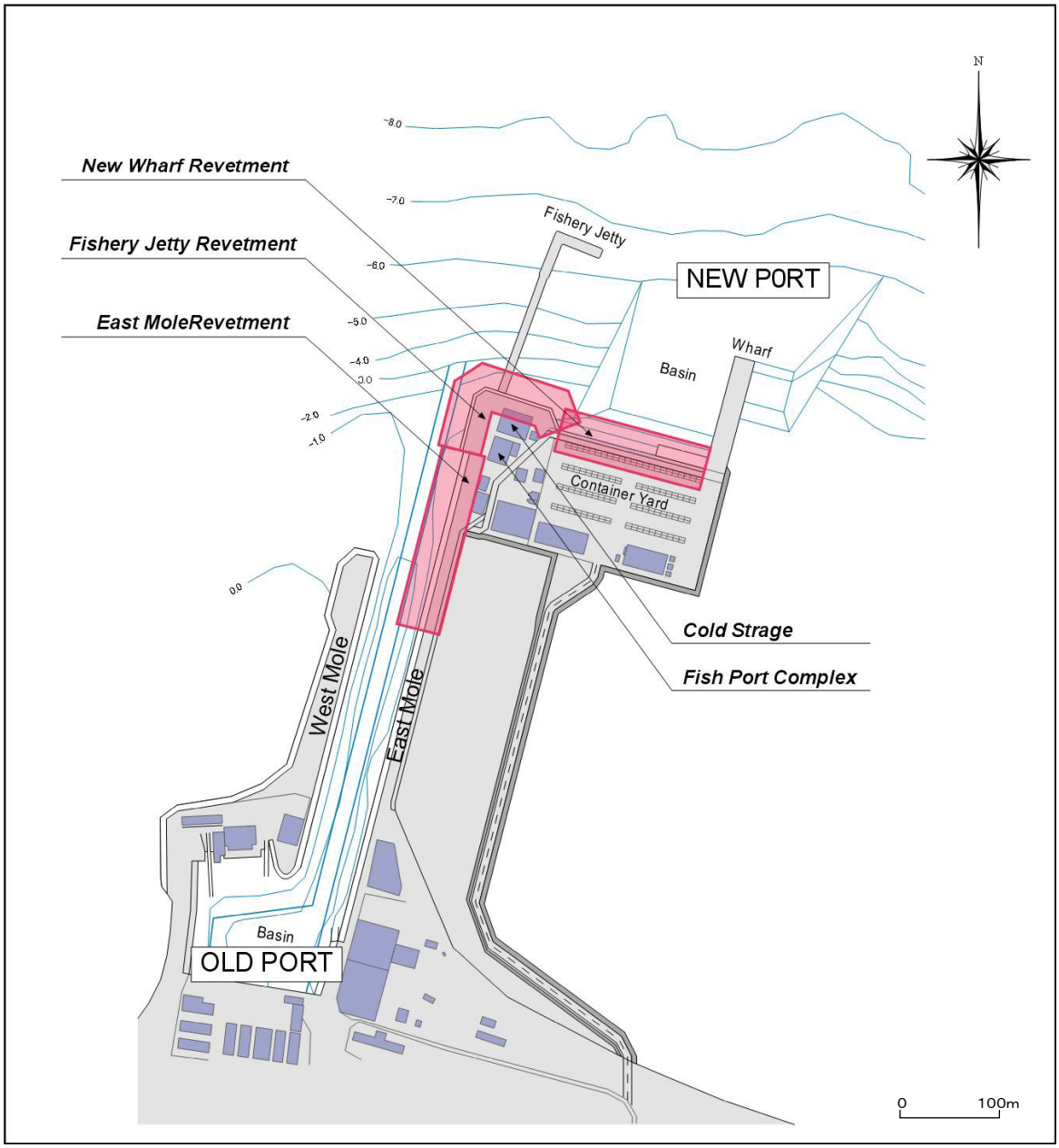
Chief Consultant,

Basic design study team on the Project for Rehabilitation of Betio Port in Kiribati

Nippon Koei Co., Ltd.







Basic Design Study on the Project for Rehabilitation of Betio Port in the Republic of Kiribati	Project Location Map

Basic Design Study on the Project for Rehabilitation of Betio Port in the Republic of Kiribati	Perspective

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ABBREVIATION

ADB	Asian Development Bank
AUD	Australian Dollar
BM	Bench Mark
CDL	Chart Datum Line
DL	Datum Level
HWL	High Water Level
JICA	Japan International Cooperation Agency
KOIL	Kiribati Oil Company Ltd.
KPA	Kiribati Port Authority
KSSL	Kiribati Shipping Services Ltd.
LWL	Low Water Level
MCTTD	Ministry of Communication, Transportation and Tourism Development
MFED	Ministry of Finance and Economic Development
MPWU	Ministry of Public Works and Utilities
MSL	Mean Sea Level
NCS	National Condition of Services
NDS	National Development Strategies
NIWA	National Institute of Water and Atmospheric Research Ltd
SPSLCMP	South Pacific Sea Level and Climate Monitoring Project
UNDP	United Nation Development Plan

SUMMARY

SUMMARY

The Republic of Kiribati (hereinafter referred to as "Kiribati") is an archipelagic country composed of 33 atolls scattered near the equator and dateline in the Central Pacific Ocean. Its land area totals just 810.5 km^2, whereas its coastal economic zone stretches 3.5 million km^2, corresponding to the national territory of India. Kiribati finds difficulty promoting social economic development due to its isolation from international markets and significantly diffuse nation's land.

Kiribati has no land suitable for farming and its socioeconomic activities rely heavily on imported daily commodities including foodstuffs. Therefore, the marine facilities function as a lifeline for supporting the nation's socioeconomic activities. Moreover, the Government of Kiribati (hereinafter referred to as "the Government") is promoting as a national strategy decentralization of people from the current concentration (2,300 persons/km^2) in the capital, Tarawa on the Gilbert Islands, to other remote islands. To enhance decentralization with offers of social services to inhabitants in the remote areas, the Government now struggles to secure the means for marine transport.

Kiribati had been provided with financial support from its former colonial power, the British Government, since its independence in 1979. After withdrawal of the financial support and implementation of a normal budget process since 1986, the Government faces an urgent national issue of achieving financial self-sustainability. To cope with this situation, the Government places the highest priority for economic development on the marine industry making good use of its vast coastal economic zones. The 10th National Development Strategies, covering the years 2004-07, has established major strategic achievements including "improved efficiency in the public sector" and "equitable distribution of services and economic opportunity".

Betio Port, situated in the capital, functions as a gateway port for the country and plays an important role in providing a lifeline to carry passengers and for mass transportation of cargo. The marine facilities of the port, originally constructed in the 1950s for utilization by small boats, have not been maintained and upgraded over the longer term. Following the Study on Ports Development in Kiribati in 1994 and 1995 (hereinafter referred to as "former M/P study"), the marine facilities were improved under the Project for Improvement of Betio Port between 1996 and 2000 (hereinafter referred to as "former project") with Japanese Grant Aid financial assistance totaling 2,959 million yen. The scope of works of this project was to construct the new port, consisting of a new wharf with navigation channel and basin (-4 m/-6 m depth), new wharf revetment, and container yard 1.7 ha in area; to rehabilitate the old port including rehabilitation of the wharf, dredging of channel and basin; and to provide an administrative office building and cargo handling equipment. However, 2.5 years after completion of the project the revetment in the New Wharf was damaged by abnormal waves induced by a depression in November, 2002. This resulted in the access road behind the revetment becoming unusable.

To prevent further loss in the port and to ensure safe and efficient port operations, all damaged facilities as well as others not presently damaged but which may be affected in the future should also be rehabilitated. Taking the above situation into account, the Government requested the Government of Japan to provide Grant Aid for the rehabilitation of the marine port facilities.

In response to the Government's request, the Government of Japan considered the possibilities of conducting a basic design study and entrusted this to Japan International Cooperation Agency (JICA). JICA dispatched a preliminary study team to Kiribati from November to December, 2003. The team examined a scope of works and defined a basic policy for rehabilitation and renovation of marine facilities in the port. This was based on checking damages and reviewing the appropriateness of designs and construction undertaken by the former project. The study concluded that it is essential to carry out not only urgent repairs but also permanent rehabilitation to ensure the durability of the damaged facilities in the future. Based on the results of the study, the Government of Japan decided to conduct a basic design study, namely the "Project for Rehabilitation of Betio Port".

Following the preliminary study, JICA dispatched a basic design study team to Kiribati from August 17 to September 22, 2004. The team conducted field surveys to investigate damage to the marine facilities and their causes and defined a basic policy for the Project. As a result of the field surveys, rehabilitation of the New Wharf Revetment (150 m), the Fishery Jetty Revetment (160 m) and the East Mole Revetment (180 m), and procurement of spare parts of an 80-t crane were selected for assessment. After the team's return to Japan, further studies were conducted and a draft final report was prepared. JICA then dispatched the basic design explanation team to Kiribati from December 7 to 18, 2004 to explain the study results. A Minutes of Discussion, mainly covering the results of the basic design and the recipient country's obligations, was then signed by both parties.

The original request from the Kiribati side included rehabilitation of marine facilities and dredging of the basin and channel in the old port. However, the scope of works for the Project is limited to the rehabilitation of the facilities, which were constructed under Japan's previous Grant Aid projects. Therefore, it is suggested that temporary remedial works be carried out for some of the facilities in the old port by the Kiribati side. Furthermore, the dredging work is not considered to be appropriate for inclusion in the Project, as it should be implemented by the Kiribati side as part of normal maintenance works. A comparison between the facilities originally requested by the Kiribati side and those finally selected in the study for possible rehabilitation is shown in the table below:

Comparison between the Original Scope of Works and the Results of the Basic Design Study

Facilities to be Rehabilitated	Original Request	Result of B/D Study	Reasons for Rehabilitation
(1) Rehabilitation of New Wharf			
1) New Wharf Revetment	O	O	Damaged facilities and others not affected but which may experience damage in the future. Rehabilitation is necessary to limit the extent of damage and to secure the functions of the original facilities and efficient port operation.
2) Repair of Building	O	―	Repairs of guard station and pump house washed away. It is determined that the guard station could be repaired by the Kiribati side due to its simple structure. The pump house has already been repaired.
3) Dredging of Channel & Basin	O	―	It is not considered appropriate to be included in the Project since it should be implemented by the Kiribati side as part of normal maintenance works.
(2) Rehabilitation to Old Port			
1) Fishery Jetty Revetment	O	O	Facilities damaged frequently and building facilities constructed behind the revetments under previous Japanese Grant Aid projects. Rehabilitation is necessary to prevent the facilities from future damage.
2) East Mole Revetment	O	O	
3) West Mole Revetment	O	―	The scope of works for the Project is limited to the rehabilitation of the facilities, which were constructed under previous Japanese Grant Aid projects. Therefore, it is suggested that temporary remedial works be carried out by the Kiribati side.
4) Dredging of Channel & Basin	O	―	It is not considered appropriate to be included in the Project since it should be implemented by the Kiribati side as part of normal maintenance works.
(3) Spare Parts of 80-t Crane	―	O	Spare parts of the crane procured by the former project. It is considered that the crane is essential to secure efficient port operation.

The basic design of the marine facilities selected for possible rehabilitation was carried out taking into account the results of the field surveys, and design manuals and guidelines from Japan and the United States for marine facilities. Considering the actual damages and their causes confirmed in the field survey, the policy to actively adopt a more economic and functional structure was applied when selecting the structure for revetments to be rehabilitated, as tabulated below:

Facility Layout

Facilities	Details	Quantity
(1) New Wharf Revetment		
1) Revetment	Steel Sheet Pile with Concrete Block	150 m
2) Pavement	Concrete Pavement	1,120 m^2
3) Surface Drainage	L-shaped Curb	164 m
(2) Fishery Jetty Revetment		
1) Revetment	Rock Mound with Steel Sheet Pile and Concrete Block	160 m
2) Utility Trench	Concrete Open Channel	65 m
3) Pavement	Concrete Pavement	1,400 m^2
(3) East Mole Revetment		
1) Revetment	Steel Sheet Pile with Anchor	180 m
2) Utility Trench	Concrete Open Channel	90 m
3) Pavement	Concrete Pavement	1,700 m^2
(4) Procurement of Equipment	Spare Parts for Port Authority's 80-t Crane	LS

Considering the scope of works for the three revetments and time required to manufacture concrete blocks, and assuming the Project will be implemented under Japanese Grant Aid, it is desirable to phase the Project. Consequently, it is proposed that urgent rehabilitation of the New Wharf Revetment be implemented in Phase 1 with rehabilitation of the Fishery Jetty and East Mole Revetments in Phase 2. Both phases will be conducted under a single Japanese fiscal year scheme.

The overall implementation period until completion of the Project is about 22 months, consisting of 6 months for detailed design/tendering and 16 months for construction. The project cost is estimated at 878 million Yen. This comprises 835 million Yen to be financed by Grant Aid and 43 million Yen to be contributed by the Kiribati side.

The beneficial effects of project implementation are recovery of the original function of the revetments, securing smooth access to the New Wharf through improvements to the road pavement and reduction of flood damage to the building facilities behind the revetments. Furthermore, it is expected that the maintenance cost and probability of collapse of revetments will be substantially reduced. This reflects their design to a higher standard based on the 50-year probable wave, thus extending the facility life by 50 years. It is worth noting that the Project will benefit the South Tarawa, which has a total population of approximately 40,000 or about 46% of the total population of Kiribati (according to the 2002 Census).

Although the importance and urgency of project implementation to sustain the Kiribati economy are obvious, the Government is not in a position to undertake the Project by itself due to present limitations in its budget and technology. It is therefore recommended that significant assistance in the form of Japanese Grant Aid be provided to the Government for the implementation of the Project.

After completion of the Project, the KPA will be responsible for the maintenance of the project structures. The annual maintenance cost is estimated at 11,500 AUD, which is equivalent to 4.2% of KPA's annual average maintenance budget of 276,000 AUD. KPA's staff is also well experienced in such labor-intensive maintenance work as they are presently undertaking suck works for other structures. Therefore, from budgetary and technical viewpoints, it is considered that KPA will be capable of properly and adequately undertaking the maintenance of the project structures.

For smooth and efficient project implementation, it is essential that the Kiribati side undertake their obligations as scheduled, including periodic maintenance/repair works of the revetments for rehabilitation and the West Mole Revetment before commencement of the Project. After completion of the Project, it is expected that the Kiribati side will undertake adequate maintenance/repair works in order to achieve and sustain the positive impacts of the Project.

BASIC DESIGN STUDY
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CHAPTER 1 BACKGROUND OF THE PROJECT

Chapter 1 BACKGROUND OF THE PROJECT

The Republic of Kiribati (hereinafter referred to as "Kiribati") had been provided with financial support from its former colonial power, the British Government, since its independence in 1979. After withdrawal of the financial support and implementation of a normal budget process since 1986, the Government of Kiribati (hereinafter referred to as "Government") faces an urgent national issue of achieving financial self-sustainability. To cope with this situation, the Government places the highest priority for economic development on the marine industry making good use of its vast coastal economic zones. The 10th National Development Strategies, covering the years 2004-07, has established major strategic achievements including "improved efficiency in the public sector" and "equitable distribution of services and economic opportunity". Even in the capital, Tarawa, infrastructure has not been well developed especially in the fields of social welfare, fishery and transportation which are indispensable to enhancing people's living standards.

Betio Port, situated in the capital, functions as a gateway port for the country and plays an important role in providing a lifeline to carry passengers and for mass transportation of cargo. The marine facilities of the port, originally constructed in the 1950s for utilization by small boats, have not been maintained and upgraded over the longer term. Following the Study on Ports Development in Kiribati in 1994 and 1995 (hereinafter referred to as "former M/P study"), the marine facilities were improved under the Project for Improvement of Betio Port between 1996 and 2000 (hereinafter referred to as "former project") with Japanese Grant Aid financial assistance totaling 2,959 million yen. The scope of works of this project was to construct the new port, consisting of a new wharf with navigation channel and basin (-4 m/-6 m depth), new wharf revetment, and container yard 1.7 ha in area; to rehabilitate the old port including rehabilitation of the wharf, dredging of channel and basin; and to provide an administrative office building and cargo handling equipment. However, 2.5 years after completion of the project the revetment in the New Wharf was damaged by abnormal waves induced by a depression in November, 2002. This resulted in the access road behind the revetment becoming unusable.

To prevent further loss of the port and to ensure safe and efficient port operation, all damaged facilities as well as others not affected but which may experience damage in the future should also be rehabilitated. Taking the above situation into account, the Government requested the Government of Japan to provide grant aid for the rehabilitation of the marine port facilities.

In response to the Government's request, the Government of Japan considered the possibilities of conducting a basic design study and entrusted the study to Japan International Cooperation Agency (JICA). JICA dispatched a preliminary study team to Kiribati from November to December, 2003. The team defined a scope of works and established a basic policy for rehabilitation and renovation of marine facilities in the port by checking damage and reviewing the appropriateness of design and construction undertaken in the former project. The study recommended to adopt engineering approaches in formulating countermeasures and to examine furtherly what cooperation is truly

required, whether in the form of grant aid or followup cooperation, by collecting sufficient information on climate and maritime conditions necessary to investigate into the cause of damage. The study also concluded that it is essential to carry out not only urgent repairs but also permanent rehabilitation to ensure the future durability of the damaged facilities. Based on the results of the study, the Government of Japan decided to conduct a basic design study, namely the "Project for Rehabilitation of Betio Port in Kiribati".

Following the preliminary study, JICA dispatched a basic design study team to Kiribati from August 17 to September 22, 2004. The team conducted field surveys to investigate damage to the marine facilities and their causes and developed a basic policy for the Project. As a result of the field surveys, rehabilitation of the New Wharf Revetment (150 m), the Fishery Jetty Revetment (160 m) and East Mole Revetment (180 m), and procurement of spare parts of the 80-t crane were selected for assessment. After the team's return to Japan, further studies were conducted and a draft final report was prepared. JICA then dispatched the basic design explanation team to Kiribati from December 7 to 18, 2004 to outline the study results. A Minutes of Discussion, mainly covering the results of basic design and the recipient country's obligations, was signed by both parties.

A comparison between the facilities originally requested by the Kiribati side and those finally selected in the study for possible rehabilitation is shown in Table 1-1.

Table 1-1 Comparison between the Original Scope of Works and the Result of Basic Design Study

Facilities to be Rehabilitated	Original Request	Result of B/D Study	Reasons for Rehabilitation
(1) Rehabilitation of New Wharf			
1) New Wharf Revetment	O	O	Damaged facilities and others not affected but which may experience damage in the future. Rehabilitation is necessary to limit the extent of damage and to secure the functions of the original facilities and efficient port operation.
2) Repair of Building	O	—	Repairs of guard station and pump house washed away. It is determined that the guard station could be repaired by the Kiribati side due to its simple structure. The pump house has already been repaired.
3) Dredging of Channel & Basin	O	—	It is not considered appropriate to be included in the Project since it should be implemented by the Kiribati side as part of normal maintenance works.
(2) Rehabilitation to Old Port			
1) Fishery Jetty Revetment	O	O	Facilities damaged frequently and building facilities constructed behind the revetments under previous Japanese Grant Aid projects. Rehabilitation is necessary to prevent the facilities from future damage.
2) East Mole Revetment	O	O	
3) West Mole Revetment	O	—	The scope of works for the Project is limited to the rehabilitation of the facilities, which were constructed under previous Japanese Grant Aid projects. Therefore, it is suggested that temporary remedial works be carried out by the Kiribati side.
4) Dredging of Channel & Basin	O	—	It is not considered appropriate to be included in the Project since it should be implemented by the Kiribati side as part of normal maintenance works.
(3) Spare Parts of 80-t Crane	—	O	Spare parts of the crane procured by the former project. It is considered that the crane is essential to secure efficient port operation.

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2-1 Basic Concept of the Project

2-1-1 Overall Goal and Project Purpose

2-1-1-1 Overall Goal

The Government gives economic development the greatest priority, placing much importance on the marine industry to make good use of its vast coastal economic zones. The 10th National Development Strategies, covering the years 2004-07, established the major strategic achievements including "improved efficiency in the public sector" and "equitable distribution of services and economic opportunity".

Kiribati has no land suitable for farming and its socioeconomic activities rely heavily on imported daily commodities including foodstuffs. Therefore, the marine facilities function as a lifeline to support the nation's socioeconomic activities. Moreover, the Government is promoting as a national strategy the decentralization of people from areas of high current concentration in the capital to other remote islands. To enhance the decentralization by offering social services to inhabitants in the remote areas, the Government struggles to secure the means of marine transport.

Betio Port, situated in the capital functions as a gateway port for the country and plays an important role in providing a lifeline to carry passengers and for mass transportation of cargo. The marine facilities of the port including the container terminal in the new port, which were constructed between 1996 and 2000 under the former project, were damaged by abnormal waves induced by the depression in November, 2002. This also resulted in an access road behind the revetment becoming unusable.

To prevent further loss to the port and to ensure safe and efficient port operation, all damaged facilities as well as others not affected but which may experience damage from another abnormally high waves and tides in the future should also be rehabilitated. Taking the above situation into account, the Government requested the Government of Japan to provide grant aid for the rehabilitation of the marine facilities of Betio Port.

The Project aims to sustain efficient port operation and to prevent the facilities, such as container terminal, cold storage and fish port complex, all of which were constructed under previous Japanese Grant Aid projects, from further damage. This will involve rehabilitating the damaged facilities as well as others not affected but which may experience future damage. In terms of results, the Project is expected to improve maritime freight activities in the country.

2-1-2 Outline of the Project

2-1-2-1 Outline of Rehabilitation Work

The Project intends to rehabilitate the facilities of Betio Port, which were constructed between 1996 and 2000 and were damaged in November, 2002. The aim is to sustain efficient port function and to attain the development goals.

2-1-2-2 Facilities to be Rehabilitated

(1) New Wharf Revetment

The field survey has revealed a structural collapse occurred at the fabric mat-type revetment of the New Wharf Revetment and also at the east end of the revetment. At this location part of the gabions located in the lower area of the concrete blocks were dislodged due to tearing-off of the steel-wire nets. Presently, the revetment has not become totally disused, although its structural safety cannot be maintained in the future without urgent rehabilitation. As such, the entire 150 m section of the New Wharf Revetment should be rehabilitated, including the east revetment portion.

(2) Fishery Jetty Revetment

The entire stretch of the Fishery Jetty Revetment, which structurally comprises steel-sheet piles, experiences severe erosion. Most of its northern face, near the low water level, has open holes of 10 to 30 cm diameter, allowing sea water to flow through. The western face has four holes of 20 to 40 cm diameter. These holes have caused a loss of backfill material, resulting in partial settlement of the apron. In the rear of the waterfront stands a cold storage that is occasionally washed by overtopping waves during high tides. As the Fishery Jetty Revetment is between the New Wharf and East Mole Revetments, the entire stretch of Fishery Jetty Revetment (160 m in length) needs to be rehabilitated. This also takes into consideration the long-time stability of the adjacent revetment structures and other port facilities established nearby.

(3) East Mole Revetment

As both the West and East Mole Revetments are made of bagged concrete (a somewhat weak structure), they are easily damaged by breaking waves approaching from the west during high tides. Following damage, repairs are undertaken by KPA. Nevertheless, the repairs are limited to quick remedial patch-work using bagged concrete. This is not a permanent rehabilitation. At the rear of the East Mole Revetment stands the Betio Fish Port Complex, which was constructed in 1999 through Japanese Grant Aid. As an offshore section of the East Mole Revetment is exposed to waves from the west, bagged concrete is easily dislodged, resulting in flooding of waterfront facilities and causing land settlement due to piping of the backfill material. In order to stop this repeated collapse of the bagged concrete structure, the offshore section of the East Mole Revetment needs to be rehabilitated permanently.

(4) Spare Parts of 80 t Crane

Under the former project, one truck crane (80 t lifting capacity) was supplied to Betio Port, although it has remained unused for half a year due to shortage of spare parts. While a 25 t crane is available, it is short of hoisting capacity, so that most of the container boxes need to be unloaded using an old stationary crane at the old port. These container boxes are unloaded onto a barge from an ocean-going ship anchoring offshore, and also for repair/maintenance services. Spare parts are therefore indispensable not only to maintain smooth port operation but also civil facilities such as moving concrete blocks and casting of additional rock. A minimum of 3-years spare parts stock would be desirable.

2-2 Basic Design of the Requested Japan's Assistance

2-2-1 Design Policy

2-2-1-1 Basic Policy

(1) Selection of Facilities for Possible Rehabilitation

In this basic design study, the extent of surveyed facilities was expanded beyond that requested by the Government after examining the relevant documents. The facilities to be rehabilitated by the Project were also selected based on an extensive field survey by the study team. Although the Government requested rehabilitation of damaged facilities in the new and old ports and dredging of the basin and channel, the facilities for possible rehabilitation were selected taking into account the necessity and urgency of rehabilitation and the purpose of the Japanese Grant Aid system, as shown in Table 2-2-1. Furthermore, considering the scales of the surveyed facilities, the policy to actively adopt more economic structural types and construction methods was applied when planning the rehabilitation.

Table 2-2-1 Facilities and Equipment to be Provided

Facilities and Equipment to be Provided	Project Scale
New Wharf Revetment	150 m section
Fishery Jetty Revetment	160 m section
East Mole Revetment	180 m section
Procurement of Equipment	Spare Parts of 80 t Crane for 3 years

(2) Consideration for Social Environment Issues and Procurement Conditions

In this basic design study, the policy of adopting the most suitable structural types and construction methods was applied in designing the revetments to be rehabilitated. Due consideration of the environmental regulations in the country and effects on the present port activities was also taken into account. Furthermore, in formulating the procurement plan of construction materials and equipment, due consideration was given to the unique procurement conditions in the country, which is an archipelago isolated from international markets geographically.

2-2-1-2 Policy for Natural Condition

(1) Design Tidal Elevations

The Basic Design Study for Improvement of Betio Port 1997 (hereinafter referred to as "former B/D study") was undertaken using tidal data collected during the former M/P study. As these tidal data are different from those actually being measured on site, the tidal elevations have been revised as shown in Table 2-2-2.

Table 2-2-2 Design Tidal Elevations

Item	Former B/D Study	Revised by this Study
Average Spring Higher High Water (HWL)	DL +1.84 m	DL +2.05 m
Mean Sea Level（MSL）	DL +0.95 m	DL +0.89 m
Average Spring Lower Low Water（LWL）	DL +0.06 m	DL -0.19 m
Highest Recorded Water Level（HHWL）	DL +2.15 m	DL +2.24 m

(2) Design Wave

In the former B/D study, the design wave had been estimated for the wind wave generated inside the lagoon. Assuming a fetch at 25 km, the design wave height (Ho') had been estimated at 1.24 m with a wave period of 4 to 5 seconds using the SMB method.

The design wave for the New Wharf Revetment is extracted from the diagram of wave height ratio analysis considering wave convergence and reflection effects and was determined at $H_{1/3}$=1.54 m. In the former M/P study, it is stated that the wave height intruded from offshore was estimated at $H_{1/3}$=1.5 m, thus the wave height generated within the lagoon and wave intruded from offshore are almost the same.

1) Wind Wave Generated Inside Lagoon

In this study, it is basically not necessary to revise the wind wave since the fetch of wind to be assumed for estimating wave generation in the lagoon is the same as in the former B/D study. Nonetheless, the design nearshore wave for the revetments shall be estimated for the condition without structure. For the westerly wave it has been estimated considering wave reflection at the New Wharf.

Considering the results of wave analysis in the former B/D study and reflection effect at the New Wharf, design nearshore waves for various directions are estimated as shown in Table 2-2-3. From the following analysis, the nearshore wave height extracted from a generated wave in the lagoon is $H_{1/3}$=1.35 m.

Table 2-2-3 Design Nearshore Waves Estimated from Waves Generated in Lagoon

Wave Characteristics/Wave Direction	NNW	N	NNE	NE
Offshore Wave Height Ho (m)	0.99	1.24	1.24	1.24
Offshore Wave Period To (sec)	4.00	4.00	4.00	4.00
Ratio of Wave Height（after consideration of reflection effect by the New Wharf）	1.18	1.09	1.01	-
Nearshore Wave Height $H_{1/3}$ (m)	1.17	1.35	1.25	1.24

2) Wave Intruding From Outside Lagoon

The wave transmitted from outside the reef has been examined with the revised tidal elevation. The design offshore wave outside the reef is shown in the report of the former M/P study. This referred

the offshore waves of Ho=6.1 m and To=9.3 second (SW direction) indicated in the report of the Basic Design Study for Betio-Bairiki Causeway 1985.

This design offshore wave had been determined from long-term wave records and was analyzed as a probable wave with a 50 year return period. The Global Wave Statistics published in England, which is statistically summarized from 20 years of data of ocular measurement, shows a wave height of 5 to 6 m occurred two times. Thus, it is reasonable to apply a design offshore wave height of 6.1 m.

Applying the above design offshore wave, the nearshore wave at the New Wharf Revetment has been estimated using the Takayama formula for waves at a reef. The assumed water depth of the reef was determined as the depth at reef edge (1.2 m) plus tidal elevation. For tidal elevation, a DL of +2.24 m, which is the highest higher water level, has been applied. Thus, the water depth of 3.44 m is adopted for estimating wave transmitting on the reef. In the Design Manual for Fishing Port and Fisheries Ground Facilities, 2003, it is recommended to apply a surf beat effect for propagating waves on a reef in case of the offshore wave height exceeding 5 m and to compute wave pressure. Wave height considering surf beat is determined as:

$H_{L1/3} = 0.10\ Ho'$ $H_{Lmax} = 1.5\ H_{L1/3}$

where,

$H_{L1/3}$: Significant wave height with surf beat effect

H_{Lmax} : Maximum wave height with surf beat effect

The design wave propagating on the reef shall be estimated combining both wave energies. As for the design wave in the lagoon, the design wave intruding from the offshore area to the New Wharf Revetment shall be estimated considering reflection effect at the New Wharf. The design nearshore wave intruding from outside the lagoon was estimated as shown in Table 2-2-4.

Table 2-2-4 Estimation of Nearshore Wave Intruding from Outside Lagoon

Design Offshore Wave Height	H_0 (m)	6.1
Design Offshore Wave Period	T_0 (sec)	9.3
Water Depth	(m)	1.2+2.24=3.44
Transmitting Distance on Reef	(m)	2,700
Intruded Wave Height	$H_{t1/3}$ (m)	1.36
Maximum Wave Height	H_{tmax} (=1.8 x $H_{t1/3}$) (m)	2.45
Water Setup	(m)	0.69
Significant Wave Height with Surf Beat	$H_{L1/3}$ (m)	0.61
Maximum Wave Height with Surf Beat	H_{Lmax} (m)	0.92
Combined Significant Wave Height	$H_{1/3}$ (m)	1.49
Combined Maximum Wave Height	H_{max} (m)	2.62
Ratio of Wave Height (Considered reflection effect by New Wharf)		1.19
Nearshore Wave considering Reflection Effect by New Wharf $H_{1/3}$ (m)		1.77
Wave Period	$T_{1/3}$ (sec)	9.3

3) Design Wave

From the above examination, it is revealed that the wave estimated from the offshore wave (1.77 m) is higher than the wave generated inside the lagoon (1.35 m). Thus, the design nearshore wave for the New Wharf Revetment has been determined at $H_{1/3}$=1.77 m÷1.8 m considering wave reflection at the New Wharf. The wave period at the reef is normally shortened by the wave breaking effect at the reef edge, but there is no reliable equation. Thus, the nearshore wave period is determined at $T_{1/3}$=9.3 second which is the same as that of offshore waves.

The design waves for the Fishery Jetty Revetment and East Mole Revetment were determined as $H_{1/3}$=1.49 m ÷ 1.5 m without consideration of refraction effect by local seabed conditions and reflection effect.

2-2-1-3 Policy for Social Condition

(1) Obedience of Environmental Act

Historically, Kiribati has used coral sand and rocks as reclamation materials and aggregates for concrete work. Recently, loss of the land due to a rising sea water level has become a focal point. The Environmental Act, enacted in 1999, allows only small-scale licensed subsistence operators to mine coral sand and rock, which is unfavorable to commercially-based large-scale mining organizations. Under these circumstances, it is desirable to minimize the quantity of these local materials in the rehabilitation work. Furthermore, it is recommended that the tender documents should be clearly defined to avoid likely illegal coral mining.

(2) Minimum Traffic Interference with Ongoing Port Operation

The rehabilitation work needs to be executed while allowing the existing port operation. The access road to the port is so narrow that some detour should be established to haul construction materials. During rehabilitation work, a construction plan to minimize traffic interference with ongoing port operation should be carefully derived. In the execution of rehabilitation work, joint meetings should be regularly organized, attended by KPA, Consultant and Contractor to ensure an interruption-free operation on site.

2-2-1-4 Policy for Construction Condition

(1) Labor Condition

In Kiribati there is a labor law named “National Condition of Services (NCS)” defining standard working hours and the minimum wage. Local contractors are engaged in various kinds of small-scale building works and temporary civil works, so workers such as common laborers, carpenters and bar-benders could be easily recruited. It would, however, be difficult to employ experienced crane operators and divers in the local market. Hence, it has been determined that experts such as crane operators and divers would be mobilized from Japan and other countries.

(2) Procurement Condition of Construction Materials and Equipment

1) Cement

In the local market, Australian-made Portland cement (40 kg) is available. In Fiji, cement is manufactured, but its export is prohibited due to a shortage for domestic supply. Therefore the Australian-made cement, which is of reasonable price and quality, has been applied for the construction plan of the Project.

2) Stone and Rock

In the local market, rock materials for construction use are not available. The Environmental Act stipulates that coral mining and blast operation are required to clear application procedures of MELAD. Presently, no permits are issued to ensure environment protection, except for necessary excavation works like channel dredging. Since the environment regulation was enforced, no mining work has been executed. As such, it has been decided that all rock materials will be imported from Fiji.

3) Aggregate

The coral sand and coral rocks locally available serve as aggregates for concrete blocks used in building works and more generally for housing. These coral materials are supplied by local mining contractors (11 contractors for coral rocks and 7 contractors for coral sand) who have mining licenses issued by the Government. Most mining is manual and small in scale, consisting of 2-4 workers per unit, so the production volume in the country is rather small in total.

With the environmental regulations being tightened recently, mining locations have become so limited that new sources are being located near the navigation channel. Coral is a marine product, containing salt, so it should be cleaned with fresh water before being used as an aggregate. Water shortages in the country discourage this requirement for coral aggregate.

Under this situation, the Government recommends using alternative materials like crushed stone and sand, most of them imported from Fiji. In this rehabilitation work, the aggregates from Fiji have been selected.

4) Reinforcement Bar and Structural Steel

In the local market, reinforcement bars (6 m size) are available, but are short in quantity. Most are imported from neighboring countries. According to local information, prices when directly imported from Japan are much lower than those from neighboring countries, so that Japanese-made steel materials will be used.

5) Fuel and Lubricant

Fuel and lubricant are available locally. Kiribati Oil Company Ltd (KOIL) imports them from Australia.

6) Construction Equipment

In Kiribati there is no retail and lease company for construction equipment. For construction work, equipment should be leased from the Government office or contractors. Equipment is limited in number and type. Main sources of lease companies and their equipment are listed below:

Table 2-2-5 Major Lease Company of Construction Equipment

Name of Company	Available Equipment for Lease
KPA	Truck, Truck Crane, Tractor, Forklift, Generator, Flat Barge, Tug Boat
Public Vehicle Unit (MPWU)	Bulldozer, Backhoe, Wheel Loader, Dump Truck, Truck, Truck Crane, Crawler Crane, Motor Grader, Tyre Roller, Concrete Mixer, Air Compressor
Kiribati Protestant Church (KPC)	Backhoe, Dump Truck, Semi-trailer, Vibro Compactor, Concrete Mixer, Concrete Vibrator, Air Compressor
T Temare Construction	Backhoe, Tire Backhoe, Rough-Terrain Crane, Wheel Loader, Dump Truck, Truck Crane, Trailer Truck
Squareline Construction	Truck, Concrete Mixer, Air Compressor

The working condition of construction equipment seems to be generally poor due to rusting induced by the ocean climate. The number of equipment available is too limited to mobilize on time. Under these circumstances, it has been judged that the local equipment will be used only for subsidiary works and as a back-up facility.

Though various types of equipment are owned by KPA for leasing, most are used for more than 40% of the time in port operations in the quayside and yard. The port-owned equipment is rather expensive in terms of lease cost, and more expensive than prices of leasing companies. This discourages using port-owned equipment as a main equipment source. Their temporary use would be more reasonable. Nevertheless, it has been decided that a flat barge would be leased from the port, because a new flat barge will be available in October 2004; the port owns three barges at present, and working days of barges will be limited to 3-4 days a month. Therefore, it is requested that one flat barge with tug boat be provided to the Contractor free of charge including crew, fuel and maintenance costs.

(3) Sea Transport and Customs Clearance

1) Condition of Sea Transport

The shipping schedules for Betio Port are listed below. Most cargoes are containerized. Since the water depth along the quayside is not enough, all cargoes are trans-shipped onto barges offshore except in the case of direct berthing by cargo ships of KSSL. This double-handling operation increases freight cost and risk of transport damage.

Table 2-2-6 Schedule of Regular Shipping

Shipping Company	Major Ship	Schedule	Ports of Call
Chief Container Service (CCS)	Kiribati Chief	Every Month	Melbourne-Sydney-Brisbane-Noumea-Vila-Santo-Suva -Tarawa-Majuro-Santo-Vila
Greater Bali Hai (GBH)	Pacific Islander-II	Bi-monthly	Kaohsiung-HongKong-Busan-Kobe-Nagoya-Yokohama-Tarawa-Vila-Noumea-Lautoka-Suva-Apia-PagoPago-Papeete-Nuku'alofa -Noumea-Santo-Honiara-Noro
Kiribati Shipping Service Ltd. (KSSL)	Matangare	Bi-weekly	Depending on the demand call Majuro, Suva and other ports in neighboring countries

The sea transport from Yokohama, Japan to Betio Port requires 9 days by GBH's exclusive bi-monthly service. If purchasing construction materials from a third country, sea transport from Suva Port in Fiji takes 5 days and 12 days from Melbourne by CCS's exclusive monthly service. KSSL also provides a unscheduled service connecting Suva and Tarawa but it is not considered in the construction schedule. It is to be noted that the shipment from Japan is available on a bi-monthly basis, thus requiring the utmost care in formulating the construction schedule and shipping schedule.

2) Customs Clearance

In the process of customs clearance, tax and duty are estimated on the basis of shipping application paper (original) and associated documents (in case of tax-exemption, calculation paper is prepared). With the request paper for tax-exception to MFED completed and its approval issued, import cargoes can be withdrawn from a bonded warehouse.

(4) Taxation

In Kiribati, consumption tax and value-added tax are not in effect. The Government seems to be accustomed to handling tax-exemption matters, because many of the Government projects are executed under a tax-exception clause, including import tax. Income is levied on a cumulative tax basis. The people should follow the social insurance policy and the Kiribati Provident Fund levy of 7.5% of basic salary. Corporation tax is exempted from a grant aid project.

2-2-1-5 Policy for Utilization of Local Contractors

In Kiribati, large civil works and buildings with financial assistance of lateral and international aid have been constructed by contractors of donor countries. Four local contractors are available in Tarawa for sub-contracting for small-scale building works and temporary works. Judging from this situation, they can participate in the Project in the limited role of subcontractor.

2-2-1-6 Policy of Operation and Maintenance Capability of Implementing Agency

KPA, the executing agency of the Project, commenced operations to replace the former KSSL organization in 2000. KPA has four divisions, Operation, Finance, Human Resources and Branch Office, in Kiribati. These are under the Board and General Manager who is also working as a pilot and is responsible mainly for port operation. The Operation Division of KPA has five sections and one is taking charge of maintenance. However, this section does not have any maintenance staff for civil works and is limited to the maintenance of mechanical equipment for port cargo handling.

Maintenance and repair of such structures as wharf and revetment are being implemented through contracts with local contractors. The expenditure for such maintenance and repair amounted to 99,000 AUD in 2002 and 184,000 AUD in 2003, as shown in Table 2-2-7. This accounted for one third to one half of the average annual maintenance budget of KPA.

Considering the above situation, structural types requiring rather less costly maintenance and repair should be adopted for design of those revetments to be rehabilitated in order to reduce the burden on KPA's maintenance budget. In any case, KPA should conduct periodic maintenance and repair since it is difficult to design complete maintenance-free structures during the entire lifetime of the facilities (50 years).

Table 2-2-7 KPA's Expenditures for Maintenance/Repair of Revetments

(Unit: AUD)

	New Wharf	Fishery Jetty	East Mole	Old Port	West Mole	Total
2002	0	0	57,051	0	42,438	99,489
2003	23,450	28,672	53,219	39,318	39,318	183,977

2-2-1-7 Policy of Grade Setting for Facility Rehabilitation

(1) Concept for Selecting Suitable Structure of Rehabilitation

1) Selection of Permeable Structure

It is recommendable to apply a permeable structure to the New Wharf Revetment in order to restrain return flow and reflection waves from the revetment itself. This will result in ensuring calmness in the New Wharf basin. The rehabilitation plan has been prepared to modify the present structure from non-permeable to permeable type with maximum utilization of existing structure.

2) Introduction of Measure to Prevent Piping of Backfill Soil

In the rehabilitation of the fabric mat section of the New Wharf Revetment, a measure to prevent piping of backfill soil has been considered. For the concrete block section, measures to avoid further corrosion of wire and steel frame of the gabion and displacement of coral rock inside the gabion as well as backfill soil shall be implemented.

3) Ensuring Calmness of New Wharf Basin

The calmness of the New Wharf basin is not very well achieved during periods of westerly offshore waves during high tides and northerly wind waves as no shelter exists. In the rehabilitation plan, suitable structures have been selected to achieve calmness from wave reflection so that operability of cargo handling can be maintained.

(2) Concept for Designing Structure for Rehabilitation

1) Fulfillment of Overtopping Wave Prevention System

Since the Fishery Jetty Revetment is at present a vertical structure, the wave reflection effect in the northern part is significant. Overtopping waves also occur repeatedly at the western side of the New Wharf Revetment as waves from the west cause diffraction. At the Fishery Jetty and New Wharf

Revetments, frequent damage is caused by submergence of land due to overtopping waves, thus a countermeasure to prevent overtopping waves by reducing wave diffraction is required.

2) Intentional Recycle Use of Demolished Construction Materials

In Kiribati, Environmental Act has been enforced since 1999 and exploration of reclamation material is strictly regulated since the land area of the island is quite limited. Also the dumping area for construction waste is limited, thus it has become a serious problem on the island. As such it is necessary to consider recycled use of waste material from demolition of the present structures as much as possible. Existing concrete blocks of 2 t Tribar shall be reused as part of the rehabilitated structure.

2-2-1-8 Policy for Construction Method and Construction Period

(1) Policy for Construction Method

In rehabilitation of the New Wharf Revetment, it is desirable to modify the structural type from non-permeable to permeable. While replacing unsuitable material contained in the present structure, a temporary cofferdam using steel sheet piles shall be applied to avoid erosion of the excavated surface of the structure by wave action. The design policy of keeping such steel sheet piles as a permanent structure is introduced so as to prevent further leakage of backfill soil.

At the Fishery Jetty Revetment, existing steel sheet piles are not stable to resist active earth pressure. Thus it shall be covered by concrete coping down to the vicinity of LWL, which will prevent further corrosion and also function as a leakage filter for the backfill soil. Moreover, a rock mound with concrete blocks shall be placed in front of the existing steel sheet pile to reduce wave reflection and active earth pressure.

The existing structure of the East Mole Revetment is made of bagged concrete and frequent damage due to erosion and overtopping waves occur. Thus steel sheet pile wall shall be installed to prevent damage due to erosion and overtopping waves.

(2) Policy for Construction Period

The Project for rehabilitation of revetments at Betio Port is mainly composed of restoration of the New Wharf Revetment, Fishery Jetty Revetment and East Mole Revetment. Among those revetments, the New Wharf Revetment suffered severe damage in 2002. Its restoration is urgently required as early as possible since there are large openings of fabric mat at six locations. While the other two revetments are also in a serious condition, they are still functioning due to maintenance by KPA. The urgency for restoration of the New Wharf Revetment is therefore much greater than for those two revetments from the viewpoint of potential further damages.

Also the port has some difficulty with a narrow access road and no alternate access apart from the present port roads. Considering non-availability of alternate access roads and use of similar construction equipment, it is recommended that Project be phased and implement restoration of the New Wharf Revetment as the first phase. The Fishery Jetty and East Mole Revetments will be included in the second phase with short gap in the commencement timing.

2-2-2 Basic Plan

2-2-2-1 Overall Plan

The facilities to be rehabilitated and equipment to be provided under the Project are listed below:

- Rehabilitation Work

  New Wharf Revetment : 150 m long

  Fishery Wharf Revetment : 160 m long

  East Mole Revetment : 180 m long

- Equipment

  Spare Parts of 80 t Truck Crane: For 3 years maintenance

(1) Design Manual and Regulations to be Applied

In designing revetments, the following design manuals and guidelines have been mainly applied.

- Technical Standards for Port and Harbour Facilities in Japan, 1999,
- Design Manual for Fishing Port and Fisheries Ground Facilities, 2003, and
- Shore Protection Manual, 1984

(2) Design Criteria

1) Maritime Conditions

[Design Tidal Elevations]

Following the Policy for Natural Condition described in Section 2-2-1-2 (1), the design tidal elevations were established as summarized in Table 2-2-8.

Table 2-2-8 Design Tidal Elevation

Item	Design Tidal Elevation
Mean Spring Higher High Water (HWL)	DL +2.05 m
Mean Sea Level (MSL)	DL +0.89 m
Mean Spring Lower Low Water (LWL)	DL -0.19 m
Highest High Water Level (HHWL)	DL +2.24 m

[Design Wave Condition]

Following the Policy for Natural Condition described in Section 2-2-1-2 (2), the design wave condition was established as summarized in Table 2-2-9.

Table 2-2-9 Design Wave Condition

Revetment	Design Wave Condition
New Wharf Revetment	$H_{1/3}$=1.8 m, $T_{1/3}$=9.3 sec
Fishery Jetty Revetment and East Mole Revetment	$H_{1/3}$=1.5 m, $T_{1/3}$=9.3 sec

2) Subsoil Condition

Reviewing the reports of the former M/P and B/D studies, and data collected by this study, the following subsoil conditions were established.

[Sandy layer (coral sand)]

Unit Weight : 1.7 t/m^3 (above water), 0.7 t/m^3 (under water)
Internal Friction Angle : ϕ =30°

[Armour layer (imported stone)]

Unit Weight : 1.8 t/m^3 (above water), 0.8 t/m^3 (under water)
Specific Gravity : 2.2
Internal Friction Angle : ϕ =40°

3) Seismic Force

A search was made to determine recorded earthquakes within a radius of 300 km with magnitude of more than 4 within the last 30 years, but none were found. Thus, the seismic force has been disregarded in the design.

4) Surcharge Load (for revetment)

The surcharge load for normal condition has been assumed to be 0.5 t/m^2, in line with the Design Manual for Fishing Port and Fisheries Ground Facilities, 2003. During the construction, it is required to remove the sand layer, which is a weak material in the present structure against potential erosion. For that purpose, some construction equipment such as crane or backhoe will be worked behind the parapet wall, although only for a short period. It has been assumed in the construction plan of the Project that the equipment needed for the work is a 35 t crane and/or 0.6m^3 backhoe.
Considering the load of such equipment, a temporary surcharge load during construction has been determined as 2.0 t/ m^2.

Normal Condition after Completion: 0.5 t/m^2
Construction Period : 2.0 t/m^2

5) Corrosion Rate of Steel Material

Based on the Technical Standards for Port and Harbour Facilities in Japan 1999, the following corrosion rates have been applied.

[Sea Side]

Above HWL (splash zone) : 0.30 mm/year
HWL to LWL-1.0m : 0.20 mm/year
LWL-1.0m to Seabed : 0.15 mm/year
Under Seabed : 0.03 mm/year

[Land Side]

Above Ground/Exposed to Air : 0.1 mm/year

Underground (above residual water): 0.03 mm/year

Underground (below residual water): 0.03 mm/year

Table 2-2-10 summarizes the design criteria.

Table 2-2-10 Summary of Design Criteria

Item		Established Design Criteria	Remarks
Maritime Condition	Tidal Elevations	HHWL : DL +2.24 (former B/D study: DL+2.15) HWL : DL +2.05 (former B/D study: DL+1.84) MWL : DL +0.89 (former B/D study: DL+0.95) LWL : DL -0.19 (former B/D study: DL+0.06)	・In the former B/D study, the results of the former M/P study have been referred to. ・Modified based on the actual observation record of more than 12.5 years by Australia starting from December 1992.
	Design Wave	New Wharf Revetment : $H_{1/3}$=1.8 m、$T_{1/3}$=9.3 sec (former B/D study: $H_{1/3}$=1.54 m、$T_{1/3}$=4-5 sec) Fishery Jetty Revetment : $H_{1/3}$=1.5 m、$T_{1/3}$=9.3 sec East Mole Revetment : $H_{1/3}$=1.5 m、$T_{1/3}$=9.3 sec	・In the former B/D study, the wind wave generated in lagoon was assumed. ・Revised based on the modified water level and offshore wave from outside lagoon. ・Revised design wave for the New Wharf Revetment taking into consideration wave reflection at the New Wharf.
Soil Condition	Reclaimed Sand	Unit Weight : 1.7 t/m^3 (above water) 0.7 t/m^3 (under water) Internal Friction Angle : φ=30°	・Assumed specific gravity of coral sand at 2.0
	Armour Stone	Unit Weight : 1.8 t/m^3 (above water) 0.8 t/m^3 (under water) Specific Gravity of Rock : 2.2 Internal Friction Angle : φ=40°	・Assumed specific gravity of rocks from Fiji at 2.2.
Seismic Force		Not considered	・No record of earthquakes within radius of 300 km having magnitude more than 4 in the last 30 years.
Surcharge		Nomal condition : 0.5 t/m^2 During construction : 2.0 t/m^2	・Assumed trucks for normal traffic for normal condition and short-term load of 35 t crane and 0.6 m^3 backhoe during construction.
Corrosion Rate of Steel		Sea Side Above HWL : 0.30 mm/year HWL to LWL-1.0m : 0.20 mm/year LWL-1.0m to Seabed : 0.15 mm/year Land Side Above Ground : 0.1 mm/year Underground (above residual water) : 0.03 mm/year Underground (below residual water) : 0.03 mm/year	・Determined based on the rates indicated in Technical Standards for Port and Harbour Facilities in Japan 1999. Also considered exposure test pieces performed in last 10 years in Philippines and Singapore.
Functional Condition	Overtopping Wave Rate	New Wharf Revetment : less than current situation at the New Wharf Revetment Fishery Jetty Revetment : same as above East Mole Revetment : same as above	・Allowable rate of q=0.01 m^3/m/sec is applied assuming a most important area.
	Calmness	New Wharf Revetment : less than current situation Fishery Jetty Revetment : same as above East Mole Revetment : same as above	

2-2-2-2 Design of Facility

(1) Design Policy

[New Wharf Revetment]

The design policy for the repair method has been established as described below considering the causes of damage observed from the field investigation and the associated analysis.

- Based on the results of field surveys, it is recommendable to apply a permeable structure to the New Wharf Revetment in order to restrain return flow and reflection waves from the revetment itself. It is necessary to select the structural type for rehabilitation after considering the influence on hydraulic characteristics.
- Measures to prevent wash out of the reclamation sand due to piping shall be taken in addition to the restoration of the damaged armor layer.
- At the section of concrete block type revetment, measures shall be taken to prevent the flow out of the reclaimed sand and filling material by piping due to the corrosion of wire and frame of gabion.
- The calmness in the New Wharf basin can be secured by the sheltering effect of the New Wharf against easterly wind waves generated by easterly winds in the lagoon. On the other hand, for wind waves from the north and transmitted waves from offshore waves generated outside the lagoon during high tide, sufficient calmness cannot be secured due to non-existence of shelter. The rehabilitation plan has been prepared to maintain present calmness by keeping or lowering wave reflection effect.
- Since it is difficult to obtain concrete aggregate and sand in the short-term from the site and to maintain acceptable quality, it has been decided to utilize imported materials. However, this can potentially result in higher costs and limited quantity to be imported, thus it will cause potential problems for the construction period. Due to this reason, the rehabilitation plan shall be prepared based on minimizing the use of such imported materials.
- Since the rehabilitation work shall be implemented within the premises of the port, it should avoid interference with current port operation.
- In order to ensure maximum use of the current structure, recycling of the demolished materials from the existing structure shall be planned as much as possible and utmost care will be taken to avoid wash out of materials during construction.
- It is proposed to reuse the existing 2 t type Tribar concrete blocks as the part of the structure for rehabilitation.

[Fishery Jetty Revetment]

- This revetment can be divided into two parts; north side revetment (about 100 m long) facing the incident waves and west side revetment (about 60 m long) facing the West Mole Revetment. Damage has been caused frequently on the north side due to overtopping

waves during high tides, resulting in flooding of the facilities in nearby areas. For this reason, the structural type planned for rehabilitation is based on avoiding overtopping waves.

- Since the existing revetment is a vertical structure with steel sheet pile, substantial wave reflection takes place especially on its north side. Furthermore, the wave diffraction effect at the edge of the revetment causes wave overtopping at the western end of the New Wharf Revetment. Therefore, a similar type of structure to the New Wharf Revetment has been proposed for the Fishery Jetty Revetment.
- Since there are many holes in the steel sheet piles caused by corrosion near the splash zone, it is hard to expect sufficient strength against active earth pressure in the long-term. Thus, it is impossible to expect sectional forces of the existing sheet pile for the rehabilitation plan.

[East Mole Revetment]

- Since the East Mole Revetment faces the navigation channel towards the old port area for small boats, it is necessary to prevent any disturbance to navigation for small boats. Firstly, it is necessary to avoid narrowing the width of the existing channel. Secondly, it is necessary to consider the influence of stem waves caused by incident waves from a westerly direction when selecting structural type.
- Since the face line of the East Mole Revetment is located landward and in an offshore direction, the incident waves propagate along the face line. The hydraulic characteristics in the vicinity of the revetment are affected by the structural type at the northern corner of the Fishery Jetty Revetment. Thus, it is necessary to consider the influence of both stem waves and wave overtopping when determining structural type.

(2) Comparative Study of Structural Type

1) New Wharf Revetment

The preliminary study team for the Project proposed three types of alternative structural types; 1) restoration of existing fabric mat revetment, 2) new construction of rock mound revetment with concrete blocks, and 3) new construction of rock mound revetment with armor stone.

From the results of field investigations, it is recommendable to apply a permeable structure to the New Wharf Revetment in order to restrain return flow and reflection waves from the revetment itself. It is important to apply a permeable type revetment in the rehabilitation plan and it was decided to discard the idea of restoration of the existing fabric mat.

[Rock Mound with Concrete Block Type (Alternative N-1)]

Both Alternative N-1 and N-2 are the same permeable type revetments, and the same effect concerning function and stability of structures is obtained. In particular, it is expected that the function of wave calmness at the basin will be much better than under existing conditions. Furthermore, it is expected that the return flow from the revetment will be drastically reduced and this will reduce the scouring effect at the toe of the revetment.

[Rock Mound with Armor Stone Type (Alternative N-2)]

This structural type has the same design concept as Alternative N-1, with application of rock as an armor material instead of the concrete block. It has been computed that the required mass of stable armor rock unit is about 2 to 3 t. These two types of revetments have high stability in the long-term, however, there are some potential problems as described below:

- In filling the rubble at the back of revetment, it is necessary to excavate the present structure, thus affecting the access road and container yard at the backside during construction. This would cause disturbance to current port operations.
- Since this structural type requires large amounts of rubble stones at the backside, the construction cost increases due to the required volume of imported rock material, although the structural stability is high.
- During the construction work to replace existing material with new stable rubble stone on the offshore side, the surface of the excavated slope of reclamation sand will be exposed resulting in an increased risk of wash out and erosion by wave action.

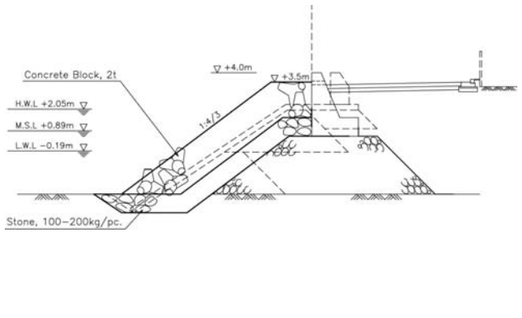
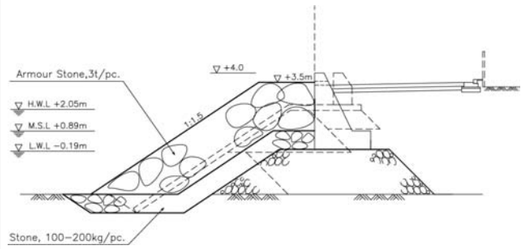
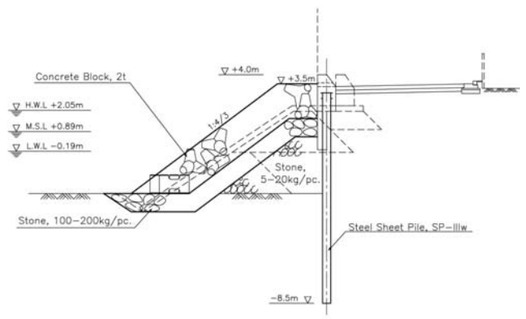
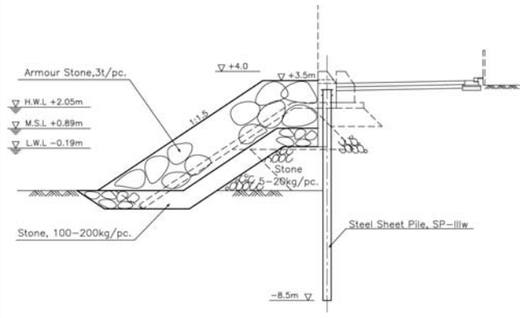
To solve these potential problems, the following new structural type, consisting of steel sheet pile with rock mound covered by the armor layer, has been proposed.

[Steel Sheet Pile Type with Concrete Block (Alternative N-3) and Armor Stone (Alternative N-4)]

Rehabilitation work will start with the removal of the existing unsuitable soil section. Considering the actual implementation procedure, it is necessary to use the steel sheet pile as a temporary coffer to avoid temporary exposure of the rubble stone to wave action. This proposed alternative plan applies steel sheet pile not only for the temporary coffer but also for the permanent structure.

The result of a comparative study on selecting the structural type of the New Wharf Revetment from four alternatives is summarized in Table 2-2-11. Alternative N-3 has an advantage concerning the construction cost, implementation procedure and influence on port activity, thus it was selected as the most suitable type for the revetment.

Table 2-2-11 Comparison of Alternative Structures for New Wharf Revetment

Description	**New Wharf Revetment**			
Alternative	Alternative N-1 Rock Mound with Concrete Block Type	Alternative N-2 Rock Mound with Armour Stone Type	Alternative N-3 Steel Sheet Pile Type (with Concrete Block)	Alternative N-4 Steel Sheet Pile Type (with Armour Stone)
Typical Section				
Design Concept	• Applying permeable structure instead of non-permeable structure to keep calmness in present wave reflection and overtopping wave rate.	• Same	In addition to Alternative N-1 • To avoid disturbance of current port activity, this structure has been planned. • By completion of pile driving, further damage can be minimized. • Reduced imported stone material.	• Same • Same • Same
Functional and Structural Aspects	• By changing structure from non-permeable to permeable type, calmness can be improved at the New Wharf basin and overtopping wave rate can be reduced. • In securing stable rock mound and filter sheet, leakage and wash out of backfill soil can be avoided.	• Same • Same	• In providing wave dissipating structure, calmness can be secured and overtopping wave can be minimized. • Steel sheet pile can function as filter against leakage and replacement of soil behind sheet pile can be minimized.	• Same • Same
	○	○	◎	◎
Port Usage Aspect	• It is required to excavate soil at road and container yard during construction causing significant disturbance in port traffic and usage.	• Same	• It is not necessary to excavate soil behind sheet pile, disturbance of port activity can be minimized.	• Same
	△	△	○	○
Construction Aspect	• It is required to provide temporary curtain wall to prevent potential erosion of slope. • Manufacturing schedule of concrete block will depend on the importation schedule of construction materials.	• Same • Construction schedule will depend on the importation schedule of stone.	• During construction, sheet pile can function as curtain wall to secure leakage and stabilization of mound. • Manufacturing schedule of steel sheet pile will govern total project schedule as it will be manufactured in Japan and shipping schedule is tight.	• Same • Same
	○	○	◎	○
Cost (only direct cost)	Yen 1,250,000/m	Yen 1,550,000/m	Yen 1,250,000/m	Yen 1,500,000/m
Total Evaluation	△	△	◎	○

2) Fishery Jetty Revetment

The existing Fishery Jetty Revetment is a vertical wall type structure with steel sheet pile. The situation of corrosion on the steel sheet piles was worsening and the stability of existing sheet pile is treated to ensure long-term stability. Furthermore, the existing structure causes problems due to wave overtopping and wave reflection. Bearing in mind these points, the following two types of structures have been proposed for the comparative study.

[Steel Sheet Pile Type with Anchor System (Alternative F-1)]

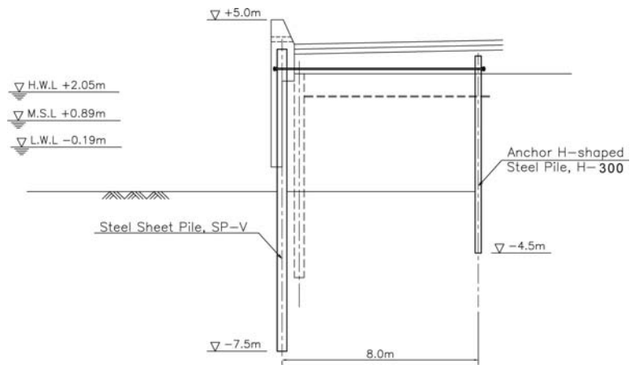
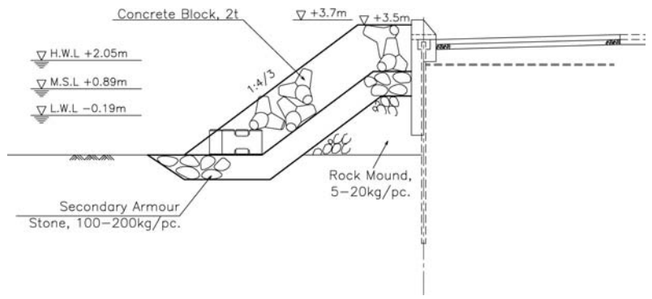
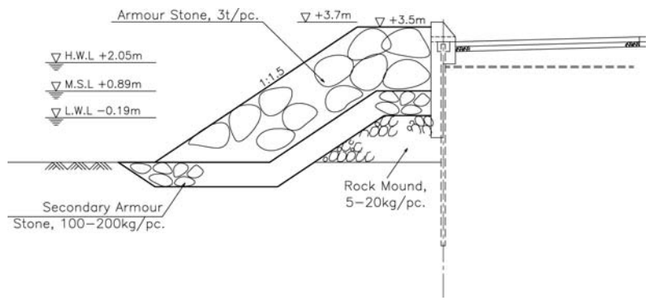
The basic design concept of Alternative F-1 follows the existing structural type with new steel sheet piles driven in front of the existing one, since the stability of existing sheet pile can no longer be expected in the long-term. However, it is necessary to raise the crown height in order to maintain the same conditions resulting from wave overtopping. Furthermore, if it is necessary to dissipate the wave energy at the revetment to reduce the effect of wave reflection (to obtain greater calmness at the New Wharf basin), the construction of additional structures such as inner jetty, etc. is needed.

[Rock Mound Type with Steel Sheet Pile and Concrete Block (Alternative F-2), with Steel Sheet Pile and Armor Stone (Alternative F-3)]

The Alternatives F-2 and F-3 are to construct the rock mound in front of the existing steel sheet piles, as in the structural type at the New Wharf Revetment, in order to reduce wave overtopping and wave reflection, which are major points to be considered in the rehabiliation plan. Applying this type of revetment, it is expected that wave overtopping at the Fishery Jetty Revetment would be reduced and calmness at the New Wharf basin increased by reducing reflection waves and forming a sheltered area for wave diffraction near the boundary between the Fishery Jetty and East Mole Revetments.

Table 2-2-12 shows the results of a comparative study of three alternative structural types. As a result, Alternative F-2 has been selected as the most suitable structure of the Fishery Jetty Revetment due to advantages on construction cost and functionality.

Table 2-2-12 Comparison of Alternative Structures for Fishery Jetty Revetment

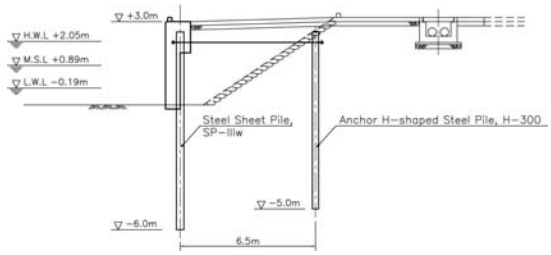
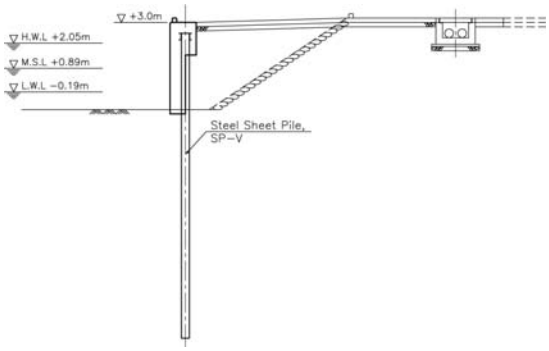
Description	Fishery Jetty Revetment		
Alternative	Alternative F-1	Alternative F-2	Alternative F-3
	Steel Sheet Pile Type with Anchor System	Rock Mound Type (with steel sheet pile and concrete block)	Rock Mound Type (with steel sheet pile and armor stone)
Typical Section			
Design Concept	• Modifying present structure and keep overtopping wave in the present status • Sheet pile cannot function against bending moment due to corrosion, thus new sheet piles are needed.	• Modifying present structure to wave dissipating type in order to keep overtopping wave rate same as the New Wharf Revetment, and to reduce wave height at western side of revetment and to improve calmness in the basin.	• Same
Functional and Structural Aspects	• Submerging problem at Betio Fish Port Complex can be avoided by reduced overtopping wave. • Wave reflection problem cannot be solved and calmness of basin remains as it is. • By introduction of new steel sheet piles and anti-corrosive measure of covering coping concrete, long-term stability of structure can be secured.	• Same • Possible to reduce wave reflection effect and to improve calmness at western side of revetment and New Wharf basin. • Provision of concrete blocks can function as counter weight for the existing steel sheet pile structure and filter against leakage of backfill soil.	• Same • Same • Same
	○	◎	◎
Port Usage Aspect	• Since excavation of backside area is not necessary, disturbance to port usage can be minimized.	• Same	• Same
	○	○	○
Construction Aspect	• It is necessary to change structure under the trestle, as steel sheet pile cannot be piled due to physical constraint. • Prior to piling work of steel sheet piles, coral stone and concrete blocks shall be removed. • It is required to prepare precise program of manufacturing and transporting steel sheet piles as they are manufactured in Japan and transported based on a bi-monthly shipping schedule. • Construction period at site is comparatively short.	• It is necessary to change structure under the trestle due to physical constraint. • Total construction schedule will depend on the importation of rock and stone materials.	• It is necessary to change structure under the trestle due to physical constraint. • Total construction schedule will depend on the importation of rock materials.
	○	○	○
Cost (only direct cost)	Yen 900,000/m	Yen 850,000/m	Yen 1,100,000/m
Total Evaluation	△	◎	○

3) East Mole Revetment (180 m Section at offshore side)

The hydraulic characteristics at the East Mole Revetment depend largely on the adjacent structural type of the Fishery Jetty Revetment located on the offshore side of the revetment. In applying the vertical type structure as at the existing Fishery Jetty Revetment, it will increase the wave height and overtopping wave due to creation of stem waves. In that case, it is necessary to construct an additional structure such as an inner jetty, etc to avoid such problems. On the other hand, if a wave absorbing type is adopted as the proposed structure for the Fishery Jetty Revetment, it is not necessary to consider the negative impact to the East Mole Revetment regarding the problem of stem waves.

Table 2-2-13 shows the results of the comparative study for these two alternative structural types. Alternatives E-1 and E-2 are almost the same concerning function, port utilization and construction procedure, however, Alternative E-1 has an advantage concerning the construction cost. For this result, Alternative E-1 was determined as the proposed structural type of the East Mole Revetment.

Table 2-2-13 Comparison of Alternative Structures for East Mole Revetment

Description	East Mole Revetment	
Alternative	Alternative E-1	Alternative E-2
	Steel Sheet Pile with Anchor Type	Cantilever Steel Sheet Pile Type
Typical Section		
Design Concept	• Protecting from leakage of backfill and upgrading usage in comparison with sloped structure	• Same
Functional and Structural Aspects	• Due to wave dissipating effect by Fishery Jetty Revetment located offshore, calmness and overtopping effects will not cause any problem. • The width of approach channel to the old port can be maintained and reclamation can accommodate broken pieces of concrete demolition	• Same • Same
	○	△
Port Usage Aspect	• No effect to be caused for traffic connecting to the Fishery Jetty	• Same
	○	○
Construction Aspect	• It is required to prepare manufacturing and transportation plan of steel sheet piles carefully	• Same
	○	○
Cost (only direct cost)	Yen 900,000 /m	Yen 1,000,000 /m
Total Evaluation	◎	○

(3) Study on Dimensions of Structure

1) New Wharf Revetment (Steel Sheet Pile Type with Concrete Block)

[Determination of Crown Height of Coping]

The crown height of coping has been determined in consideration of the following two conditions:

- The same basic elevation of existing crown height (DL +4.0 m) shall be maintained.
- The overtopping wave rate should be lower than the allowable overtopping rate for the most important area.

Table 2-2-14 Allowable Overtopping Wave Rate by Degree of Importance of the Hinterland

Importance of Hinterland	Allowable Overtopping Wave Rate (m^3/m/sec)
Areas where a high concentration of houses, public facilities etc. exist behind the seawall and damage by overtopping wave or splash is anticipated	About 0.01
Other important areas	About 0.02
Other areas	0.02 to 0.06

Source: Technical Standard and Commentaries for Port and Harbour Facilities in Japan

Overtopping wave rate has been calculated by using experimental diagrams shown in Figure 2-2-1; conditions for calculating overtopping wave were summarized in Table 2-2-15.

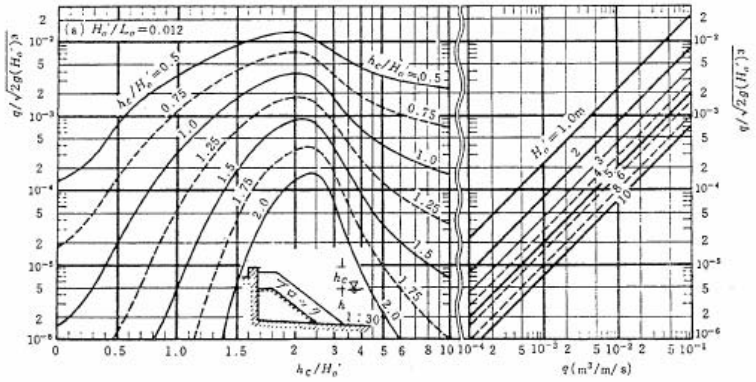


Figure 2-2-1 Diagrams for Estimating the Overtopping Rate for Wave-Absorbing Seawall (S=1/30、Ho'/Lo=0.012)

Table 2-2-15 Conditions for Calculation

Items for Calculating Assumption		Assumed Value
Wave Height	$H_{1/3}$	1.8 m
Wave Period	$T_{1/3}$	9.3 sec
Wave Length	Lo	132.0 m
Tide Condition	HWL	+2.05 m
Wave Steepness	H/Lo	0.014
Ground Level	D	-2.5 m
Sea Level	H = d+HWL	4.55 m
h/Lo		2.57
Crown Height		+ 4.0 m
Hc		1.95 m
Hc/Ho'		1.10

Overtopping wave rate has been calculated at 0.0018 m^3/m/sec for the New Wharf Revetment which is lower than the allowable overtopping rate. Based on this, the crown height of coping at the New Wharf Revetment has been determined at DL +4.0 m, which is as for the existing condition.

[Determination of Dimensions for Steel Sheet Pile]

The type of steel sheet pile and embedded length have been determined assuming the design condition that the shore side of the existing structure should be excavated to DL -2.5 m in order to replace unsuitable sandy soil by rock after driving the piles. During the construction stage, the steel sheet pile will act as a cantilever. In order to reduce the stress acting on the steel sheet pile during that time, it has been assumed that the ground level of access road at the backside will be excavated down to an elevation of DL +1.9 m. Based on stress analysis (156 N/mm^2 < allowable stress 180 N/mm^2), it has been determined that the steel sheet pile of SP-III_W (U-type) will be used. The required embedded length was computed as DL -8.5 m, assuming the minimum length during construction is 2/ß from the virtual ground level considering the duration of such load acting on the steel sheet piles is so short. After completion, it has been confirmed that both stress and embedded length are sufficient (embedded length is longer than required length of 3/ß under the condition of long-term loading).

[Determination of Dimension for Concrete Block Section]

Existing 2 t type Triber blocks are adopted in the New Wharf Revetment in the section of concrete block type. Although this type of block is suitable to place with single layers, it is necessary to treat the flat surface of the layer below the armor layer. To provide the flat surface, the existing under layer had been provided with steel wire type gabions. From the field investigation, it has been confirmed that the corrosion of wire and frame is severe. Therefore, it has been determined to use rubble stone as the under layer.

For the armor layer with concrete block, two layers will be placed to avoid the flow out of rubble stones of the under layer and to maintain the stability of concrete block. Existing Triber blocks will be used as a part of the newly constructed armor layer.

[Minimum Mass of Concrete Block (Armor Unit)]

The minimum mass of concrete block (armor unit) has been calculated using Hudson's formula:

$$W = \rho_r H^3 / (K_D \cot\alpha (S_r - 1)^3)$$

where,

W	: Mass of armor units
ρ_r	: Mass density of armor units (t/m^3)
H	: Characteristic wave height used in the design calculation (= 1.8 m)
S_r	: Relative density of armor units in water
α	: Slope angle (=36.9°)
K_D	: Stability coefficient

Although the minimum mass of concrete block has been calculated at 0.7 t (for mass density of concrete unit; 2.2 t/m^3), it has been decided to use 2 t type concrete blocks after considering the construction

condition. The thickness of armor layer has been determined as 1.9 m for two-layer placing of concrete blocks.

The crown height for the section of concrete block has been determined at DL +3.5 m, which is the same elevation as the section of existing concrete block type revetment.

[Under Layer and Rubble Foundation]

The material of the under layer has been changed from gabion to rubble stone. The minimum mass of rubble stone has been determined at 100-200 kg/piece by using as a guideline the Shore Protection Manual (the minimum mass for under layer is commonly used at 1/10-1/20 for mass of armor unit). The thickness of under layer has been determined at 1.0 m for two-layer thickness of rubble stone.

The minimum mass for rubble foundation has been determined at 5-20 kg/piece by using the same guideline (the minimum mass for rubble foundation is commonly used at 1/200-1/6000 for mass of armor unit).

[Scouring Protection]

From the results of the underwater ocular survey at the existing concrete block type revetment, it has been confirmed that there was no scouring and settlement at the toe part of the slope. As long as the permeable type is adopted, it is sufficient to apply a common scour protection of toe rock.

[Drainage for Wave Overtopping]

The crown height of the existing parapet wall is DL +4.0 m, however, wave overtopping occurs frequently when the wave height is high at high tides. It is expected that the quantity of overtopping waves will be reduced by changing the structural type from the existing non-permeable type to the newly-adopted permeable type. However, it is necessary to avoid flood damage to the container yard, thus it has been decided to set the curb at the edge of the access road behind the revetment to prevent the intrusion of water into the container yard.

The typical cross section of the New Wharf Revetment is shown in Figure 2-2-2.

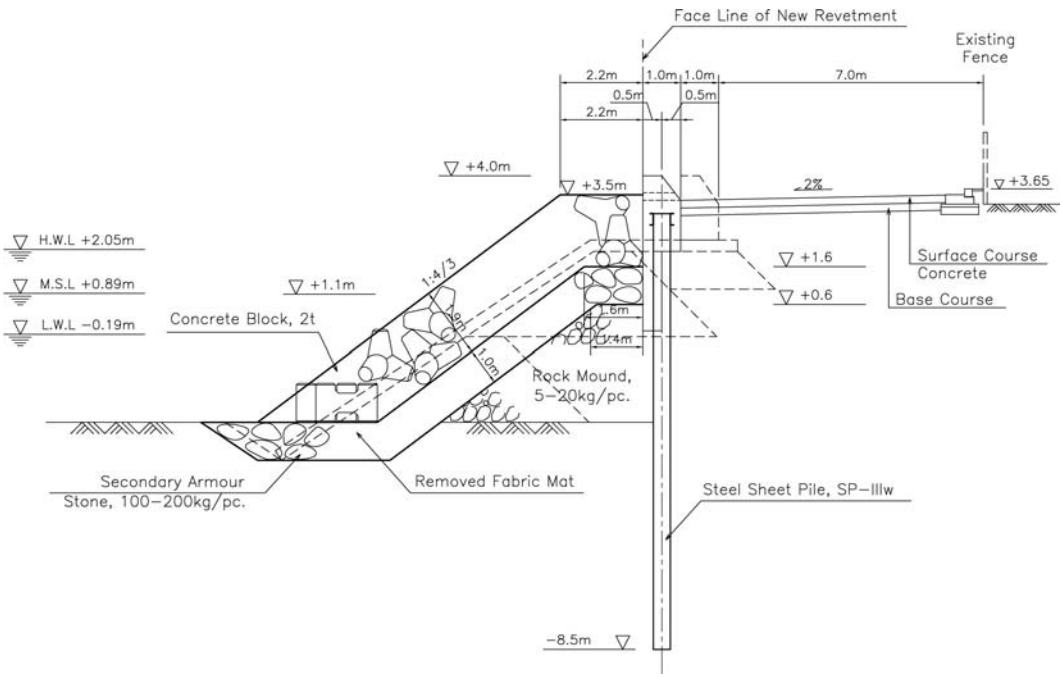


Figure 2-2-2 Typical Cross Section of the New Wharf Revetment

2) Fishery Jetty Revetment (Existing Steel Sheet Pile+Wave Absorbing Revetment with Concrete Block)

[Coping]

The coping concrete at the top of the existing steel sheet pile has already been dislocated along the majority of the section. It has been decided to remove the remaining concrete coping and to replace with new coping concrete down to an elevation of DL -1.0 m for the purpose of corrosion protection.

The crown height of coping has been determined at DL +3.7 m to satisfy the allowable overtopping wave rate of q = 0.01 m^3/m/sec, the same as the New Wharf Revetment.

[Minimum Mass of Concrete Block]

Although the minimum mass of concrete block was calculated at 0.5 t, it has been decided to use 2 t type concrete block in consideration of construction conditions.

The thickness of armor layer has been determined at 1.9 m for two-layer placing of concrete blocks, as in the New Wharf Revetment.

The crown height in the section of concrete block has been determined at DL +3.5 m, the same as the section of existing concrete block type revetment.

[Under layer and Rubble Foundation]

The minimum mass of rubble stone has been determined at 100-200 kg/piece. The thickness of under layer has been adopted as 1.0 m for two-layer thickness of rubble stone.

The minimum mass for rubble foundation has been determined at 5-20 kg/piece.

The typical cross section of the Fishery Jetty Revetment is shown in Figure 2-2-3.

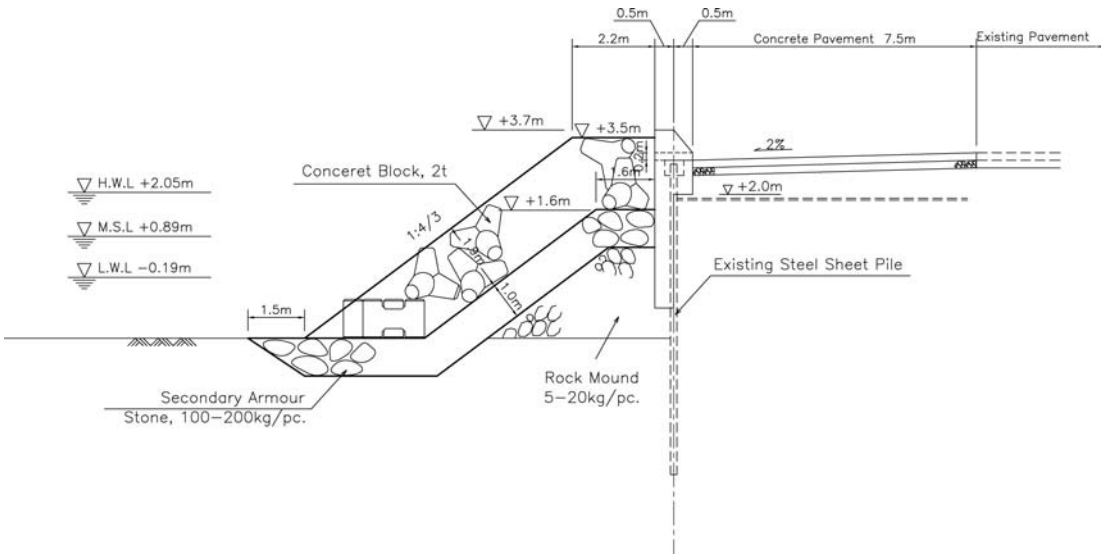


Figure 2-2-3 Typical Cross Section of the Fishery Jetty Revetment

3) East Mole Revetment (Steel Sheet Pile Anchorage Type Vertical Revetment)

[Determination of Dimensions for Steel Sheet Pile]

The type of steel sheet pile and embedded length have been examined for the section after completion. The bending stress has been calculated at 42.8 N/mm^2, which is less than the allowable bending stress of 180 N/mm^2. Nonetheless, SP- III$_W$ will be adopted as the type of steel sheet pile in consideration of construction conditions for pile driving. The bottom elevation of embedment has been determined as DL -6.0 m. H-shaped steel pile (300x300x10x15) has been used as a pile anchorage system and the elevation of the bottom of embedment has been determined as DL -5.0 m.

[Determination of Crown Height of Coping]

Since the East Mole Revetment is located on the onshore side of the Fishery Jetty Revetment, the hydraulic characteristics are affected by the structural type of the Fishery Jetty Revetment. Since the new Fishery Jetty Revetment has been selected as a wave absorbing type with concrete block, it is expected to reduce wave dissipation and height of stem waves.

In the case of oblique incident waves, the crown height can be reduced to 70% of that required. In addition, the effect of wave reduction due to existence of concrete blocks at the Fishery Jetty Revetment forming a sheltering effect can be considered. Considering these points, the elevation of crown height of coping has been determined as DL +3.0 m.

The existing top elevation of ground at the East Mole Revetment is DL +3.2 m. Assuming the apron grade is 2%, the ground level at the face line of the revetment is DL +3.0 m. Since this level is the same as the required crown height, it is not necessary to raise the coping and therefore the crown height has been determined as DL +3.0 m.

[Position of Face Line]

The position of the face line has been determined at the position 8.2 m on the offshore side from the existing face line. This location is almost the same as that of the toe part of the existing revetment and will not affect the navigation of the channel.

The typical cross section for the East Mole Revetment is shown in Figure 2-2-4.

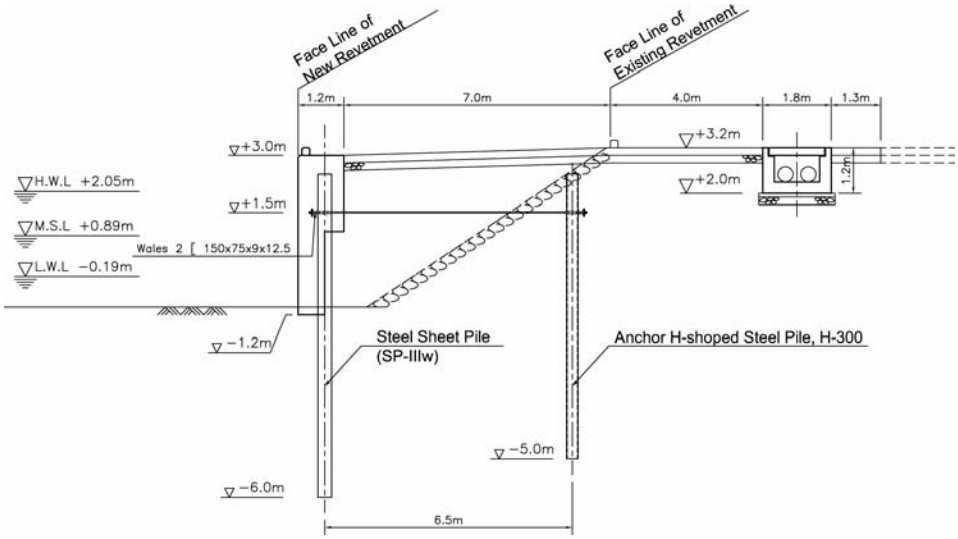


Figure 2-2-4 Typical Cross Section of East Mole Revetment

2-2-3 Basic Design Drawing

Basic design drawings are provided as follows:

- General layout Plan

[New Wharf Revetment]

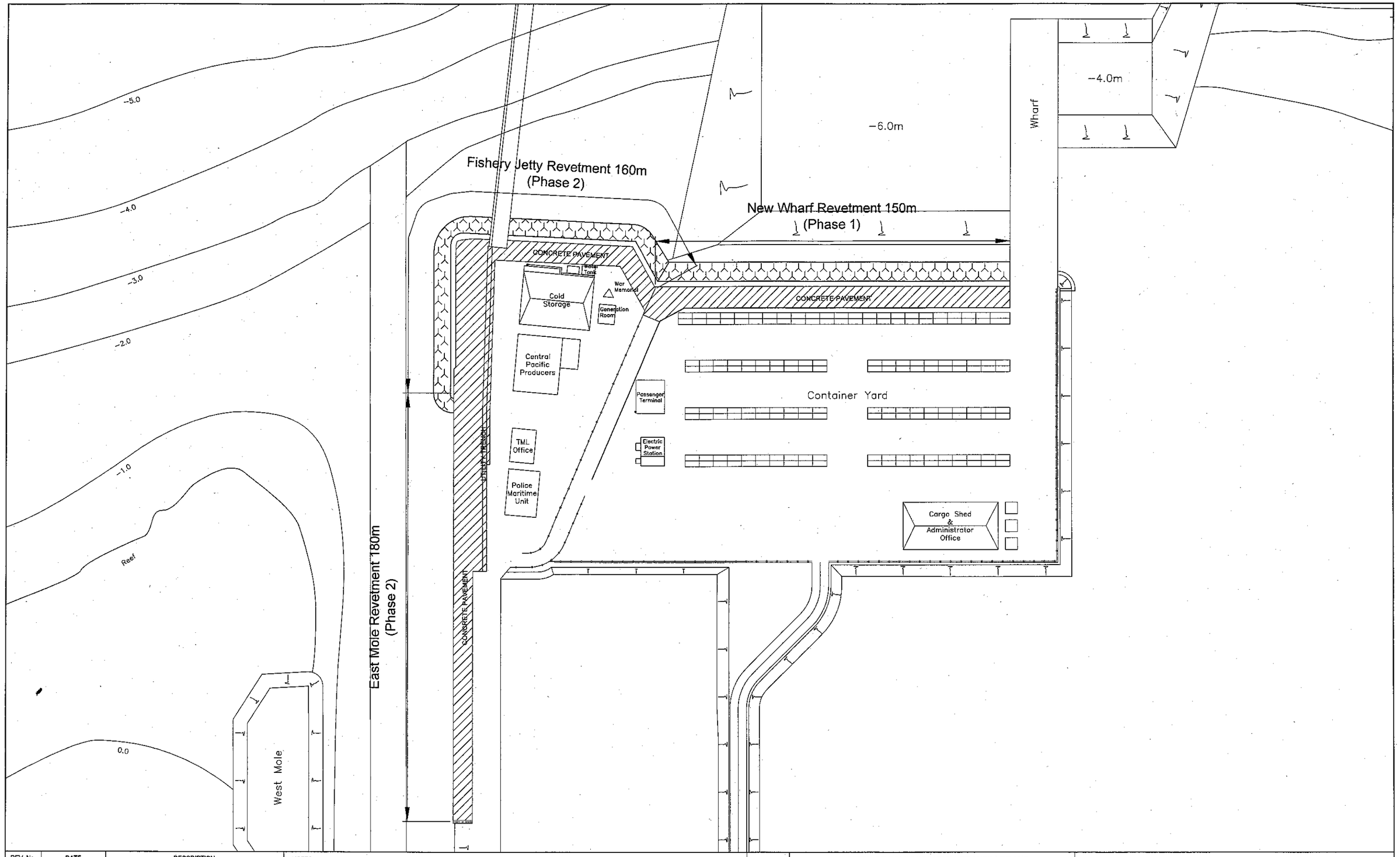
- Layout Plan
- Typical Cross-Section
- Details of Coping Concrete and Wales

[Fishery Jetty Revetment]

- Layout Plan
- Typical Cross-Section
- Details of Coping Concrete

[East Mole Revetment]

- Layout Plan
- Typical Cross-Section
- Details of Coping Concrete



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CONSULTANT	NIPPON KOEI CO., LTD.				GENRAL		
	PREPARED BY	CHECKED BY	APPROVED BY PM	APPROVED BY OWNER	General Layout Plan		
NAME	S. ONAKA	M. ISHIGURO	R. NISHIMURA		SCALE	DRAWING No.	REV. No.	SHEET No.
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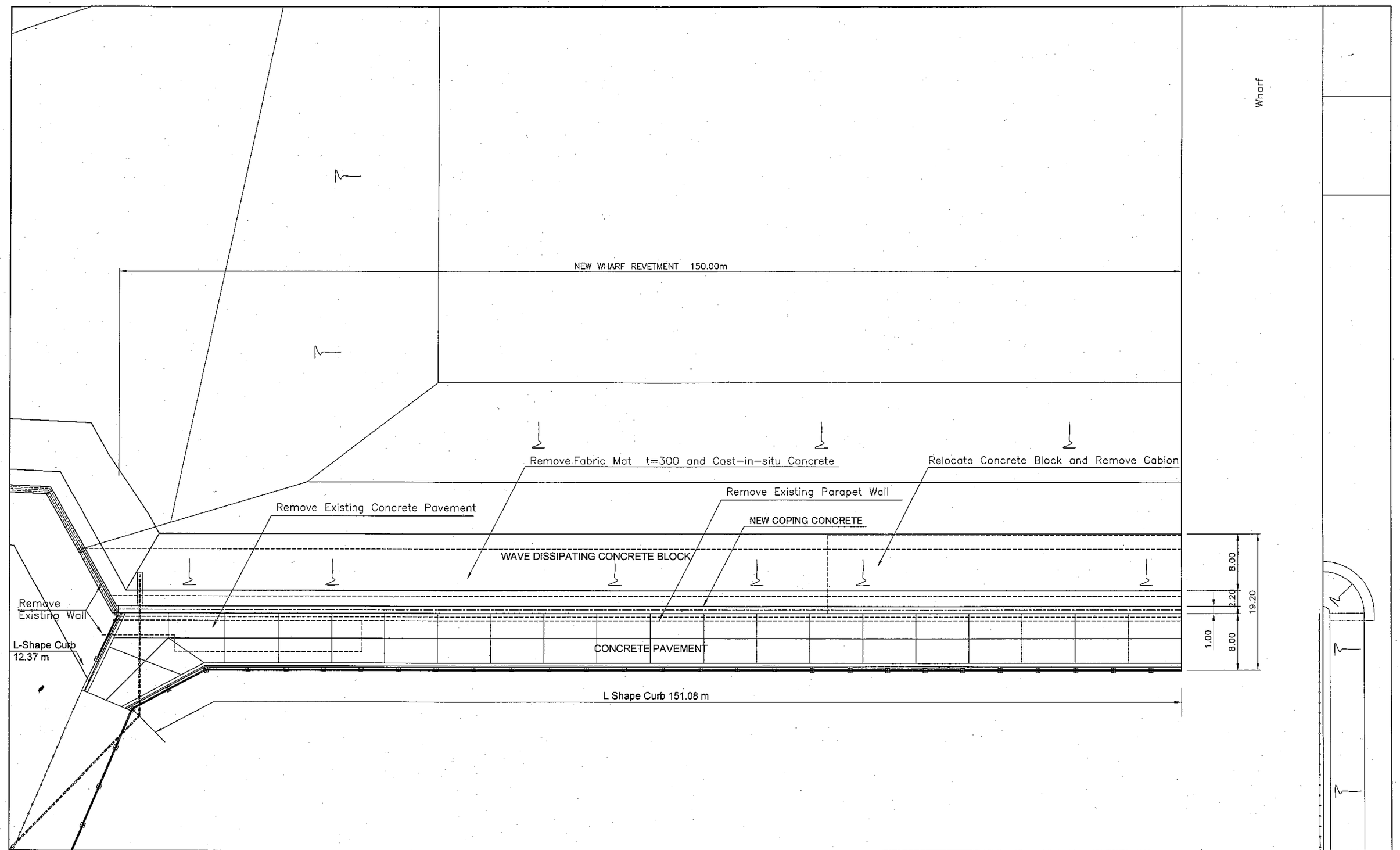

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CONSULTANT	NIPPON KOEI CO., LTD.				NEW WHARF REVETMENT		
	PREPARED BY	CHECKED BY	APPROVED BY PM	APPROVED BY OWNER	Layout Plan		
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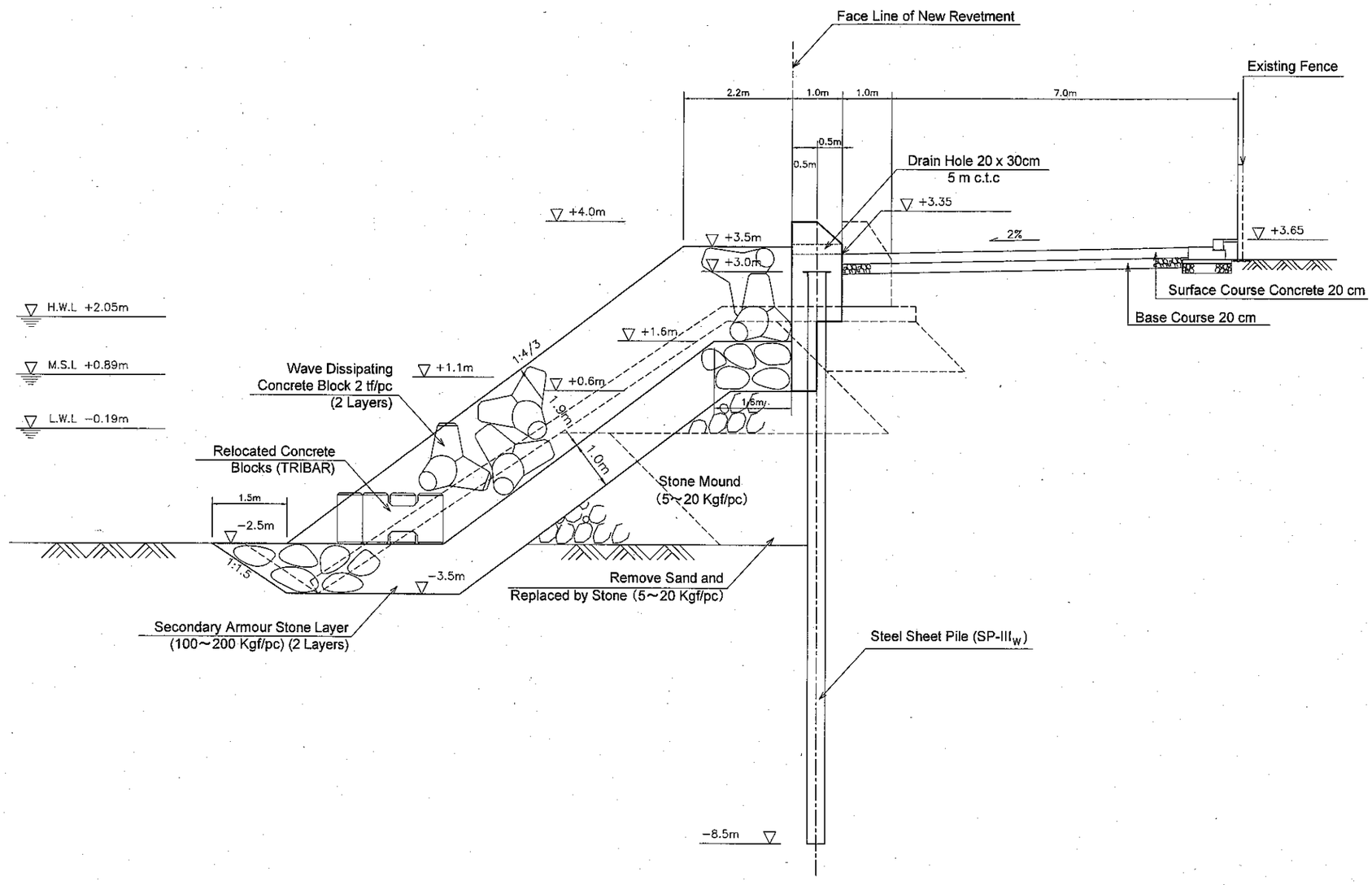

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CONSULTANT	NIPPON KOEI CO., LTD.				NEW WHARF REVETMENT
	PREPARED BY	CHECKED BY	APPROVED BY PM	APPROVED BY OWNER	Typical Cross Section
NAME	S. ONAKA	M. ISHIGURO	R. NISHIMURA		
DATE					

SCALE	DRAWING No.	REV. No.	SHEET No.
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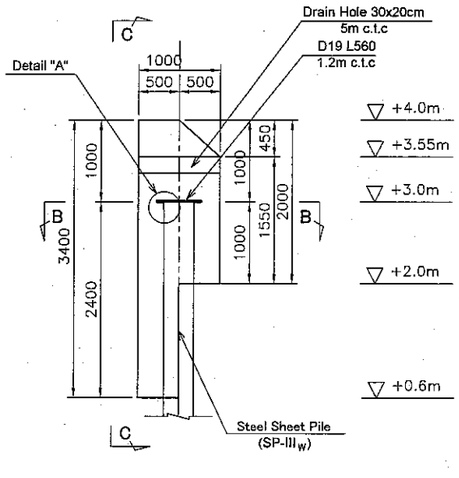

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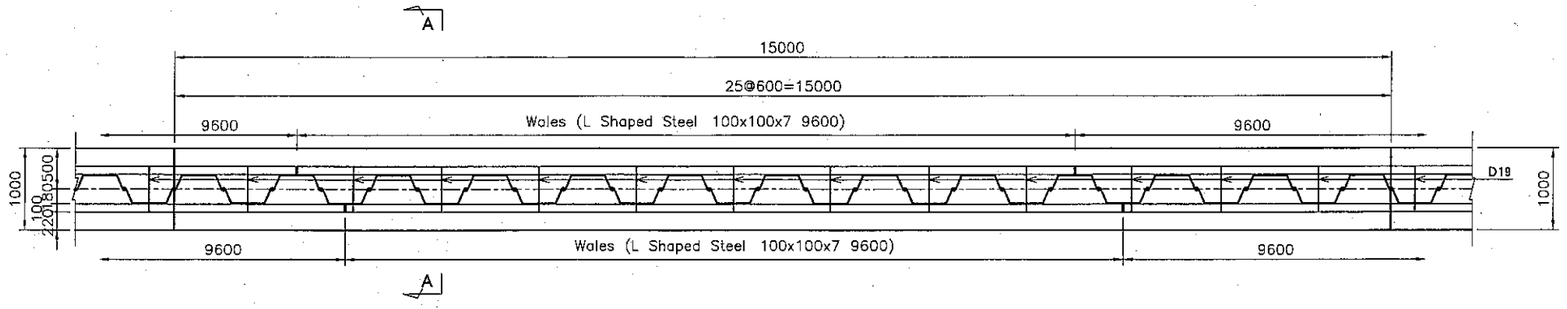

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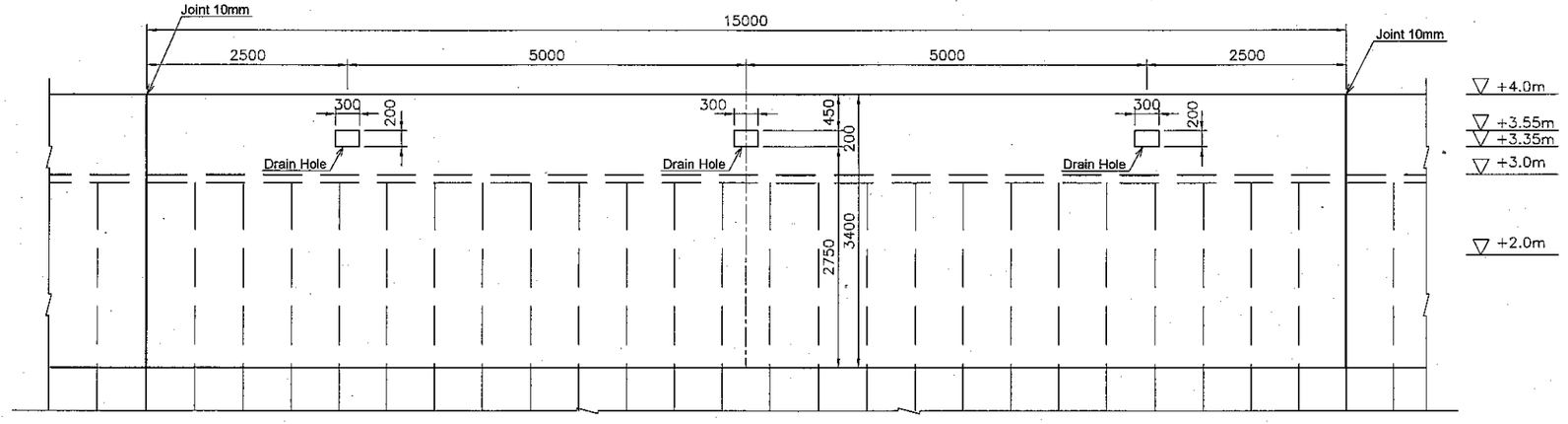

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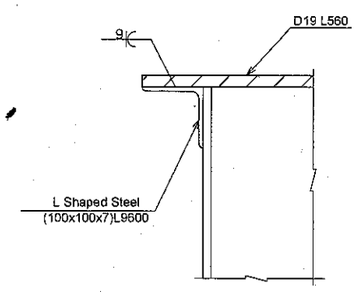

Detail A

REV. No.	DATE	DESCRIPTION
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OWNER	MINISTRY OF COMMUNICATION, TRANSPORT AND TOURISM DEVELOPMENT				THE PROJECT FOR REHABILITATION OF BETIO PORT
CONSULTANT	NIPPON KOEI CO., LTD.				NEW WHARF REVETMENT
	PREPARED BY	CHECKED BY	APPROVED BY PM	APPROVED BY OWNER	Details of Coping Concrete and Wales
NAME	S. ONAKA	M. ISHIGURO	R. NISHIMURA		
DATE					

SCALE	DRAWING No.	REV. No.	SHEET No.
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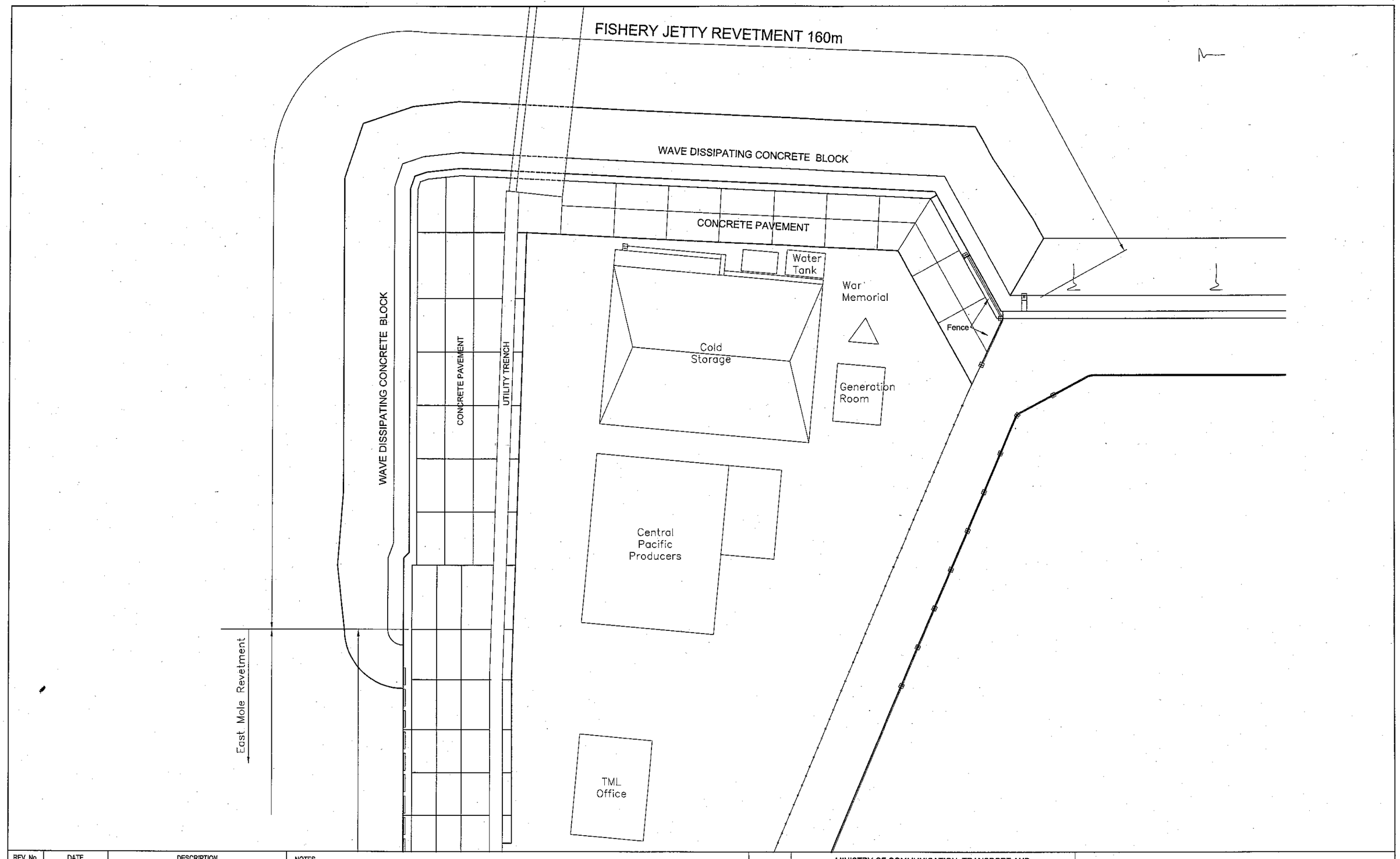
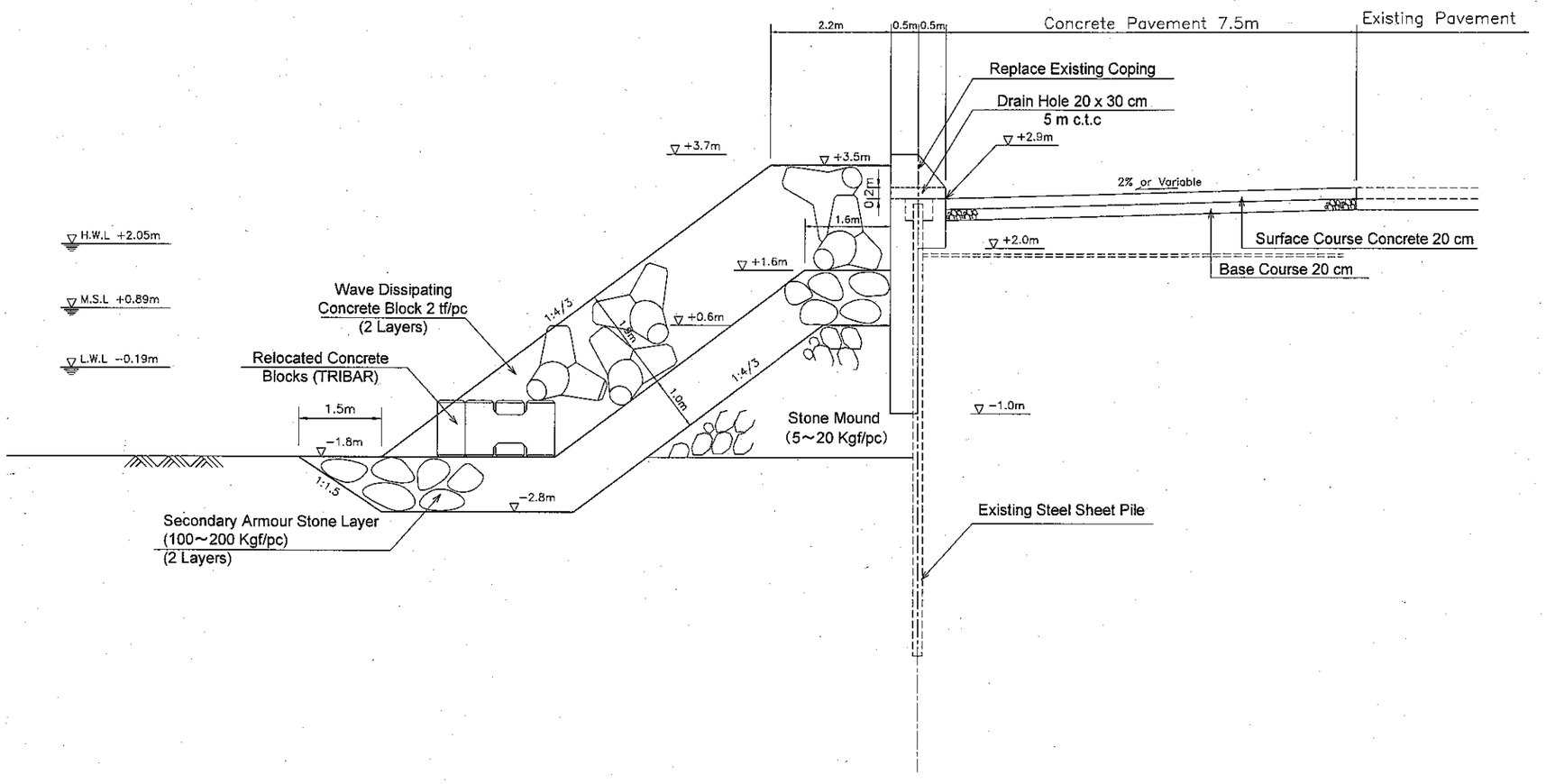


REV. No.	DATE	DESCRIPTION
0		

NOTES

OWNER	MINISTRY OF COMMUNICATION, TRANSPORT AND TOURISM DEVELOPMENT				THE PROJECT FOR REHABILITATION OF BETIO PORT		
CONSULTANT	NIPPON KOEI CO., LTD.				FISHERY JETTY REVETMENT		
	PREPARED BY	CHECKED BY	APPROVED BY PM	APPROVED BY OWNER	Layout Plan		
NAME	S. ONAKA	M. ISHIGURO	R. NISHIMURA		SCALE	DRAWING No.	REV. No.	SHEET No.
DATE					A3 1/500	F-001		



REV. No.	DATE	DESCRIPTION
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NOTES

OWNER	MINISTRY OF COMMUNICATION, TRANSPORT AND TOURISM DEVELOPMENT				THE PROJECT FOR REHABILITATION OF BETIO PORT
CONSULTANT	NIPPON KOEI CO., LTD.				FISHERY JETTY REVETMENT
	PREPARED BY	CHECKED BY	APPROVED BY PM	APPROVED BY OWNER	Typical Cross Section
NAME	S. ONAKA	M. ISHIGURO	R. NISHIMURA		
DATE					

SCALE	DRAWING No.	REV. No.	SHEET No.
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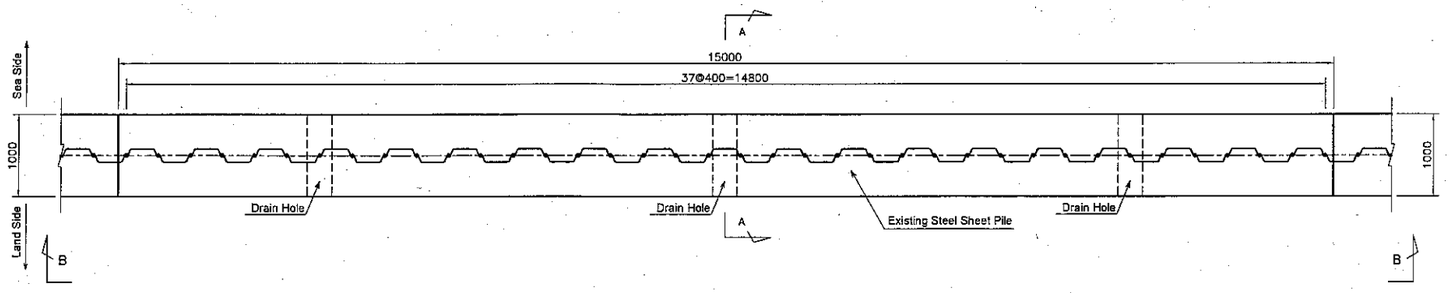

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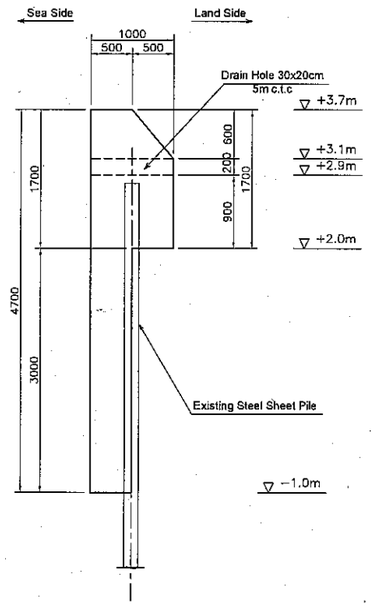
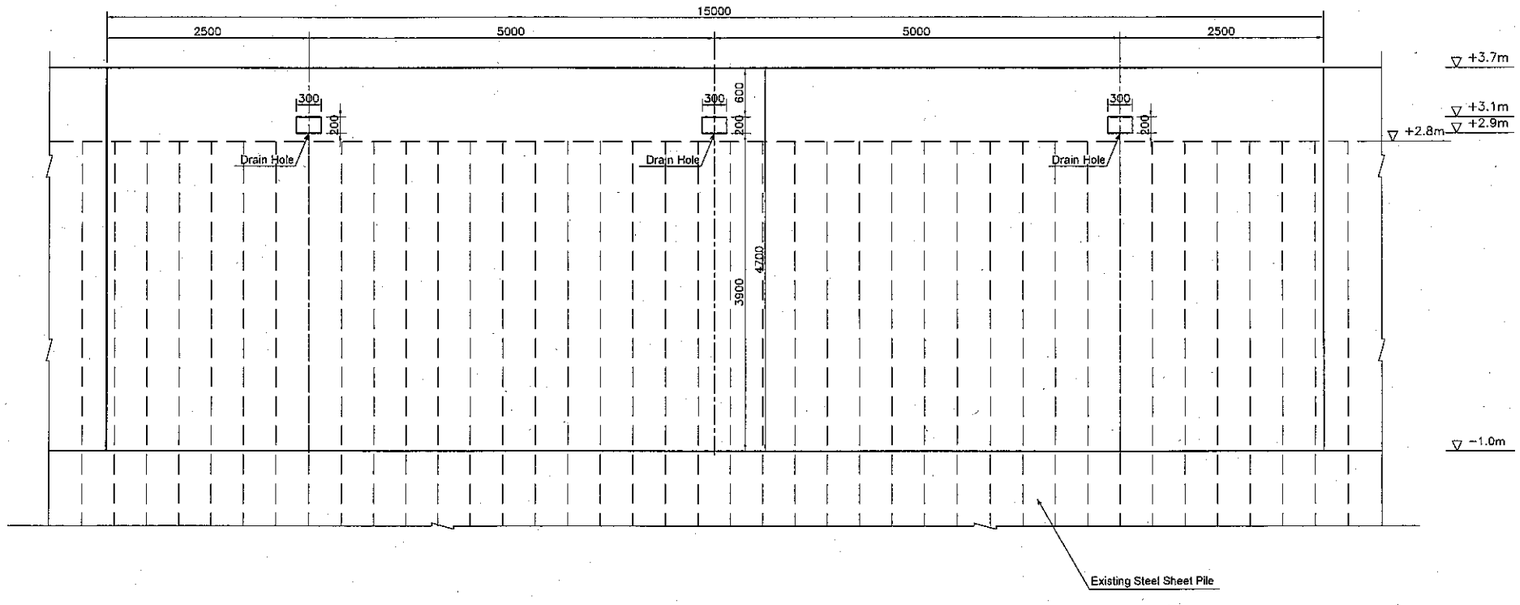


Section A-A



Section B-B

REV. No.	DATE	DESCRIPTION
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NOTES

OWNER	MINISTRY OF COMMUNICATION, TRANSPORT AND TOURISM DEVELOPMENT				THE PROJECT FOR REHABILITATION OF BETIO PORT
CONSULTANT	NIPPON KOEI CO., LTD.				FISHERY JETTY REVETMENT
	PREPARED BY	CHECKED BY	APPROVED BY PM	APPROVED BY OWNER	Details of Coping Concrete
NAME	S. ONAKA	M. ISHIGURO	R. NISHIMURA		
DATE					

SCALE	DRAWING No.	REV. No.	SHEET No.
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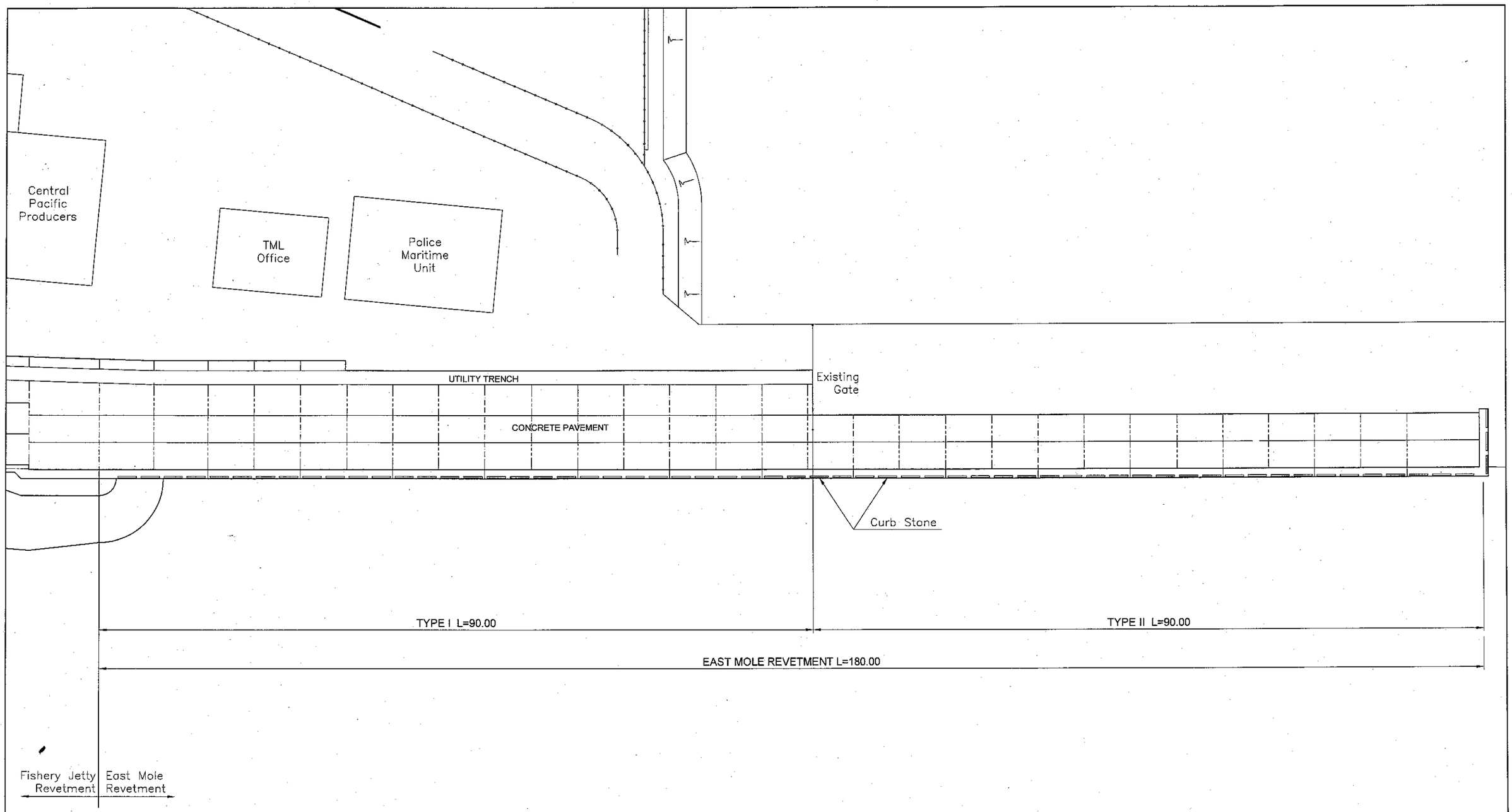

REV. No.	DATE	DESCRIPTION
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NOTES

OWNER	MINISTRY OF COMMUNICATION, TRANSPORT AND TOURISM DEVELOPMENT				THE PROJECT FOR REHABILITATION OF BETIO PORT
CONSULTANT	NIPPON KOEI CO., LTD.				EAST MOLE REVETMENT
	PREPARED BY	CHECKED BY	APPROVED BY PM	APPROVED BY OWNER	Layout Plan
NAME	S. ONAKA	M. ISHIGURO	R. NISHIMURA		
DATE					

SCALE	DRAWING No.	REV. No.	SHEET No.
A3 1/500	E-001		

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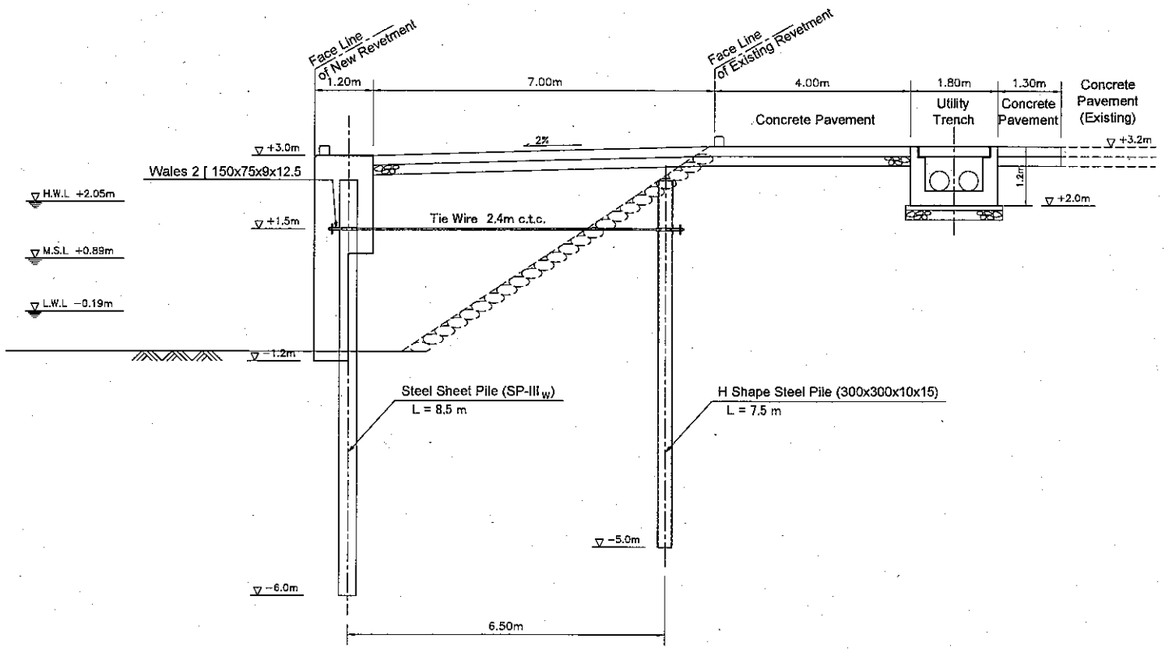

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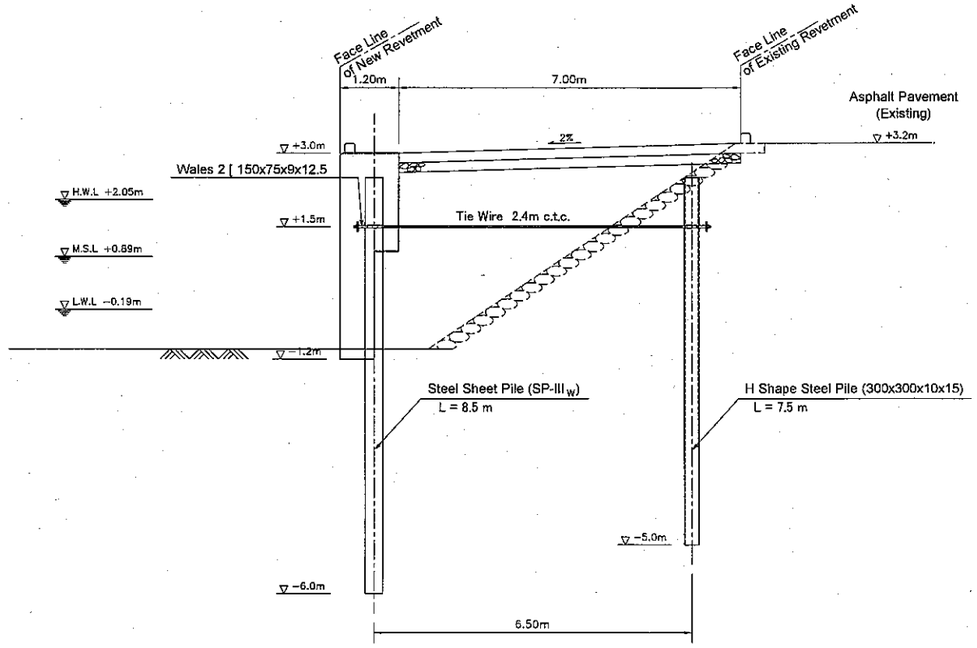

REV. No.	DATE	DESCRIPTION
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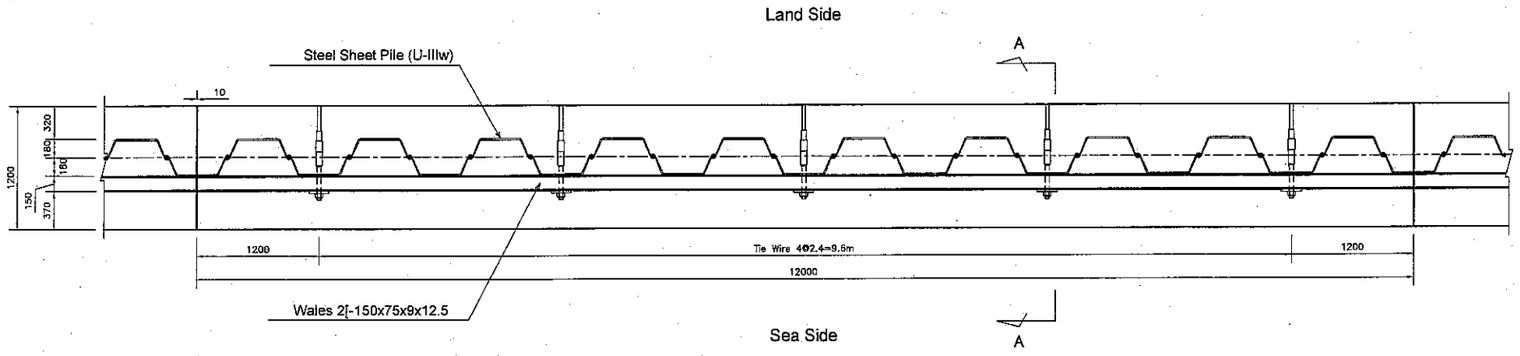
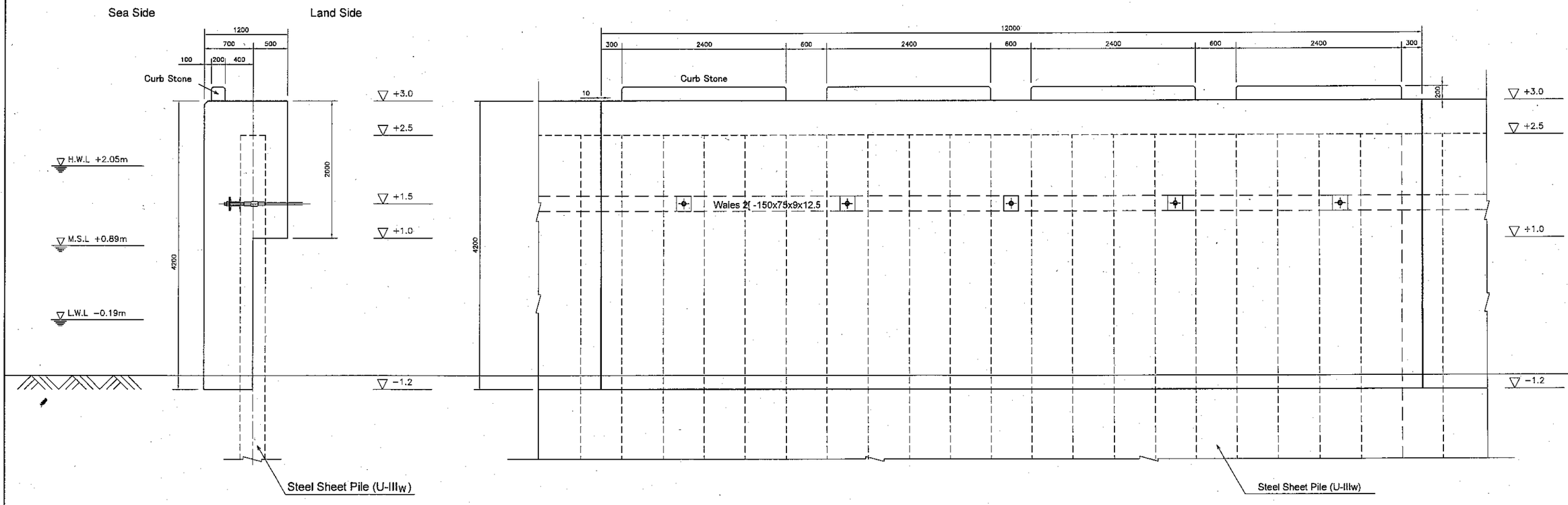
NOTES

OWNER	MINISTRY OF COMMUNICATION, TRANSPORT AND TOURISM DEVELOPMENT				THE PROJECT FOR REHABILITATION OF BETIO PORT		
CONSULTANT	NIPPON KOEI CO., LTD.				EAST MOLE REVETMENT		
	PREPARED BY	CHECKED BY	APPROVED BY PM	APPROVED BY OWNER	Typical Cross Section		
NAME	S. ONAKA	M. ISHIGURO	R. NISHIMURA		SCALE	DRAWING No.	REV. No.	SHEET No.
DATE					A3 1/125	E-002		



PLAN



Section A-A

Section B-B

REV. No.	DATE	DESCRIPTION
0		

NOTES

OWNER	MINISTRY OF COMMUNICATION, TRANSPORT AND TOURISM DEVELOPMENT				THE PROJECT FOR REHABILITATION OF BETIO PORT
CONSULTANT	NIPPON KOEI CO., LTD.				EAST MOLE REVETMENT
	PREPARED BY	CHECKED BY	APPROVED BY PM	APPROVED BY OWNER	Details of Coping Concrete
NAME	S. ONAKA	M. ISHIGURO	R. NISHIMURA		
DATE					

SCALE	DRAWING No.	REV. No.	SHEET No.
A3 1/60	E-006		

2-2-4 Implementation Plan

2-2-4-1 Implementation Policy

The implementation policies are outlined taking into account the fact that the Project would have to be implemented under the Japanese Grant Aid scheme, as described below:

a. To maximize procurement of local labor, materials and equipment in Kiribati so as to increase employment opportunities, facilitate technology transfer and provide positive impact to the local economy.
b. A cargo ship reaches the port every other month to transport construction materials and equipment from Japan. Therefore, it is necessary that a precise transportation plan be prepared in order to prevent unnecessary delays in the project implementation.
c. The Project will be implemented at and around the area of the existing port. Therefore, it is important that the traffic diversion plan be prepared and prior consultation with KPA be conducted so as to minimize disturbance for the ordinary port activities.

2-2-4-2 Implementation Conditions

Special considerations to be given in the project implementation are as follows:

(1) Transportation of Construction Materials and Equipment

The construction materials and equipment to be imported from Japan or third countries will be discharged at Betio Port. Regular cargo ships are anchored offshore due to limited depth alongside the New Wharf and cargoes shall be transported by barge to the wharf. Containers are mainly used from the viewpoints of safety of cargo and ease of cargo handling by barge. In order to implement the Project smoothly, the construction plan shall be prepared in due consideration of these particular conditions relating to marine transportation.

(2) Environmental Considerations during Construction

The Environmental Act in Kiribati has come into force since 1999. The national land conservation including the problem of sea level rise is a serious issue for the Government. It is important to note that sand and coral rocks are valuable property and it is necessary to place great care on this issue.

Construction waste and scrapping of vehicles are considered to be similar recent problems in the country due to narrow land area available. It should be considered that construction waste from demolition and removal shall be reused as part of construction facilities as much as possible. Moreover, these waste products shall be brought back to Japan, if required.

(3) Public Traffic Diversion during Construction

The Project will be implemented in the area surrounding the existing port. However, the access roads to the wharf and jetty are narrow and alternative routes are limited. When a traffic control or temporary road closure is required, it is necessary to arrange prior consultations with KPA and implement possible countermeasures to reduce obstacles to the existing port activities.

2-2-4-3 Scope of Works

The scope of works to be undertaken by the Government of Japan as well as by the Kiribati Government is as follows:

Table 2-2-16 Scope of Works by Japanese and Kiribati Governments

Works and Facilities to be provided by the Government of Japan	Works and Facilities to be provided by the Government of Kiribati
- Rehabilitation works of three revetments. - Installation and removal of temporary facilities (storage yard, construction plant, site offices, quarters, etc.) required in execution of construction works. - Removal and re-use of waste and demolished construction materials from existing structures. - Safety measures required in execution of the construction works and for public traffic in and around the construction area during construction - Prevention measures for environmental pollution in execution of the construction works. - Procurement, import and transport of equipment /materials required for the rehabilitation works as per Procurement Plan described in Section 2-2-4-6, and re-export of imported equipment. - Consulting services for detailed design, preparation of tender documents, assistance to the Kiribati Government for tender proceedings, and construction supervision as per Consultant Supervision described in Section 2-2-4-4.	- Application of permission for project implementation in accordance with the Environmental Act. - Provision of construction site and yard for construction, temporary facilities and other construction activities required in execution of the construction works. - Provision of flat barge and tug boat to the Contractor free of charge for the construction work. - Exemption of Consultant and Contractors from taxes, customs duties and other levies charged in Kiribati for execution of construction works. - Arrangement for visas, certificates and other privileges to Japanese nationals and third country personnel related to and required in execution of construction works. - Payment of bank service charges for banking arrangements and authorization to pay. - Waiver of port charges against consignee/consignor for importing construction materials and equipment for the Project except for importing construction materials such as rocks, stone aggregate, sand, rubble and cement in a form of break bulk.

2-2-4-4 Construction Supervision

(1) Consulting Services

The Consultant will provide the following consulting services within the limits of Japanese Grant Aid:

1) Detailed Design and Preparation of Tender Document Stage

Detailed design, which includes the following outputs, should be conducted for the facilities based on this Report. Finally, tender documents will be prepared for approval by the Kiribati Government.

- Design report
- Drawings
- Tender documents

2) Tender Stage

The MCTTD and KPA, with assistance of the Consultant, will select a successful tenderer and conclude the construction contract through a competitive tender procedure among Japanese construction firms. Representative(s) from the Kiribati Government attending tender opening and signing the contract with a winning Contractor should be legal representative(s) responsible for this procedure. The Consultant should assist MCTTD and KPA to conduct the following:

- Bid announcement
- Pre-qualification of Contractors
- Tender and tender evaluation
- Contract negotiation

3) Construction Supervision Stage

After obtaining the verification of the construction contract from the Ministry of Foreign Affairs of the Government of Japan, the Consultant will issue a Notice to Proceed to the Contractor and then construction supervision shall begin.

The Consultant, within his capacity as the Engineer, should directly report to MCTTD and KPA, Embassy of Japan in Fiji and JICA Fiji Office about the various field activities, and should issue field memoranda or letters to the Contractor, if necessary, regarding the various matters including progress, quality, safety and payment control of the Project.

The defects liability period expires on the date one year after the completion of the Project. At the end of the defects liability period, a defects liability inspection will be conducted as the final work of the consulting services.

(2) Staffing

The required staff and their responsibilities in the detailed design, tender and construction supervision stages are described below:

1) Detailed Design Stage

Project Manager : Responsible for supervising all technical and managerial aspects of consultancy services for detailed design

Civil Engineer I (Port Planner)	: Responsible for design of revetments, facilities on land and utility facilities, quantities calculation, and temporary construction plan
Civil Engineer II (Structure)	: Responsible for detailed design of revetments, facilities on land and utility facilities
Construction Planner/Cost Estimator	: Responsible for construction planning and updating cost estimates based on the latest work quantities and unit prices
Document Specialist	: Responsible for preparation of tender documents

2) Tender Stage

Tasks assigned to the Consultant are to assist the Kiribati Government in advertisement of PQ notice, issuance of PQ documents and tender documents, evaluation of PQ and tender documents and other activities relating to tendering.

Project Manager	: Responsible for all the aspects of consulting services during the tender stage.
Civil Engineer I (Port Civil)	: Responsible for assistance in PQ evaluation.

3) Construction Supervision Stage

Project Manager	: Responsible for all the aspects of consulting services during the construction stage.
Resident Engineer	: Responsible for all the aspects of construction supervision at the sites and coordination with and reporting to MCTTD, KPA, Embassy of Japan and JICA Fiji Office.

2-2-4-5 Quality Control Plan

According to the Japanese Standards of Construction Works, the quality control shall be conducted based on the quality control plan as shown in Table 2-2-17.

Table 2-2-17 Quality Control Plan

Item			Test Method	Frequency
Subgrade	After Spreading and Leveling Works		CBR Test	Every 250 m^2
Base Course (Crushed Rock)	Mixed Material		Sieve Gradation (Mixed)	Every mixing
			Aggregate Density	
			Maximum Dry Density	
	After Paving		Field Density (Compaction Test)	Daily
Concrete	Material	Cement	Quality Guarantee, Chemical & Physical Analysis	Every sending
		Water	Chemical Analysis	Every sending
		Admixture	Quality Guarantee, Chemical Analysis	Every sending
		Fine Aggregate	Dry Bulk Specific Gravity	Every sending
			Sieve Gradation, Finesse Modulus	
			Clay and Friable Particles	
		Coarse Aggregate	Dry Bulk Specific Gravity	Every sending
			Sieve Gradation (Mixed)	
			Sodium Sulphate Soundness	
	Mixing Test		Compressive Strength at 7 days & 28 days	Every mixing
	Pouring		Slump	Every batch
			Concrete Temperature before Pouring	Daily
	Strength		Compressive Strength at 7 days & 28 days	Daily or Every 50m^3
Rock	Quarry Site		Abrasion Loss	Each quarry lot
			Bulk Specific Gravity	Each quarry lot
Reinforcement bar	Material		Quality Certificate, Tensile Strength Test	Each lot
Structural Steel · Steel Sheet Pile	Material		Mill Sheet	Each lot
Welding	After Constructing		Colour Check	Each Member
Tie Wire	After Manufacturing		Tensile Strength Test	One sample

2-2-4-6 Procurement Plan

(1) Procurement of Construction Materials

Most of the construction materials to be used for the revetment works are not available in Kiribati and imported goods from overseas countries and the available construction materials are extremely limited. An indicative procurement schedule of major construction materials is shown in Table 2-2-18.

Table 2-2-18 Indicative Procurement Schedules of Construction Materials

Item	Indicative Procurement Schedule		
	Kiribati	Japan	Third Countries
Reclamation Materials	O	-	-
Armour Stone	-	-	O (Fiji)
Base and Subbase Materials	-	-	O (Fiji)
Aggregates	-	-	O (Fiji)
Portland Cement	-	-	O (Australia)
Concrete Admixture	-	O	-
Reinforcement Bar	-	O	-
Structural Steel · Steel Sheet Pile	-	O	-
Forms of Concrete Block	-	O	-
Steel Forms	-	O	-
Geotextile Sheet	-	O	-
Form Wood	O	-	-
Lubricant	O	-	-
Fuel, Gasoline, others	O	-	-
Laboratory Equipment	-	O	-

(2) Procurement of Construction Equipment

The working condition of construction equipment seems to be generally poor due to corrosion effects induced by the ocean climate. The numbers of equipment available are too limited to mobilize on time. Under these circumstances, it has been judged that the local equipment will be used only for subsidiary works and as back-up facilities.

Considering the above procurement conditions, the procurement source of main construction equipment has been determined from Japan. A list of major construction equipment to be procured in the Project is listed in Table 2-2-19.

Table 2-2-19 Indicative Procurement Schedule of Construction Equipment

Item	Capacity Spec.	Indicative Procurement Schedule	
		Kiribati	Japan
Dump Truck	10 t diesel	−	○
Bulldozer	16 t	○	−
Backhoe	0.8 m^3	−	○
Crawler Crane	50 t	−	○
Crawler Crane	30-35 t	−	○
Rough Terrain Crane	25 t	−	○
Truck	11 t	○	○
Trailer	15 t	○	−
Concrete Breaker	600-800 kg	−	○
Vibration Hammer	60 kW	−	○
Clamshell Bucket	0.8 m^3	−	○
Concrete Plant	1.0 m^3	−	○
Truck Mixer	3.0-3.2 m^3	−	○
Concrete Pump	20 m^3/hr	−	○
Wheel Loader	1.8 m^3	−	○
Vibrator	60 mm	−	○
Flat Barge	Steel-made, 200 t	○	−
Tug Boat	210 hp	○	−

2-2-4-7 Implementation Schedule

Considering the work scope of three revetments and the time required for manufacturing concrete blocks, and assuming the Project will be implemented under the Japanese Grant Aid scheme, it is desirable to apply phasing of the Project.

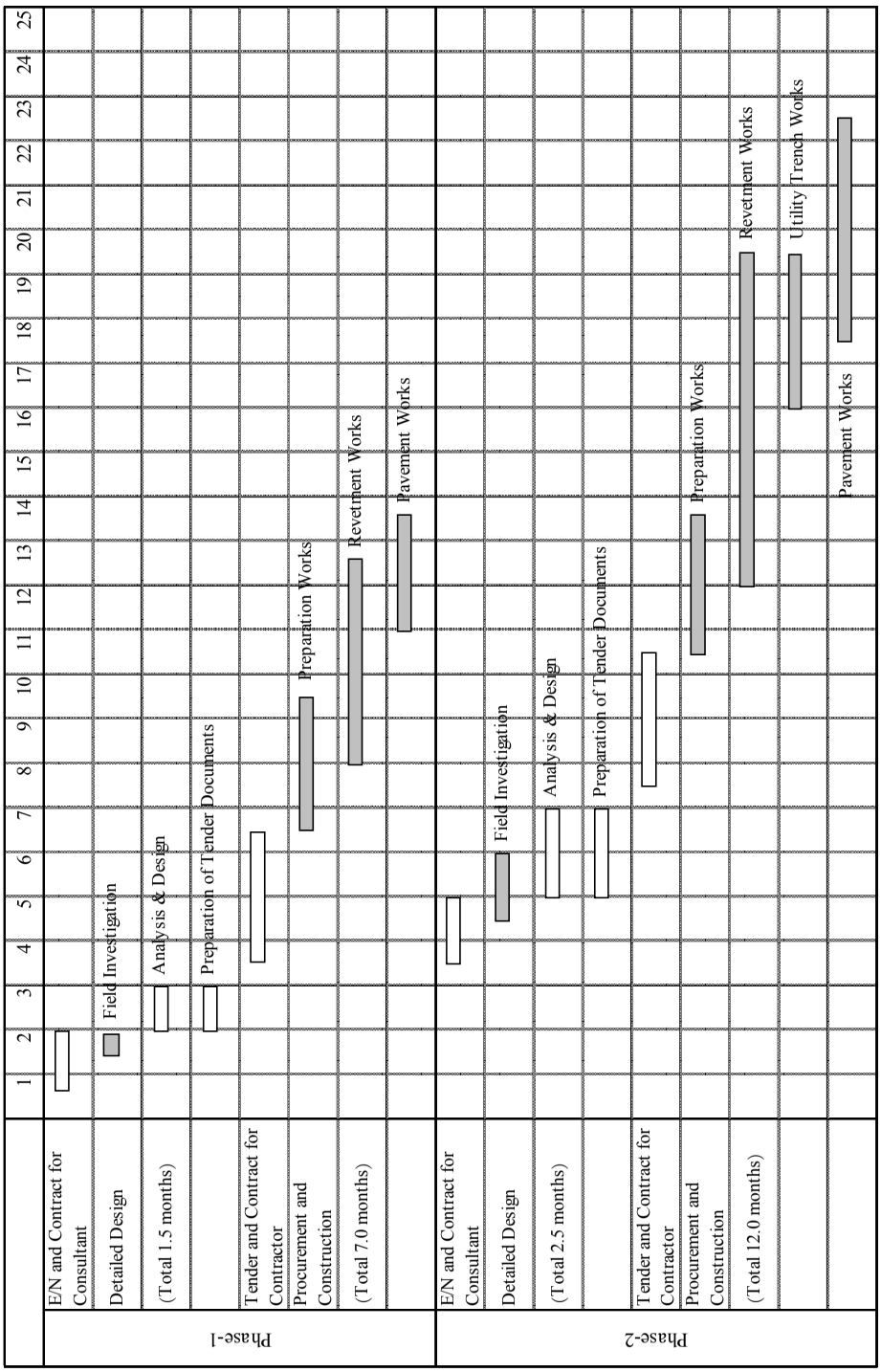
It is proposed that the urgent rehabilitation of the New Wharf Revetment shall be implemented under Phase 1 while the rehabilitation of the Fishery Jetty and East Mole Revetments will occur during Phase 2. Both will be conducted under the Japanese single fiscal year scheme.

The consulting services will be commenced under the Grant Aid Project only after the Exchange of Notes (E/N) covering the detailed design, tendering, construction supervision and civil work for Phase 1 of the New Wharf Revetment have been signed with the Kiribati Government. At the beginning of the Services, the Consultant will conduct the detailed design and prepare the tender documents. The tendering activities such as prequalification of Contractors, tender evaluation, selection of a Contractor, etc. will be performed as a task to assist the Kiribati Government. After selection of successful Contractor through competitive bidding, the Kiribati Government will sign the civil works contract with the selected Contractor and the contract will be verified by the Government of Japan. The notice to proceed will be issued to the Contractor after verification of the contract. The construction will be officially commenced with a construction period of 7 months for Phase 1.

On the other hand, the Exchange of Notes (E/N) for the detailed design of Phase 2 including the Fishery Jetty and East Mole Revetments will be conducted between the two Governments. The detailed design will follow after contracting with the Kiribati Government and the Consultant. After the completion of detailed design, all necessary tender procedures, including prequalification of Contractor, tender, selection of successful Contractor and signing of contract, will be performed. The construction period of Phase 2 work will be 12 months.

A tentative implementation schedule for the Project is depicted in Table 2-2-20.

Table 2-2-20 Tentative Implementation Schedule



2-3 Obligations of Recipient Country

The following measures will need to be undertaken by the Government of Kiribati as conditions of the grant aid being extended for the Project by the Government of Japan.

(1) Acquisition of Construction Permission

It is prerequisite to acquire permission for project implementation in accordance with the Environmental Act enacted by MELAD. The Development Consent for the Project was issued from MELAD to MCTTD in January 2005.

(2) Provision of Land for Project

Land necessary for as a temporary yard for the Contractor's work, storage, manufacture and temporary storage of concrete blocks shall be provided.

(3) Provision of Construction Equipment

Provision of one flat barge with associated tug boat owned by KPA free of charge including necessary crews for operation, fuel, maintenance, etc. for the construction work of the Project during idle time of cargo handling operation will be provided upon request by the Contractor.

(4) Waiver of Port Charges

Waiver of port charges against consignee/consignor for importing construction materials and equipment for the Project, except for importing construction materials such as rocks, stone aggregate, sand, rubble and cement in a form of break bulk, will be provided.

(5) Exemption from Taxation

Provision of all the expenses and prompt execution for unloading, customs clearance at the port of disembarkation and internal transportation of the products purchased under the grant aid shall be secured.

Japanese nationals and third country personnel related to and required for execution of construction works will be exempt from customs duties, internal taxes and other fiscal levies, which could be imposed in Kiribati with respect to the supply of the products and services under the verified contracts.

(6) Banking Arrangements

Bear an advising commission of an authorization to pay and payment commissions to the Bank for execution of work.

(7) Permission of Entry and Stay

Accord Japanese nationals, whose services may be required in connection with the supply of the products and services under the verified contracts, such facilities as may be necessary for their entry into Kiribati and stay therein for the performance of their work.

2-4 Project Operation Plan

The KPA is responsible for maintenance and operation of rehabilitated facilities by the Project. Such maintenance and operation works shall be subcontracted with local private firms because no staff in charge of maintenance of civil works are available in KPA.

(1) Maintenance Work

The maintenance works can be divided into two types, one annual and the other periodic maintenance. These works will be carried out in accordance with the work schedule below:

[Annual Maintenance]

- Checking whether any concrete blocks have shifted
- Removal of deposits in drainage facilities
- Inspection of settlement and cracking of pavement concrete
- Removal of deposits in utility trench
- Inspection of covers for the utility trench

[Periodic maintenance]

- Inspection of state of corrosion for steel sheet pile below the water surface
- Inspection of variation of water depth in front of revetment

(2) Considerations for Maintenance and Operation

In maintenance and operation of rehabilitated facilities by the Project, KPA should give due consideration to the following points:

1) East Mole Revetment

In front of the Betio Fish Port Complex, some sections of the East Mole Revetment are utilized by small fishing boats and pilot boat for loading ice and embarking/disembarking of pilot during high tide. However, the revetment for rehabilitation is designed to function as a revetment and not as a wharf. There is a possibility that the revetment could be structurally unstable if the existing seabed is dredged further below the original elevation in front of the steel sheet piles. Hence, dredging should be avoided in front of the revetment.

2) West Mole Revetment

The West Mole Revetment absorbs wave actions against the East Mole Revetment due to its sheltering effect. There is a possibility that the East Mole Revetment could be exposed to unexpected wave actions if damages to the West Mole Revetment spread more substantially than the present situation. Hence, it is essential for KPA that they should undertake periodic maintenance/repair works of the West Mole Revetment.

2-5 Cost Estimate

2-5-1 Project Cost to be borne by Japan's Grant Aid

The total cost of the Project by Japanese Grant Aid is estimated at 835 million Yen, consisting of 315 million Yen for Phase 1 and 520 million Yen for Phase 2 as summarized in Table 2-5-1. This cost estimate is provisional and will be further examined by the Government of Japan for the approval of the Grant.

Table 2-5-1 Project Cost to be borne by Japanese Grant Aid

Japanese Grant Aid: 835 million Yen

(Unit: million Yen)

Items		Phase 1			Phase-2			Total		
Facilities	Revetment Works	257.7	279.2	279.2	383.9	463.4	467.8	641.6	742.6	747.0
	Utility Trench Works	-			27.2			27.2		
	Pavement Works	21.3			47.0			68.3		
	Ancillary Facilities Works	0.2			5.3			5.5		
Procurement of Equipment		-			4.4			4.4		
D/D, Construction Supervision		35.4			52.3			87.7		

Conditions of Cost Estimate

Exchange rate : USD 1.0 = Yen 110.57 (6 month average before August 31, 2004)

: AUD 1.0 = Yen 80.95

(The above-mentioned exchange rate is to be reviewed by the Government of Japan.)

Construction period : 7 months for Phase 1 and 12 months for Phase 2

Others : On condition implementation under Japanese Grant Aid scheme.

2-5-2 Project Cost to be borne by Kiribati Side

Based on the Obligations of Recipient Country recommended in Section 2-3, the project cost required for the undertakings by the Kiribati side are as shown in Table 2-5-2.

Table 2-5-2 Project Cost to be borne by Kiribati Side

Work Items	Cost (AUD)	Yen Equiv. ('000 Yen)
1. Administration Cost for Project Implementation	32,000	2,951
2. Provision of Flat Burge with Tug Boat	11,580	937
3. Commission and Charges for Banking Arrangement and Authorization to Pay	11,490	930
4. Waiver of Port Charges	470,000	38,000
Total	525,070	42,818

Although the project cost to be borne by the Kiribati side amounts to about 525,000 AUD (43 million Yen), the cost of waiver of port charges are (work item 4) accounted for fixed salaries of staff and operation costs for cargo handling equipment in the annual budget. Consequently, KPA will bear only about 55,000 AUD for the project implementation. On the other hand, the annual maintenance budget of KPA was

recently 276,000 AUD (22 millionYen) in total. Hence, the above project cost corresponds to 20.0% of the annual maintenance budget of KPA, so it is judged to be financially possible for KPA to bear.

2-5-3 Maintenance Cost

Based on the Project Operation Plan recommended in Section 2-4, the periodic maintenance schedule and cost are estimated as shown in Table 2-5-3.

Table 2-5-3 Estimated Maintenance Cost

Classification	Frequency	Component	Work	Estimated Cost (AUD)	Equiv. to Yen ('000 Yen)
Check of Concrete Block	Once a year	On land, underwater	Visual Check	2,000	162
Maintenance of Drainage	Twice a year	Curb	Cleaning	300	25
Maintenance of Pavement	Once a year	Pavement Surface	Repair	2,000	162
Maintenance of Utility Trench	Once a year	Inside of Trench	Cleaning	200	16
(ditto)	Once a year	Ditch Plunk	Repair	2,000	162
Annual Maintenance Cost				6,500	527
Inspection of Steel Sheet Pile	Every 2 year	Underwater Section	Underwater Inspection	2,000	162
Inspection of Water Depth	Every 2 year	In front of Steel Sheet Pile	Sounding	8,000	648
Annual Maintenance Cost	(equiv.)			5,000	405
Annual Maintenance Cost				11,500	932

From the above table, KPA is required to bear a maintenance cost of about 6,500 AUD (527 thousand Yen) annually as well as 10,000 AUD (810 thousand Yen) for checking of steel sheet piles and sounding of water depth in front of the revetments every two years. These maintenance costs average out at about 11,500 AUD (1 million Yen) a year.

On the other hand, the annual maintenance budget of KPA was recently 276,000 AUD (22 million Yen) in total. Hence, the above-estimated annual maintenance cost for the revetments rehabilitated by the Project corresponds to only 4.2% of the annual maintenance budget of KPA, so that it is judged financially possible for KPA to continue the maintenance of the rehabilitated revetments.

CHAPTER 3 PROJECT EVALUATION AND RECOMMENDATIONS

Chapter 3 PROJECT EVALUATION AND RECOMMENDATIONS

3-1 Project Effect

As a result of the socio-economic and field surveys and the basic design in the study, the impact and effects generated by project implementation are as follows.

It is worth noting that the project benefits will cover the South Tarawa, which has a total population of approximately 40,000 or about 46% of the total population of the country (according to 2002 Census).

(1) Direct Impact and Effects

- The revetments, which have become vulnerable to wave action and been damaged, will be rehabilitated by the Project to recover their original functions and improve durability.
- The road behind the New Wharf Revetment, utilized as an access route to the New Wharf, is unpaved and is washed away frequently by overtopping waves, resulting in an extremely bumpy surface and being a hazard to moving traffic. Smooth access will be secured by implementing countermeasures against overtopping waves and road pavement to be undertaken by the Project.
- The building facilities situated behind the revetments suffer flood damage including corrosion of accessory utilities due to frequent overtopping of waves in the spring tide. The extent of overtopping will be reduced through countermeasures to be implemented by the Project, resulting in less flood damage to the facilities.

(2) Indirect Impact and Effects

- The damages to cargoes, which will be transported via the road behind the New Wharf Revetment, will be reduced by improved accessibility to the New Wharf as a result of the Project.
- It is expected that the amount of spindrift reaching the container yard will be reduced by the countermeasures against overtopping waves to be implemented by the Project, resulting in reduced damages to containers and cargo handling equipment stored in the container yard.
- At the New Wharf Revetment, it is envisaged that goods loaded in containers will be damaged if erosion of the revetment reaches the premises of the container yard. However, damage to the containers can be prevented by countermeasures to limit erosion of the revetment to be undertaken by the Project.
- At the New Wharf Revetment and Fishery Jetty Revetment, installation of concrete blocks will reduce reflected waves in front of the revetments and enhance the tranquility inside the basin. As a result, it is expected that the efficiency of cargo handling operation will be improved and damage to vessels at berth and the wharf itself will be reduced.
- KPA is forced to bear a huge financial burden year after year spending 57,000 AUD in 2002 and 105,000 AUD in 2003 for maintenance and repair of the revetments to be rehabilitated

by the Project. It is envisaged that the maintenance and repair cost for the revetments rehabilitated by the Project will be substantially reduced after their completion.

3-2 Recommendations

After completion of the Project, it is essential that KPA should undertake adequate maintenance/ repair works in order to achieve and sustain the positive impacts of the Project. However, it is desirable that KPA should improve their technical capability for maintenance and operation works since they presently have no maintenance staff for civil work. Therefore, it is recommended that the possibility of recruiting technical trainees be examined to assist the development of human resource development as part of Japanese technical assistance.

Appendices

1. Member List of the Study Team

Appendix 1. Member List of Study Team

1-1. Preliminary Study in Kiribati (From August 17, 2004 to September 22, 2004)

Name	Position	Belonging
Tadashi Ikeshiro	Leader	Resident Representative, JICA Fiji Office
Kohtaro Nishigata	Project Coordinator	Project Management Group II, Grant Aid Management Department, JICA
Ryoichi Nishimura	Chief Consultant/ Port Facilities Planner	Nippon Koei Co., Ltd.
Susumu Onaka	Natural Condition Expert	Nippon Koei Co., Ltd.
Junichi Ishizuka	Construction Planner/ Cost Estimator	Nippon Koei Co., Ltd.

1-2. Draft Report Explanation in Kiribati (December 7, 2004 to December 18, 2004)

Name	Position	Belonging
Tadashi Ikeshiro	Leader	Resident Representative, JICA Fiji Office
Ryoichi Nishimura	Chief Consultant/ Port Facilities Planner	Nippon Koei Co., Ltd.

2. Study Schedule

Appendix 2. Schedule of Study

2.1 Field Investigation（August 17 to September 22, 2004）

No.	Date	Day	Schedule	Stay	Activities
1	8/17	TUE	Study team (Nishigata, Nishimura) left for Nadi via Auckland	Flying overnight	Moving day
2	8/18	WED	Study team arrived at Nadi	Nadi	（同上）
3	8/19	THU	Study team moved to Suva & joined with Ikeshiro	(ditto)	Courtesy call to EOJ & JICA
4	8/20	FRI	Study team moved to Tarawa	Tarawa	Courtesy call to MCTTD & KPA, Submission of ICR, Site inspection of Betio Port
5	8/21	SAT		(ditto)	Site inspection of North Tarawa, Courtesy call to the President
6	8/22	SUN		(ditto)	Site inspection of Betio Port
7	8/23	MON		(ditto)	Explanation of & discussion on ICR with MCTTD & KPA
8	8/24	TUE	Onaka arrived at Tarawa	(ditto)	Preparation of Draft MoD
9	8/25	WED		(ditto)	Signing of MoD, Site inspection of other Projects
10	8/26	THU	Ikeshiro & Nishigata left Tarawa (Ikeshiro resumed his official duties, Nishigata arrived at Tokyo the next day)	(ditto)	Field investigation, Data collection & analysis
11	8/27	FRI	Onaka arrived at Tarawa	(ditto)	(ditto)
12	8/28	SAT		(ditto)	(ditto)
13	8/29	SUN		(ditto)	(ditto)
14	8/30	MON		(ditto)	(ditto)
15	8/31	TUE		(ditto)	(ditto)
16	9/01	WED		(ditto)	(ditto)
17	9/02	THU		(ditto)	(ditto)
18	9/03	FRI		(ditto)	(ditto)
19	9/04	SAT		(ditto)	(ditto)
20	9/05	SUN		(ditto)	(ditto)
21	9/06	MON		(ditto)	(ditto)
22	9/07	TUE		(ditto)	(ditto)
23	9/08	WED		(ditto)	(ditto)
24	9/09	THU		(ditto)	(ditto)
25	9/10	FRI		(ditto)	(ditto)
26	9/11	SAT		(ditto)	Preparation of field investigation report
27	9/12	SUN		(ditto)	(ditto)
28	9/13	MON	Nishimura & Ishizuka moved to Suva via Nadi	Tarawa/Suva	(ditto)
29	9/14	TUE		（ditto）	Report to EOJ & JICA, Data analysis, Investigation of procurement status in Fiji
30	9/15	WED		(ditto)	Investigation of procurement status in Fiji
31	9/16	THU	Nishimura left Nadi & arrived at Tokyo the next day	(ditto)	(ditto)
32	9/17	FRI	Ishizuka left Nadi & arrived at Tokyo the next day via Brisbane	Tarawa	Field investigation, Data collection & analysis, Preparation of field investigation report
33	9/18	SAT		(ditto)	(ditto)
34	9/19	SUN		(ditto)	(ditto)
35	9/20	MON	Onaka left Tarawa & moved to Nadi	Nadi	Moving day
36	9/21	TUE	Onaka left Nadi & arrived at Tokyo the next day via Brisbane	Flying overnight	(ditto)
37	9/22	WED	－		(ditto)

MCTTD: Ministry of Communication, Transport and Tourism Development, KPA: Kiribati Port Authority, MoD: Minutes of Discussion

2.2 Explanation of Draft Final Report（December 7 to December 18, 2004）

No.	Date	Day	Schedule	Stay	Activities
1	12/07	TUE	Nishimura left for Nadi	Flying overnight	Moving day
2	12/08	WED	Nishimura arrived at Nadi via Auckland	Nadi	(ditto)
3	12/09	THU	Nishimura moved to Suva & joined with Ikeshiro, Study team moved to Nadi	(ditto)	Courtesy call to EOJ & JICA
4	12/10	FRI	Study team moved to Tarawa	Tarawa	Courtesy call to MCTTD & KPA, Submission of DFR, Site inspection
5	12/11	SAT		（ditto）	Site inspection, Document preparation
6	12/12	SUN		(ditto)	Document preparation
7	12/13	MON		(ditto)	Discussion on MoD with MCTTD & KPA, Courtesy call to MFED
8	12/14	TUE		(ditto)	Discussion on MoD with MCTTD & KPA, Discussion on development application with MELAD
9	12/15	WED		(ditto)	Discussion with CPP, Discussion on and signing of MoD
10	12/16	THU	Study team left Tarawa & moved to Nadi	Nadi	Site inspection of Bonriki Int'l Airport, Moving day
11	12/17	FRI	Study team moved to Suva (Ikeshiro resumed his official duties) Nishimura moved to Nadi	(ditto)	Report to EOJ
12	12/18	SAT	Nishimura left Nadi & arrived at Tokyo	－	Moving day

MCTTD: Ministry of Communication, Transport and Tourism Development, KPA: Kiribati Port Authority

MFED: Ministry of Finance and Economic Development, MELAD: Ministry of Environment, Land and Agriculture Development

CPP: Central Pacific Producer, MoD: Minutes of Discussion

3. List of Parties Concerned in the Recipient Country

Appendix 3. List of Parties Concerned in the Recipient Country

1. Ministry of Communications, Transport and Tourism Development (MCTTD)	
Mr. Tebwe Ietaake	Permanent Secretary
Ms. Utina Anruti	Actg. Senior Assistant Secretary
Mr. John Carr	Director of Civil Aviation, Aviation Division
Mr. Tekena	Director, Meteorological Division
2. Kiribati Port Authority (KPA)	
Capt. Koubwe Ienraoi	General Manager
Capt. Bonteman Tabesa	Operation Manager/Deputy General Manager
3. Ministry of Environment, Lands and Agriculture Development (MELAD)	
Ms. Tererei Abete	Deputy Director, Environment & Conservation Division
Mr. Puta Tofinga	Assistant EIA Officer, Environment & Conservation Division
Mr. Tebutonga	Director, Land Management Division
4. Ministry of Finance and Economic Planning (MFEP)	
Mr. Peter Tong	Director, National Economic Planning Office
Mr. Kamaua Bareua	Director, Human Resource Planning & Development
Mr. Tekeraoi Nangka	Economist, AID
Ms. Kurinati Tekena	Project Economist
5. Ministry of Public Works & Utilities (MPWU)	
Mr. Titaake Binataake	Chief Engineer
6. Ministry of Labor	
Mr. Ngutu Awira	Director
7. Embassy of Japan	
Tatero Iino	Ambassador extraordinary and plenipotentiary
Shigeki Takaya	First Secretary
Motoo Sakakibara	Second Secretary
Kenji Miyata	Minister-Counsellor
8. JICA Fiji Office	
Tadashi Ikeshiro	Resident Representative
Nakaba Suzuki	Resident Officer
9. Kiribati Shipping Services Limited (KSSL)	
Capt. Itibwinnang Aiaimoa	General Manager

4. Minutes of Discussions

4-1 Minutes of Discussions for Field Survey (August 25, 2004)

4-2 Technical Note (September 9, 2004)

4-3 Minutes of Discussions for Explanation of Draft Final Report (December 15, 2004)

4-4 Official Letter from MCTTD (January 20, 2004)

4-1 Minutes of Discussions for Field Survey (August 25, 2004)

Minutes of Discussions
on the Basic Design Study
on the Project for Rehabilitation of Betio Port
in the Republic of Kiribati

Based on the result of the Preparatory Study which was held on December 2003, the Government of Japan decided to conduct a Basic Design Study on the Project for Rehabilitation of Betio Port (hereinafter referred to as "the Project"), and entrusted the study to the Japan International Cooperation Agency (hereinafter referred to as "JICA").

JICA sent to the Republic of Kiribati (hereinafter referred to as "Kiribati") the Basic Design Study Team (hereinafter referred to as "the Team"), headed by Mr. Tadashi Ikeshiro, Resident Representative, JICA Fiji Office, and is scheduled to stay in the country from August 20 to 26, 2004.

The Team held discussions with the officials concerned of the Government of Kiribati and conducted a field survey in the study area.

In the course of the discussions and the field survey, both sides confirmed the main items described in the attached sheets.

Tarawa, August 25, 2004

Tadashi Ikeshiro
Leader
Basic Design Study Team
Japan International Cooperation Agency

Tebwe Ietaake
Permanent Secretary
Ministry of Communications, Transport and Tourism Development
Republic of Kiribati

Capt. Koubwere Ienraoi
General Manager
Kiribati Ports Authority
Republic of Kiribati

ATTACHMENT

1. Objective of the Project

The objective of the Project is to rehabilitate the Port of Betio suffered from bad sea conditions in November and December, 2002.

2. Project Site

The Project site is the Port of Betio constructed by Japan's Grant Aid.

The Project site is as shown in Annexes-1-1 and 1-2.

3. Responsible and Implementing Organizations

3-1. The responsible ministry is the Ministry of Communications, Transport and Tourism Development (MCTTD).

3-2. The implementing agency is the Kiribati Ports Authority (KPA).

3-3. The organizations of MCTTD and KPA are shown in Annexes -2-1 and 2-2, respectively.

4. Items Requested by the Government of Kiribati

As the result of discussions, requested components were confirmed as below:

- Rehabilitation of the New Wharf Revetments suffered from bad sea conditions in November and December, 2002

And the Kiribati side also requested the Team to rehabilitate the Old Port East Mole Revetment and to dredge in the basin and channel of the Old Port. The Team pointed out that the dredging work is not appropriate to be included in the Grant Aid Project because the dredging work in the basin and channel of the Old Port should be implemented by the Kiribati side as a part of the ordinal maintenance works. And the Kiribati side understood the dredging work is not appropriate to be included in this Project. On the rehabilitation of the Old Port East Mole Revetment, both sides agreed that the Team would continue further survey and analysis to examine the necessity, urgency and appropriateness of the rehabilitation works.

JICA will assess the appropriateness of the request and will report to the Government of Japan.

5. Japan's Grant Aid Scheme

The Kiribati side understood the Japan's Grant Aid scheme explained by the Team, as described in Annex-3.

6. Further Schedule of the Study

6-1. The consultant members of the Team will proceed with further studies in Kiribati until September 20, 2004.

6-2. JICA will prepare the Draft Basic Design Study Report in English and dispatch a mission to Kiribati in

order to explain its contents in December 2004.

6-3. When the contents of the Report are accepted in principle by the Government of Kiribati, JICA will complete the Final Report and send it to the Kiribati side by the end of March 2005.

7. Temporary Measure

7-1. The Team requested and the Kiribati side agreed that the Kiribati side should take temporary measures to prevent the damage of port facilities from expansion until the Project would be implemented, if necessary.

7-2. The team will propose the way of works for temporary measures by the Kiribati side as a result of further study.

8. Other Relevant Issues

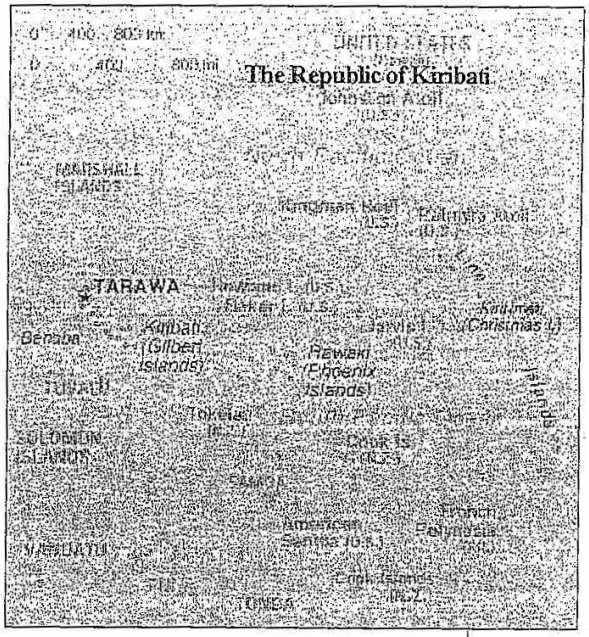
8-1. The Kiribati side will take the necessary measures, as shown in Annex-4, for smooth implementation of the Project, as a condition for the Japan's Grant Aid to be implemented.

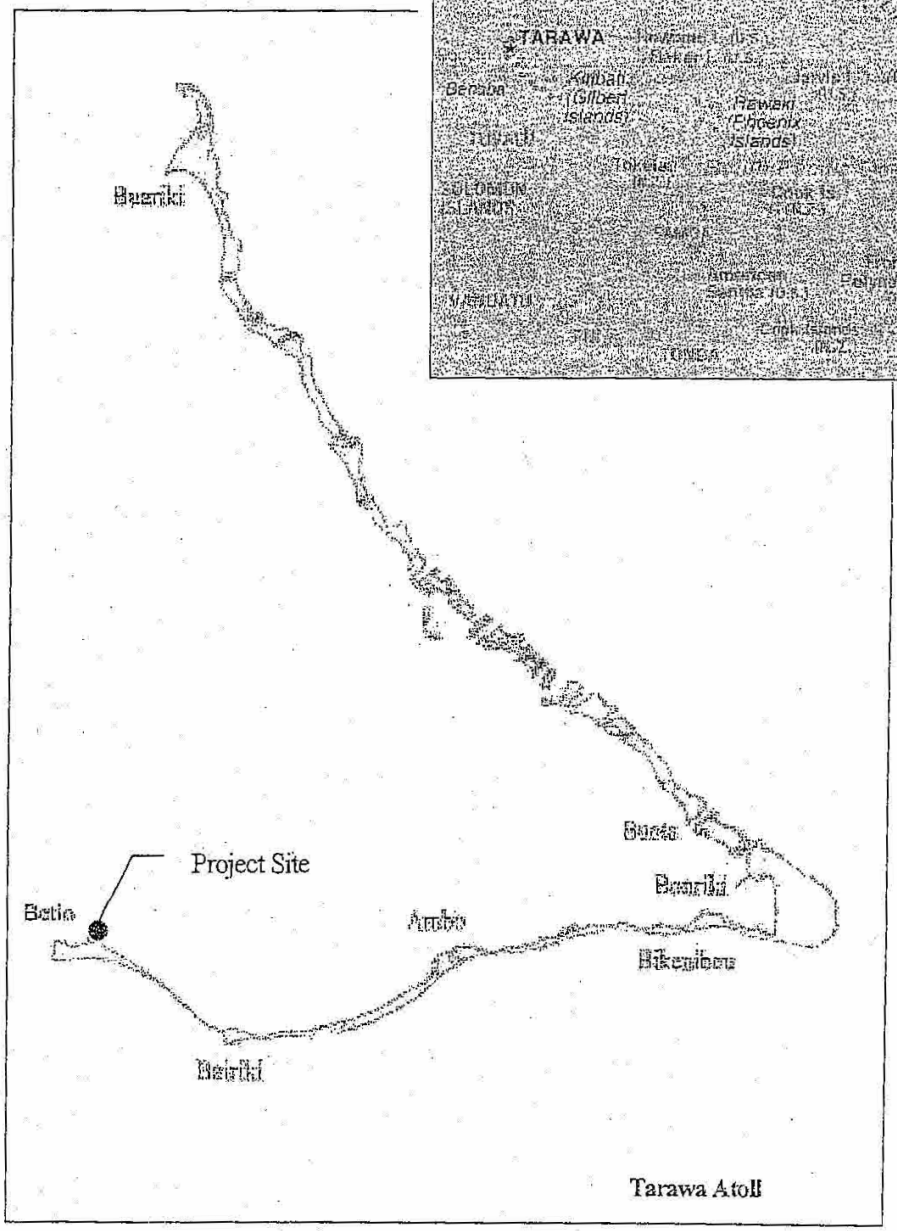
8-2. The Kiribati side suggested applying a vertical structure as the rehabilitation of the New Wharf Revetment. The Team agreed to include such structure as one of alternative structures to be examined in selecting the most appropriate type for the revetment.

8-3. The Kiribati side explained a necessity to extend the wharf to accommodate larger container ships and increased container cargoes. Currently the containers carried by the international container ships are loaded/unloaded at offshore anchorage area and transfer by small barges/lighters between the wharf and container ships causing unnecessary double handling operation of container cargoes. The Team explained the extension of the wharf should not be included in the Project because the purpose of the Project was focused only on the rehabilitation works.

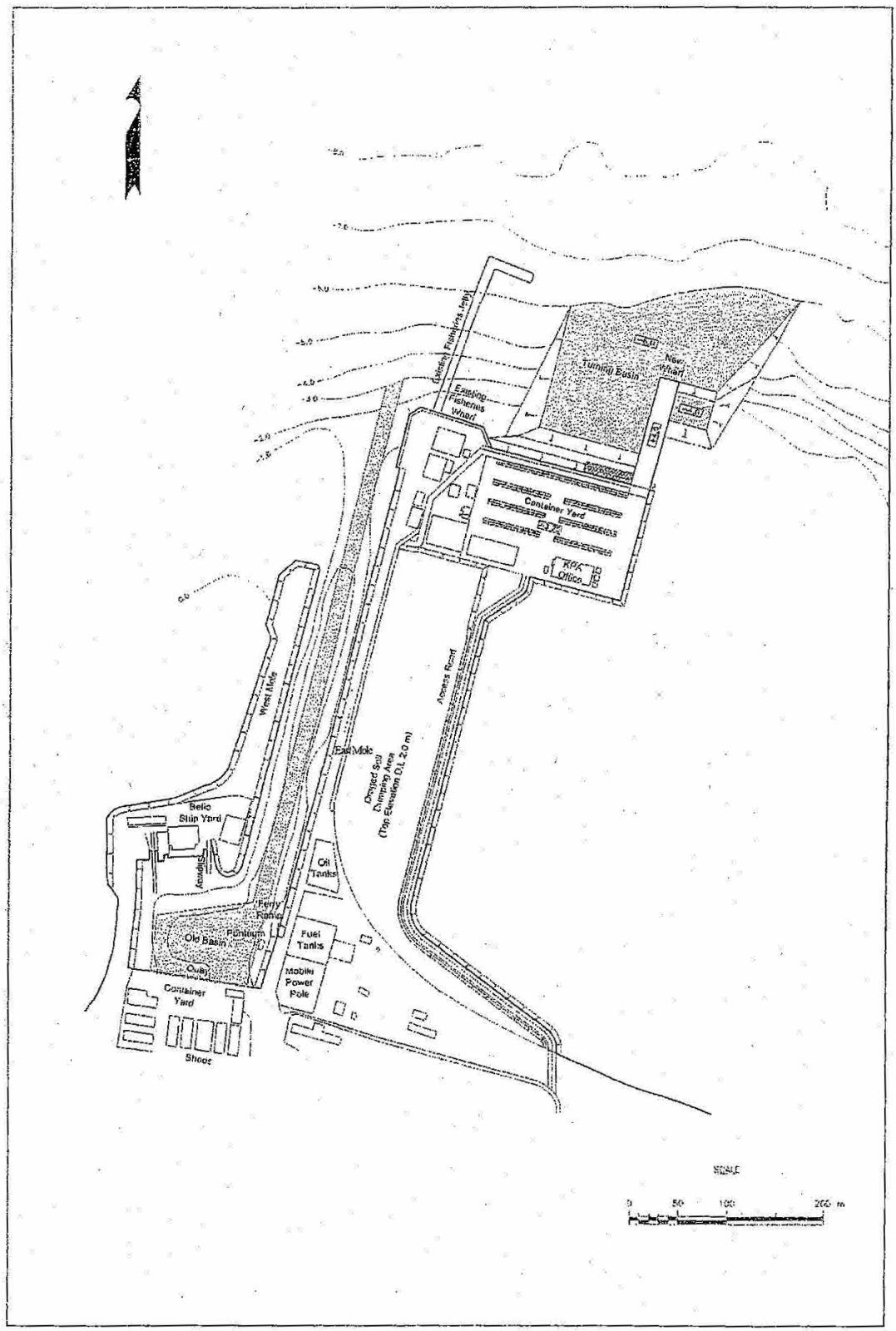
8-4. The Kiribati side also explained a necessity to enhance its ability to carry out routine dredging needs in view of lack of proper equipment.

Project Site

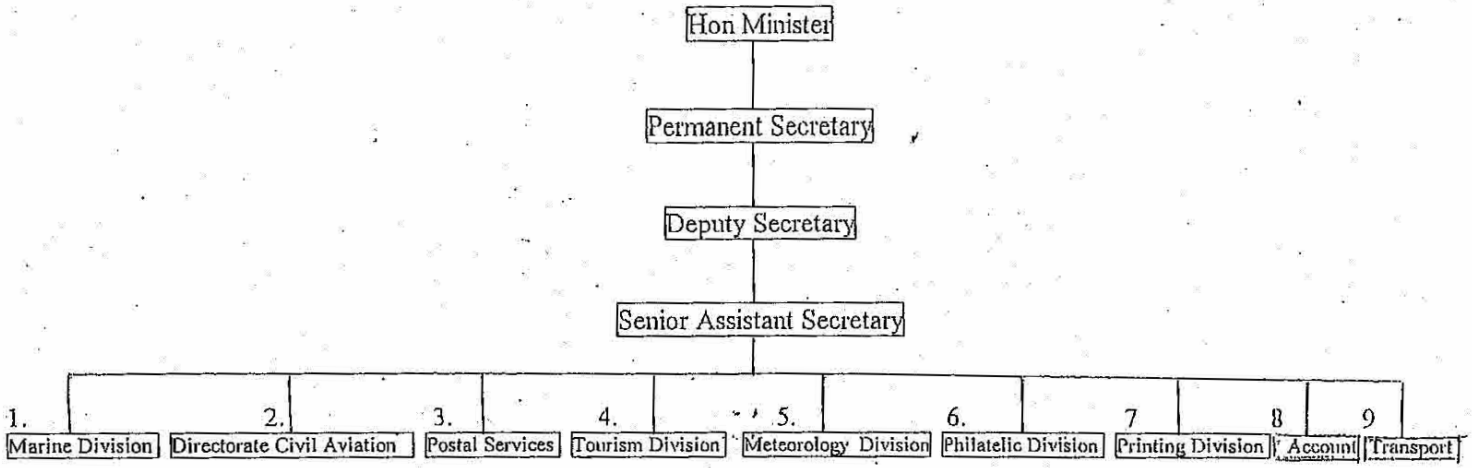




Project Port



The Organization Charts of the MCTTD



1. Director of Marine is the Head of the Marine Division assisted by the Registrar of Ships/Seamen and the Marine Surveyor. There are twenty total number of staff at the Marine Division

2. Director of Civil Aviation is the Head of the Civil Aviation assisted by the Deputy Director of Civil Aviation. The total number of staff of the Directorate of the Civil Aviation is 31.

3. Director of Postal Services is the Head of the Postal Services assisted by Controller of Postal Services. The total number of staff is 29

4. The Senior Tourism Officer is the Head of the Tourism Division assisted by the Tourism Development Officer. There are 9 officers in total.

5. Meteorology Division is headed by the Chief Meteorological Officer. There are twenty five staff in total.

6. Philatelic Division is headed by the Chief Philatelic Officer assisted by the Senior Philatelic Officer. There are 9 staff in total

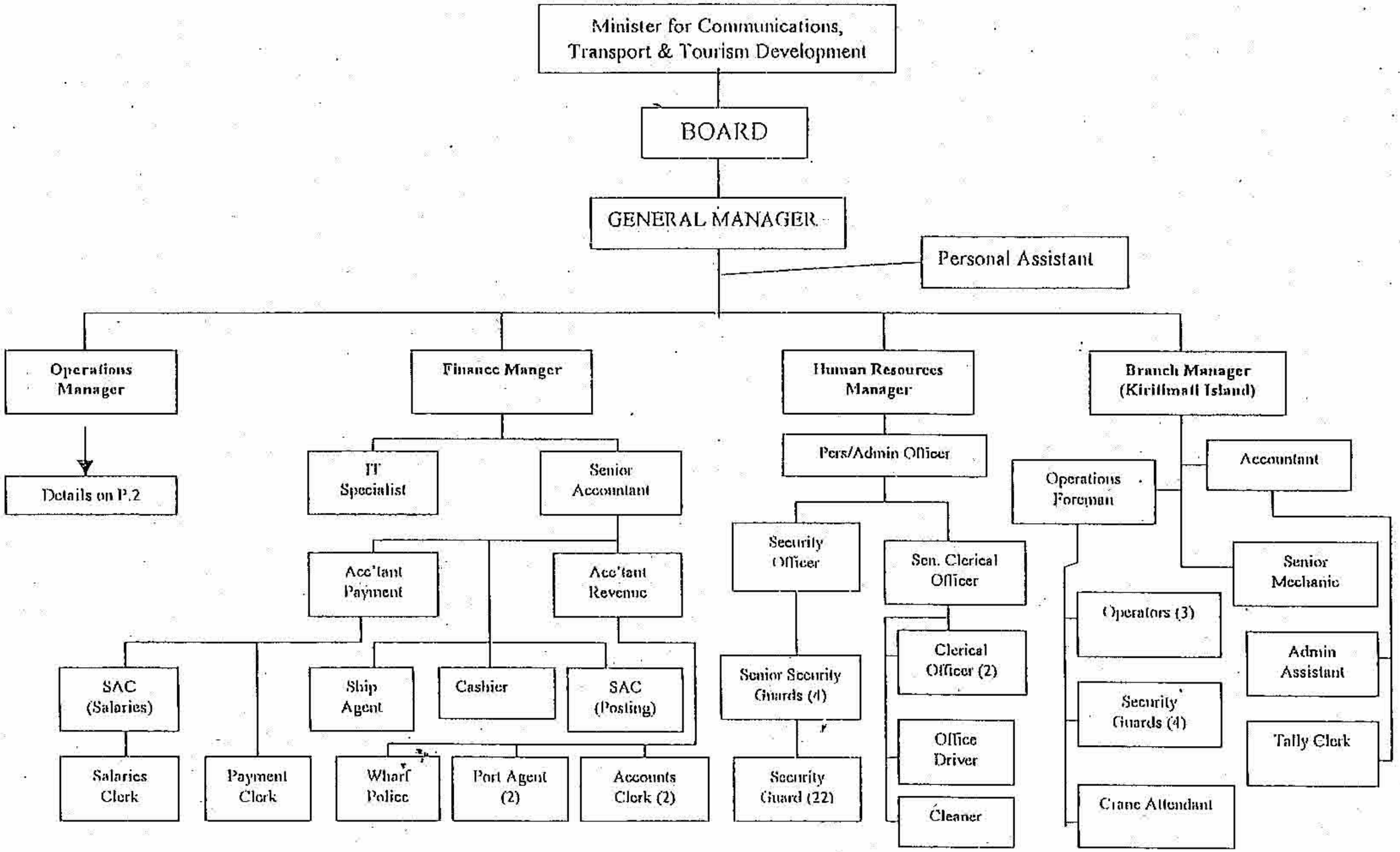
7. Printing Division is headed by the Government Printer and assisted by the Printing superintendent. There are 19 staff in total.

8. Account Division is headed by the Senior Accountant. There are six staff in total.

9. Transport is headed by the Senior Transport Economist with his Assistant assisting him.

Annex 2

KPA - ORGANISATION CHART



OPERATIONS DEPARTMENT – ORG'N CHART