THE PROJECT
FOR
RECOVERY AND DEVELOPMENT OF CAUSEWAY
IN
LAAMU ATOLL

Tender Documents (Technical Specifications)

VOLUME-II SPECIFICATIONS

PART-A GENERAL SPECIFICATIONS

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PART A GENERAL SPECIFICATIONS

CLAUSE 1. DEFINITIONS

In addition to the words and expressions defined in Volume-I, the following words and expressions in the Specifications of Volume-II shall have the meanings as stated below:

(1) "Site" means the land and other places on, under, in or through which the Work or Temporary Work are to be prepared, constructed, completed and maintained. The Sand borrow pits which shall be identified and registered by the Contractor for collecting the sandy materials for dike filling are also constituting the part of Site.

(2) "Bid and Tender" throughout these Tender Documents, the Terms "bid and tender" and their derivatives ("bidder/tender", "bid/tendered", "bidding/tendering", and etc.) are synonymous.

(3) "The Employer's Representative" means the Engineer and all other staff and other employees of the Engineer and of the Employer; and any other personnel notified in writing to the Contractor by the Employer or the Engineer, as the Employer's Representative.

(4) "Engineer" is the Organization appointed by the Employer and has been engaged or designated by the Employer to provide professional services in supervision of the Work which the Contractor shall carry out in accordance with the Contract.

(5) "Engineer's Representative" means any resident engineers or assistants to the Engineer and shall be notified to the Contractor in writing from time to time.

(6) "Contractor's Personnel" means the Contractor's Representative, who acts on behalf of the Contractor and all personnel whom the Contractor employs on Site, who may include the staff, labour and other employees of the Contractor and of each Subcontractor; and any other personnel assisting the Contractor in the execution of the Work.

(7) "Party" means the Employer including the Engineer or the Contractor, as the context requires.

(8) "Schedules" means the document(s) entitled as schedules, completed by the Contractor and submitted with the Tender in Forms of Tender: Implementing Schedule: Schedule II, and as included in the Contract.

(9) "Cost" means all expenditure reasonably incurred (or to be incurred) by the Contractor, whether on or off the Site, including overhead and similar charges, but does not include profit.

(10) "Contractor's Equipment" means all apparatuses, machinery, vehicles, floating equipment and other things required for the execution and completion of the Work and the remedying of any defects.

(11) "Materials" means things of all kinds (other than Plant) intended to form the whole or the part of the Work, including the supply-only materials (if any) to be supplied by the Contractor under the Contract.

(12) "Reference Information" means the available natural conditions of preliminary topographic data and geotechnical information near the Site for reference purpose only. The Contractor shall read and translate them by his responsibility.

(13) "Contractor's Documents" means the shop drawings, stability calculations of Temporary Works including computer programmes and other software, Site and prefabrication Specifications, samples, manuals, models and other documents of a technical nature (if any) to be supplied by the Contractor for approval of the Engineer under the Contract.

CLAUSE 2 GENERAL CONDITIONS

2.1 Details not to be Published

The Contractor shall treat the details of the Drawings and these Specifications as confidential for his own information only and shall not publish or disclose them in any trade or technical paper or elsewhere (except as necessary for the purpose thereof), without the prior consent in writing of the Employer.

2.2 Project site

Maldives are dispersed over 26 Atolls and 1,198 islands, among which islanders are living on 200 islands before the Tsunami in 2004. It locates 675 km down to the south-west from Sri Lanka. All islands are scattering in a wide ocean extending about 820 km to the north-south and about 130 km to the east-west. Down to the South in 250km from Male, there is another atoll named as Laamu. Laamu Atoll has a population of 11,588 and its capital is Fonadhoo. Inhabited islands, 12 out of 83, are located in a wide water basin of 40 km long and 25 km wide.

As many years ago a Buddhist group settled here, relics of this previous culture are seen in Mabaidhoo, Mundhoo and Gan. Kontiki explorer visited Gan in 1981 and found the historical monuments.

This atoll is enclosed by a massive circular reef embracing 700 km2 of the ocean. Maldivians sail cautiously in this waters. Thus it allows entry and exit only through a few narrow passages. The eastern rim of the reef is dotted with many deserted islands, sandbanks and local villages, some separated only by knee-deep lagoons. There is a causeway connection formed from the capital, Fonadhoo Island to the north for Maandhoo Island. After Maandhoo it goes further to the north through Gan Island, the largest one in Maldives.

The Causeway built in 1980's consists of two dikes namely a 250m long one and 1000m long one. The Causeways connect three islands then the total length of these chains is 16.4km as follows;

Gan Island	8km
(This split was only 200m then closed naturally by sand deposit.)	
Maandhoo Island	1km
Causeway No.1	0.25km
Kadhoo Island	2.5km
Causeway No.2	0.65km (facility length 1.0km)
Fonadhoo Island	4km
Total	16.4km

This is to strengthen the damaged causeway by Tsunami in tow locations.

Causeway No.1; Between Maandhoo Island and Kadhoo Island; approx. 300m

Causeway No.2; Between Kadhoo Island and Fonadhoo Island; approx. 900m

Before these construction, this 16.4km is divided into four parts, thus there being three water passages, namely 200m, 250m and 650m. These openings were provided the natural passages through which sea water was able to move in and out of the open sea.

Aerial photograph indicates the followings;

- Current of offshore comes normally from the East to West.
- Offshore current associating with waves jumps on the flat reef and crosses over to the opposite side of the inner reef edge.
- This action raises the water level.
- Flat reef current direction is normal to the reef edge then tracing a line and curve to the inner lagoon following coastal configuration.
- When it hits the island coastal line, it turns to the bottom area seeking the passages.
- If a passage exists, it goes through the passage and to the inner lagoon. Then goes off to the offshore area through the passage.
- If no passage is found, it returns to the mother offshore by so-called rip current.

In case of construction of artificial causeways like in Fonadhoo, there is no choice other than the returning rip current. Since there is an actually no water passage, the water level at the offshore coast remains high, which introduces a higher wave at the coast. A high wave easily runs up the coastal zone and generates coastal current which is dangerous to erosion. Cutting natural water passages by the causeway is deteriorating the rate of sea water exchange and generates a dead water zone where the water quality will become worse.

Supporting above, it should be recorded that the sea bottom condition at the North section of No.1 causeway is completely deteriorated. A diving inspection shows the existence of anaerobic condition. It is assumed this happened due to the closed water zone by the natural sand dike and causeway. This requires providing water passages to maintain aerobic condition as before the provision of the existing causeway.

This situation causes adverse effects against safety and environmental preservation of the causeway. Thus the provision of water passage is a must.

It is proposed to provide artificial openings by means of following alternatives;

- Providing concrete culvert, 1.3m x 0.9m, approx. every 100m
- Providing a bridge of 18m span (Causeway No.2)

According to the Site survey results, there is a head difference in approximately 0.3m between the East (outer side facing to the open ocean) and West (inner side facing the calm lagoon). Water surface in the East basin is higher than that of the West. It is estimated that the average current velocity through the new opening by a bridge will amount to four meters per second. The Contractor shall always take this situation into account. Other finding tells that the existing seabed elevation also shows difference in both sides; East seabed is stabilizing in plus or minas zero to the datum, LAT, while the west side indicates plus 0.5m above the datum. This makes seabed elevation difference bordering the causeway.

The existing ground formation of access road connection to the causeway is + 1.5m to 1.7m above the datum. The crown height of the proposed causeway is 2.0m above the datum. Reconstruction of the causeways will be carried out at the same location of the existing ones, in order to maintain the construction economic and ensure an easy maintenance access for islanders.

Causeway 1 can stay at the present location; Causeway 2 will be relocated by seven meters to the east in parallel seeking a sound seabed formation.

Basic design of main body consists of sand core backfill, armour rock protection and simple pavement.

2.3 End User's Responsibilities

(1) As supplementary information to the End-User's Responsibilities stipulated in Part-III "Form of Contract" of Volume-I, End-User shall provide the area for the Work in 0.5ha within one (1) km from the Project Site as shown in Figure A-1.

(2) The End-User shall ensure that the Work provided under this Grant Aid of Japan are to be maintained and used properly and effectively.

2.4 Scope of Work

(1) The Work to be rendered under this Contract shall cover of the following components as specified in the Contract Documents.

Main Work

Causeway No. 1

Main Body as Standard Section

- Armour rock revetment Work
- Core materials filling Work
- Pavement and fittings

Concrete Box Culvert

- Prefabrication Work, if any
- Site installation
- Slope protection Work

Causeway No. 2

Main Body as Standard Section

- Armour rock revetment Work
- Core materials filling Work
- Pavement and fittings

Bridge Section

- Abutment Work
- Pier Work
- Bridge superstructure Work
- Apron protection Work (Bridge Bed Riprap)

Concrete Box Culvert

- Prefabrication Work, if any
- Site installation
- Slope protection revetment Work

Peripheral Facilities

Road lighting poles, lamps and wiring

Traffic sign board

(2) The scope of the Work prescribed above shall be include Site survey, design and supply of Temporary Work, permanent installation of materials, transportation, insurance and all other things required in and for the Project implementation in due conforming to the Contract Documents.

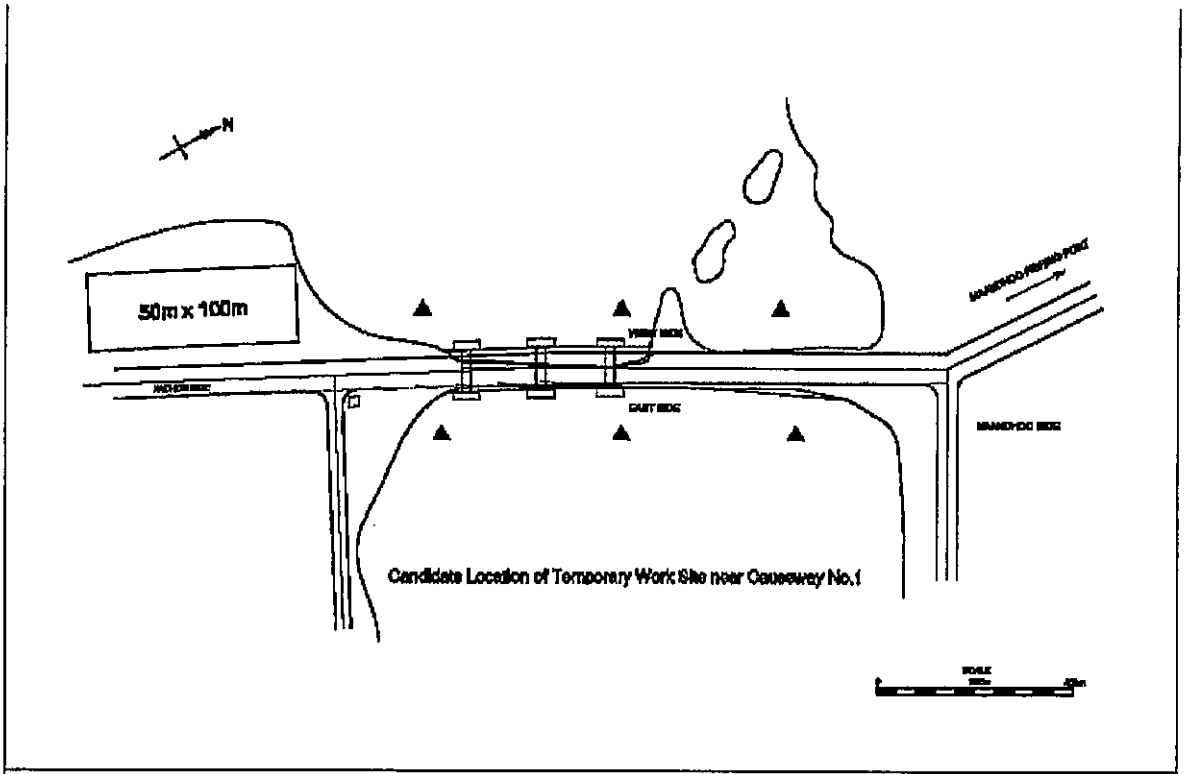
(3) Temporary Work shall include provision for temporary access to the users throughout construction period. Such access shall be six meter wide with crown height in 1.7m or higher above the datum. LAT. Part of the Permanent Work could be used for the purpose with the Engineer's approval.

2.5 Laws and Regulations

In addition to the requirement for the Contractor to abide by all laws and regulations of the Recipient, he shall consider for the specific cultural, social and religious aspects of the Recipient.

2.6 Standards and Codes of Practice

All Work shall be carried out to the standards and Codes of Practice quoted in the Specifications. If no particular standard is quoted, then the approved Japanese Standard shall be applied.



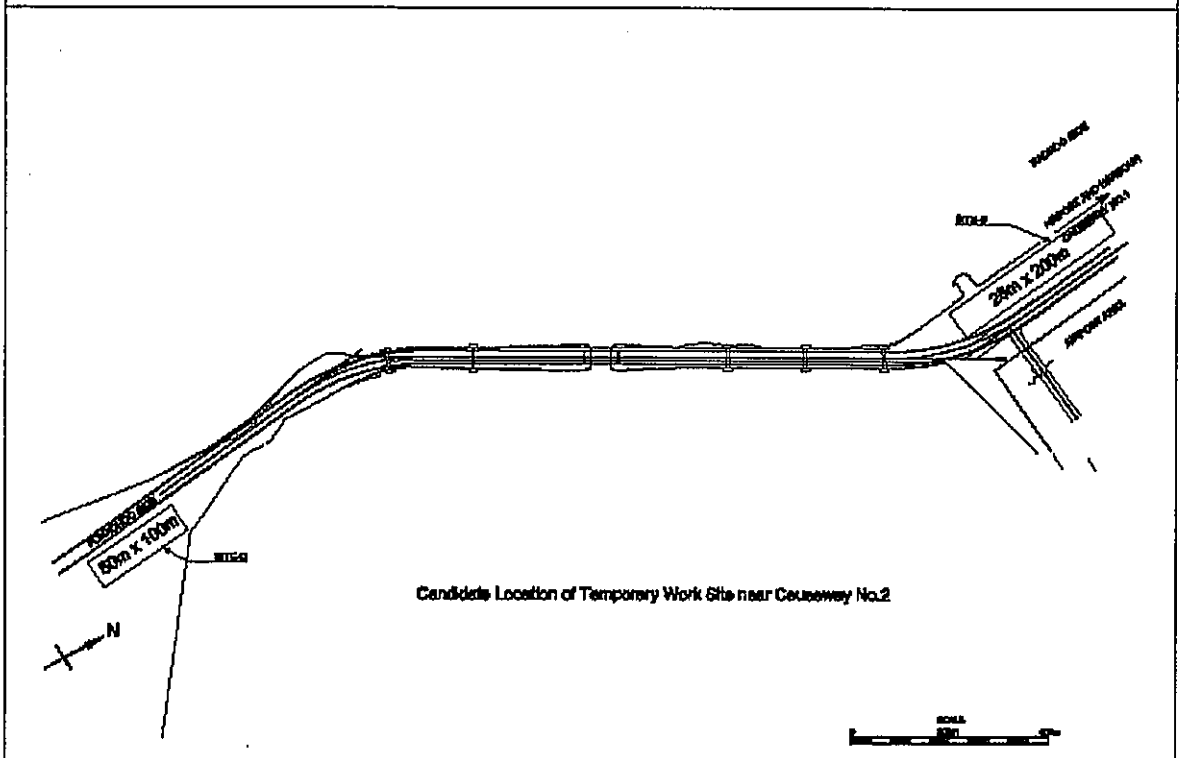


Fig. A-1 Location Map of Temporary Yards

CLAUSE 3 SITE CONDITIONS

3.1 General

This Section will provide the Contractor with general Site information for the reference purpose. The Contractor shall form their own opinion of the Work, and shall make their own interpretation regarding all conditions affecting the Work to be performed. Any variation from there shall not relieve the Contractor from his responsibility to accomplish the Work as required by the Contract.

3.2 Site Survey Covered by the Contract

Within two (2) months after the Date of Contract, the Contractor shall undertake Site survey in order to supplement the existing data. Cross section survey shall cover the area of both 25m from the existing causeway center line. Such survey shall include:

(1) Topographic Survey for the Existing Causeway

Cross Section;

Causeway No. 1	
Kadhoo side connection area	three sections
Causeway in the sea	four sections
Mmandhoo side connection area	three sections
Causeway No. 2	
Kadhoo side connection area	five sections
Causeway in the sea	eight sections
Mmandhoo side connection area	five sections
	Total 28 Cross sections

Longitudinal Sections;

Causeway No. 1	300m (Approx.)
Causeway No. 2	1000m (Approx.)

(2) Use of Survey Results; Topographic Survey

No survey results shall affect the Contract Price. The Contractor, however, shall use the data for the following purposes;

1) Verification of the Work's quantities and construction programme
2) Applying it to the base map for the As-Built Drawings

3.3 Natural Conditions (1); Meteorology

The year in Maldives may be divided into the northeast monsoon season between December and March, and the southwest monsoon season from the end of April to October.

General climatic conditions are depending on the location of the Site and surrounding atmosphere environment. It is no doubt that Maldives is governed by oceanographic circumstances rather than influence by the atmospheres of nearby continental.

Temperature

Daily temperature varies little throughout the year with the mean annual temperature of 28 °C. The mean daily minimum temperature recorded for Male' during 2003 was 25.4 °C and the daily mean maximum temperature for the same year was 31.1 °C.

The highest temperature ever recorded in the Maldives was 36.8 °C, recorded on 19 May 1991 at Kadhoo Meteorological Office. Likewise, the minimum temperature ever recorded in the Maldives was 17.2 °C recorded at the National Meteorological Center on 11 April, 1978.

Rainfall

Rainfall in Maldives varies from north to south with the amount of rainfall increasing towards the south. This difference in rainfall patterns is primarily due to the NE monsoon period and April being much drier in the north than in the south.

Rainfall patterns measured throughout the country by eight rainfall stations and it is evident that there are variations in rainfall from north to south through the atoll chain, with the north being drier and the south wetter. The average monthly and annual rainfall for Male are 162.4 mm and 1,948.4 mm respectively. There have been considerable inter-annual variations in rainfall from 1,407 mm to 2,707 mm over the last 30 years.

Humidity

The Maldives has hot and humid tropical climate. The weather is dominated by two monsoon seasons: the north-east (dry) monsoon season from January to March and the south-west (rainy) monsoon season from May to November when winds blow predominantly from either of these two directions. The annual average relative humidity ranges from 73% to 85%.

Wind Record

Wind directions in the area are seasonal and governed mainly by two monsoon seasons-the NE monsoon (December to March) and SW monsoon (June to September).

Slightly stronger winds are associated with winds from the west typical of the SW monsoon season. On average wind speeds vary between 7 to 12 knots. The sever monsoon months are typically May, June and July during the early part of the SW monsoon, and September and October at the latter half. Squally gusty winds of 50-60 knots have been recorded at Male (DoM, 2000).

Department of Meteorology indicates the monthly wind data at L.Kadhoo which is located in Laamu Atoll and the closest wind observation point. This data is shown in A-1 summarizing as follows:

1) High wind speed is seen in May and September, at the time of seasonal changes. Among these, the winds in May indicated the most sever situation. The maximum wind speed is from WSW and its intensity is 22 knots or 11m/sec or more.
2) Study team experienced these wind with shower in the middle of May 2005. However, it is not by cyclone.
3) The maximum wind speed recorded should be referred to the estimation of design wave strength. According to the Maandhoo Fishing Port design, the wind speed is 23m/sec or 46 konts for estimating the design wave. Maandhoo port is located at the same inner reef flat side, like Fonadhoo Island Harbour and Causeways.

Table A-1 Monthly Wind Data in Kadhoo

Month	Wind Speed (Knots)						Main Direction
	>22	17-21	11-17	7-11	4-7	1-4	
Jan			NE	NE	NE		NE
Feb				NNE	NNE		NNE
Mar				W	W, NE		W
Apr			W, WSW	W, SW	SW, W		W, WSW
May	WSW	WSW	W				W
Jun			WSW	WSW, SW			WSW, SW
Jul			W	WSW, W	W		W
Aug			W		SW		W
Sep		W	WSW, W	SW, W			W
Oct			WSW	SW, W	W		W, SW
Nov			WNW	WNW, W	W		WNW, W
Dec			NE	NE	NE, N		NE, N

Source; Department of Meteorology

3.4 Natural Conditions (2); Oceanography

(1) Tides

Assumed Tide at Project site; Laamu Atoll and Thaa Atoll are collected and compared four locations namely;

- Kulhudhuffushi, Haa Dhaalu Atoll (Latitude 07.37N, Longitude 073.04E)
- Hulhule, Male (Latitude 04.11N, Longitude 076.32E)
- Maandhoo, Laamu Atoll (Latitude 02.10N, Longitude 073.30E)
- Gan, Addu Atoll (Latitude 00.37S, Longitude 073.05E)

Design tide data of the Projects at four locations is indicated as follows;

Table A-2 Tides at Male, Maandhoo, Kulhudhuffushi and Hithadhoo

Unit ; m

No.	Location	HHWL	HWL	MSL	LWL	LLWL	LAT*
1	Male	-	+1.34	+0.64	-	-	±0.00
2	Maandhoo	-	+1.20	+0.65	+0.10	-	±0.00
3	Kulhudhuffushi	+1.33	-	+0.72	-	±0.00	-
4	Hithadhoo	+1.41	-	+0.75	-	±0.00	-

Note: LAT is Lowest Astronomical Tide

Male and Maandhoo are similar in tidal conditions. Maandhoo is located in Laamu Atoll and close to the Project site. Tide of Male is used for the Project.

Since no survey bench marks exist at the Project site, survey by the Engineer was based on

the sea level, variation of which is known as the Tide Table, indicated daily high water and low water with time. Tide Table of A Gun was used since it indicated the average value among them.

(2) Currents on Reef Flat

General View on the Currents

It is believed that the ocean current generally changes its direction by season. This current keeps its direction in the open sea then changes it gradually approaching the atoll and island. The current regime in the Indian Ocean is strongly influenced by the monsoon climate. In the region of the Maldives, the currents flow westward during NE monsoon season, and they flow eastward during the SW monsoon season.

The ocean currents flowing through channels between the atolls are driven by the monsoon winds.

At the outer east coast of Atoll, general patterns of the flow are shown as follows;

a) Offshore waves in 1.5 m to 2.5 m
b) Breaking at reef edge then wave height in 0.5 m to 1 m
c) Simultaneously the water level raises modifying kinetic energy to static one
d) On propagating on the flat reef, the wave loses further its energy by bottom friction and the wave height becomes lower to 0.3 m to 0.6 m, this wave height is regulated with the water depth too
e) In case island is on the route, the wave hits the beach, generates coastal current and further travels along the beach of shallow water. And finally return its head to the reef edge then to the ocean.
f) In case of flat reef and no island, the wave is propagating and changing it energy into current then to lagoon.

In and Out Water Level Deference at Fonadhoo Causeway

The water level changes from time to time. It is observed that there is water head difference between the East side water and West side water. Observed head difference is ranging between 25cm to 35 cm. It is observed that the water level outer side is always higher than that of inner side. It is a major reason why water flows always to lagoon side.

Current Pattern by the Sea Bottom Configuration at Site

Current pattern indicating on the sea bottom figures shows the general water flow.

The flow goes to the backside and goes through the passage for the another side.

If no Passage, the water current will be forced to return to reef flat then to the open ocean as discussed above.

It is believed that the sea bottom level makes smooth changes before the construction of the existing causeways. It is found that there is elevation gap by 0.5m between the east side (outer reef) and west side (inner reef).

It is assumed that the west side was affected by siltation and deposited by the fine sand settlement due to the low speed current.

Construction of the causeway automatically cut down the natural sea water passing. The western area was shaped as a catchments area of sand. This indicated necessity of careful design of the causeway taking the possible deeper water by 0.5m to 1.0m at the west side

of the causeway after the openings (Bridge and Box Culverts) are provided.

This indicated possibility of seasonal changes of seabed elevation and configuration.

Estimated Flow Speed through the Bridge Opening

According to the estimation of flow, the maximum flow speed through the bridge opening will be about four meters per second. It is indicating that a careful construction is required when any openings are provided through the causeway.

(3) Waves

General Conditions

Wave condition at Maldives is rather moderate. No serious cyclone is recorded.

The swells and wind waves experienced by the Maldives are conditioned by the prevailing biannual monsoon wind directions, and are typically the strongest during April-July in the SW monsoon season. During this season, swells generated in the north of the equator with heights of 2-3 m and with periods of 18-20 seconds have been reported in the region. However, the Maldives also experiences swells originating from cyclones and storm events occurring well in the south of the equator.

It is reported that the swell waves from SE to SSE occur due to strong storms in the southern hemisphere in the west area of Australia with direction towards the Maldives. The swell waves that reached Male and Hulhule in 1987 had significant wave heights in the level of 3 m (JICA, 1987). Local wave periods are generally in the range of 2-4 seconds and are easily distinguished from the swell waves.

Wave Data at Male Main Island

Wave data at Male Main Island processed by MPA are as follows.

Table A-3 Design Wave Conditions at Male Main Island

No.	Direction	Ho(m)*	T (sec)	Notes
1	NW	1.20	4.6	Applied to West coast shore Protection
2	SW	1.60	6.7	
3	SE	2.60	14.5	

Note 1: Ho is Significant Offshore Wave Height.
Note 2: Design Wave of North coast shore protection is H1/3=0.60 m, T=4.6 sec.

Waves In front of the Causeway; Fishing Port Site at Laamu Atoll

It is observed that all the offshore waves are breaking at the edge to the outer reef. This is common in the similar condition. After this breaking, wave intensity is significantly decreasing then bottom friction at shallow flat reef will further consume the wave energy resulting in lower wave height.

Maandhoo is the closest location to the Project site. Wave adopted in the Maandhoo fisheries port is as follows;

Table A-4 Design Wave Conditions at Maandhoo; Significant Waves

	Study	Offshore Wave Height (m) In Lagoon	Period (sec)	Fetch (km)	Wind (m/s)
1	Structural Stability Study	2.3	5.0	21	23
2	Calmness Study	0.8	3.3		

Wave data at the Maandhoo Fishing Port is applied for the wave conditions of Project site in Laamu Atoll and Thaa Atoll.

3.5 Geotechnical Conditions

(1) Boring Data at the Site

One of the available data is soil investigation data during the causeway design for Maandhoo Industrial Site Development. This indicates the soil conditions as measured by CBR for the on-land road Site only.

(2) Boring Data as Maandhoo Fishing Port

The port is located just 500m to the north-east of the Causeway No. 1. The area is located at the eastern end of the flat reef in 600m. Four boring investigations were carried out. (Ref. Figs. A-2 and 3.) These indicate the present soil condition and characteristics as follows;

- All layers consist of the sandy soil.
- Upper sandy layer is loose to medium density. N value is five to 25.
- If lower layer is dense sandy layer, whose N value is 40 or more. This layer starts -11m to -13m below the datum, LAT.

(3) Soil Boring for the Project

There has been done three Borings at Causeway No.2. Locations of borings are at No.2 box culvert, No.4 box culvert and the center of an 18m-span bridge (Ref. Fig.A-4).

The result of the Borings shall be referred to Drawing No. CW-REF-12 attached in Part-B of Volume-II of the Tender Documents.

(4) Application to the Project

The Engineer assumed that soil data at Maandhoo fishing port shall be applied to Project Site, before the new boring investigation is carried pout at the Site.

Causeway No.1 and new three borings shall be applied to Causeway No.2.

3.6 Datum and Levels

(1) The Engineer and End-User will nominate the authorized bench marks and control stations

near the Site to be used as references for all setting out of the Work.

(2) The Contractor shall prepare two (2) bench marks at least each causeway. Existing bench mark at Maandhoo Fishing Port shall be applied with the approval by the Engineer.

(3) The Contractor shall carry out tidal observation for fifteen (15) days to establish the Mean Sea Level; MSL and confirm and verify the data of the existing Bench Marks at Maandhoo Fishing Port.

3.7 Local Positioning

(1) The Engineer and End-User will nominate the Basic Survey Point and axis of the causeway as follows; Basic survey point at both ends of each causeway, namely Point B at the Southern corner and Point E at the Northern corner

(2) The Contractor shall be responsible for the establishment, maintenance, and protection of suitable permanent and temporary bench marks (survey points) and control points throughout the Contract period.

(3) Maintenance of Site Roads and Existing Access
The Contractor shall be responsible for providing, maintaining and removing, at his own cost, detour and access wherever the Work will interfere with the existing roads, footways or other ways over which there is a public or private right of way. Such diversions shall comply with the requirements of the relevant authority and shall be constructed and maintained with the approval of the Engineer.
Such detour and access shall be equipped with enough capability of allow vehicles, cyclists and walkers to pass safely as indicated below;

1. Six meter wide
2. Crown height is1.7m or higher above Datum, LAT

3.8 Site Conditions

(1) Transportation Infrastructure

Only direct access to the Laamu Atoll by domestic air is possible.

All international cargo is usually handled at the only international port at Male' and then carried to the Fonadhoo Island Port, the closest port to the Project site.

End-User shall assist the Contractor as much as possible to get approval by the local committee (authority) of his priority use of the nearby port facility/facilities (Fonadhoo I. Port and/or Kadhoo port) for the seaborne Mobilization/Demobilization.

(2) Public Utilities, Communication and Water Supply

Fonadhoo Island has a 24 hrs power plant that provides the necessary electric power for the Island's needs. Operating Voltage is 220-240V.

The islands in the Project site have a telephone link connecting to all international destinations.

Since the islands have no central water supply network, water supply for the Project shall be arranged by the Contractor, either by well water or collection of rainwater or by desalination plant and any combination thereof.

(3) Accommodation

Very few accommodations are available for expatriate professional and technical staff near the Project site.

(4) Health and Welfare

Basic healthcare is available on Fonadhoo in the form of a government run facility. The Contractor shall be advised to insure himself of service available at the health facility.

3.9 Official Language

Unless otherwise agreed or provided herein, all correspondences between the parties hereto, including notices, requests, consents, offers or demands shall be made in English. All Specifications, reports and other documents shall also be presented in English

The Contractor's supervisors shall have one interpreter at least who has the ability to communicate with the local workers and islanders in DHIVEHI (Maldivian language).

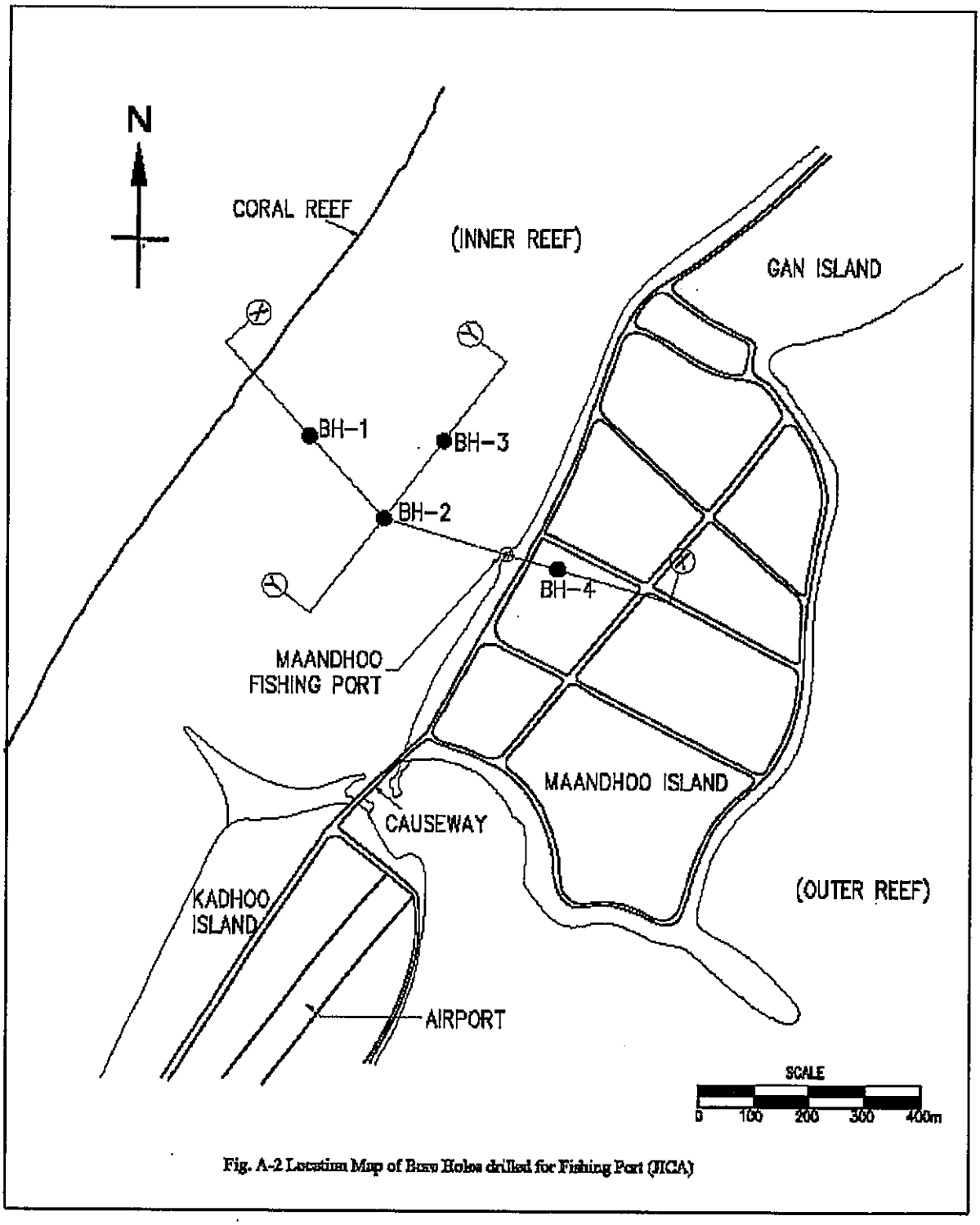


Fig. A-2 Location Map of Bore Holes drilled for Fishing Port (JICA)

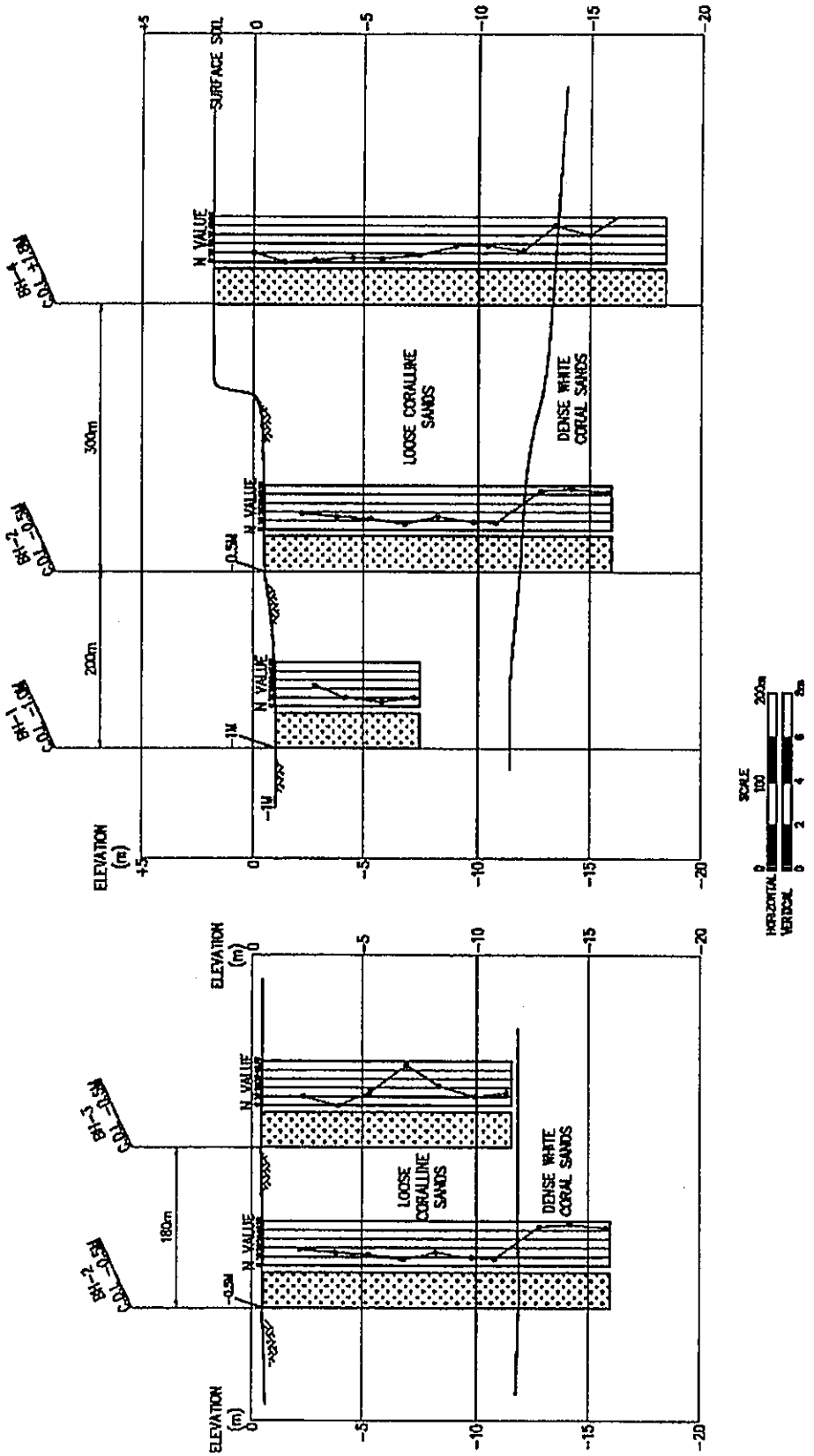


Fig. A-3 Boring Profiles; Kadhoo Fishing Port Site

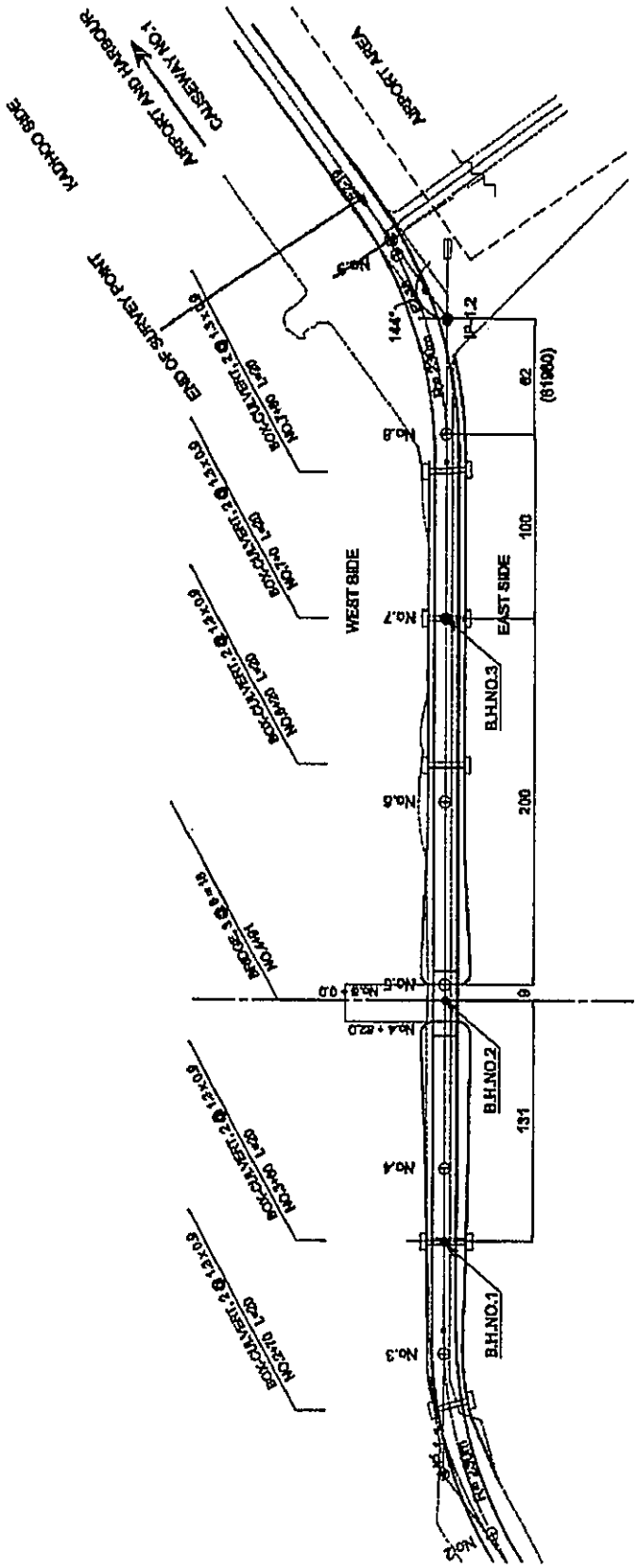


Fig. A-4 Proposed Boring Location along the Proposed Causeway

CLAUSE 4 TEMPORARY WORK

4.1 General

This section sets forth general provisions regarding Temporary Works required under the Contract.

4.2 Temporary Work and Installations

(1) Temporary Work

Before any Temporary Work are commenced, the Contractor shall submit at least fourteen (14) days in advance to the Engineer his proposals for all Temporary Work including shop drawings and calculations.

Notwithstanding the submitted design for any of the Temporary Work, the Contractor shall remain entirely responsible in all aspects for such Works.

(2) Layout of Temporary Installations

Before commencing the Work, the Contractor shall submit a plan for approval of the Engineer and such plan shall show the proposed disposition of all Site offices, stores, mixing Plants, casting and bending yard, spoil heaps, and ancillary buildings, roads, jetties, mooring and other Temporary Works and structures and installations which the Contractor proposes to provide for the execution of the Work.

(3) Maintenance of Site Roads and Existing Access

The Contractor shall be responsible for providing, maintaining and removing, at his own cost, detour and access wherever the Work will interfere with the existing roads over which there is a public or private right of way. Such diversions shall comply with there requirements of the relevant authority and shall be constructed and maintained with the approval of the Engineer.

Such detour and access shall be equipped with enough capability to allow passing vehicles, cyclists and walkers as indicated as below;

1. Six meters wide at least

2. Crown height should be 1.7m above the datum, LAT or higher.

(4) Contractor's Working Area

A working area in 0.5ha will be provided by the End-User for the Contractor's use. The Contractor will have exclusive use of this area during the period of the Contract. Access to the working area by both land and sea will be available at all times, day and night. The Contractor shall be responsible for any improvements to this area which may be required for his use.

(5) Offices, Workshops, and etc. for the Contractor

The Contractor shall provide, erect, construct and equip all offices, Workshop, stores, sheds, buoys, harboring moorings, loading, unloading and launching facilities, and the like, required by him or his principals, employees, or agents. These shall be completed with all machines and equipment, all services, access roads, and the like, required by him or his principals, employees or agents directly or indirectly for the construction or maintenance

of the Work. The Contractor shall comply with all applicable local regulations and recommendations for first-aid practice.

(6) Maintenance of Temporary Working Area

The Contractor shall keep depots, stores and canteen area set up during the Contract period clean and litter free. The Contractor shall be responsible for dealing with all forms of vermin at the Site during the Contract.

(7) Use of Permanent Materials for Temporary Work

Materials for the Permanent Work shall not be used for Temporary Work unless otherwise approved by the Engineer.

(8) Temporary Fencing

Immediately on gaining use of the working area the Contractor shall provide temporary fencing with an unclimbable wire netting or fencing, if requested by the Engineer. Gates and fence shall be adequate to maintain the security of the area. Upon completion of the Work the temporary fencing shall be removed.

(9) Drains, Watercourses, and etc.

All drains, pipes, channels, watercourses or streams being temporarily cut through or disturbed due to the execution of the Contractor's Temporary Work are to be restored so that the water in them may flow continuously as full and free in a manner as it did before the disturbance.

(10) Temporary Jetties, Moorings and Breakwater

The Contractor shall be responsible for the provision and maintenance, during the execution of the Work, of all temporary jetties, moorings and breakwater, if required, necessary for the safe transfer of all personnel and safe operation of all floating plant and craft. All such temporary jetties and mooring shall comply with all relevant laws and regulations.

(11) Contractor's Camp

1) Arrangements:

The Contractor shall make arrangements, if required, for the housing, feeding and welfare of his own employees by providing, servicing, and maintaining a camp on the Site.

2) Maintenance:

The camp shall be run and maintained in an efficient condition in accordance with the standards of the appropriate authority during the period of the Contract.

3) Sanitation

The Contractor is to arrange for an acceptable standard of sanitation to be maintained throughout the camp and the Work. He shall construct and maintain, at his own cost, the system of surface drainage and waste disposal before any work commences. Sanitary conveniences for the use of persons employed in the Workhall be provided and maintained by the Contractor in accordance with the appropriate laws and regulations in force in

Maldives and all persons connected with the Workhall be obliged to use them.

4) Medical Arrangement

The Contractor shall make adequate arrangements for treatment on the Site of casualties and sick persons in first-aid units and shall provide the means whereby injured or sick personnel receive medical attention.

5) Fire Protection

The Contractor shall equip and administer, at his own cost, fire control points in such positions and of such size as will provide an adequate service for the protection against fire of the camp and all buildings, stores and properties on the Site.

4.3 Site Laboratory

(1) Laboratory Office

The Contractor shall provide, erect, staff and maintain the Site Laboratory with testing equipment throughout the Contract period.

The laboratory shall be located at the Site and of a construction and design suitable for the Site conditions. It shall be provided with power and running water, sinks and other facilities required for a laboratory and shall be used exclusively for that purpose.

(2) Equipment and Staff

The Contractor shall provide all testing equipment and tools to carry out the field and laboratory tests on materials and workmanship as specified in the Contract. Staffing of the laboratory shall be with engineer(s) or technical assistants well experienced in materials testing. The laboratory, equipment, samples, tests and records shall be open to inspection by the Engineer at any time and shall be available for the use of the Engineer to perform control tests on materials and workmanship related to the Work.

Equipment and furnishings to be provided are listed in Appendix A-2.and A-3.

4.4 Temporary Electricity Supply, Lighting and Water Supply

The Contractor shall install and maintain, at his own cost, a system of lighting to provide a reasonable degree of illumination over the area of the Work, offices and camp.

The Contractor shall arrange for adequate supply of safe drinking and other water on the Site.

The quality, number, capacity and location of the installations shall be to the satisfaction of the Engineer, and conform to the requirements of the appropriate authorities.

4.5 Telecommunications

The Contractor shall arrange, provide, install and construct, at his own cost, sufficient means of telecommunications to be connected with the national telecommunications system by telephone.

4.6 Surveys and Levels to be Agreed

The Contractor shall survey and take levels of the Site both above and below water level; and obtain the Engineer's agreement on all particulars.

Plans of completed surveys shall be prepared for the Engineer by the Contractor. Plans of

completed pre-working and post-working surveys for the Work are to be produced by the Contractor as directed by the Engineer. Such plans are to be submitted to the Engineer for approval and shall be drawn on an established film base at a scale of 1:500.

The Contractor shall also provide the Engineer a copy of all survey plans and charts produced in connection with the Work and shall make available for inspection all Drawings, data sheets, field books, and etc. as may relate to any surveys carried out.

4.7 Survey Control and Setting Out

The Contractor shall provide at his own cost, all survey control necessary for setting out the Work from the survey points, bench marks, reference lines and dimensions shown on the Drawings or directed by the Engineer and shall be responsible for the correctness of all such setting out.

Included in such setting out shall be the supply, installation, maintenance and removal of all survey and positioning equipment.

4.8 Tide Gauge Board

One tide gauge board clearly marked in meters and subdivided into 50 mm intervals are also to be provided and maintained at the Site throughout the Contract period. It shall be erected as directed by the Engineer and the zero of the tide gauge is to be set at the Datum Level.

4.9 Verification Survey

The Contractor shall execute the verification survey on the Site topography and sounding survey and inform the results of survey to the Engineer within two (2) month after the Date of Contract.

Contractor to Keep Site Clear

During the execution of the Work the Contractor shall keep the Site reasonably free from all unnecessary obstruction and shall store or dispose of any Contractor's Equipment and surplus materials and clear away and remove from the Site any wreckage, rubbish or Temporary Work no longer required.

Clearance of Site on Completion

Upon the issue of any Taking-Over Certificate the Contractor shall clear away and remove from that part of the Site to which such Taking-Over Certificate relates all Contractor's Equipment, surplus materials, rubbish and Temporary Work of every kind, and leave such part of the Site and Work clean and in a workmanlike condition to the satisfaction of the Engineer, except when the Contractor is entitled to retain on Site, until the end of the Warranty Period, such materials, Contractor's Equipment and Temporary Work as are required by him for the purpose of fulfilling his obligations during the Warranty Period.

CLAUSE 5 PROGRAMME OF WORK

5.1 General

Within fourteen (14) days after the Date of Contract, the Contractor shall submit to the Engineer the preliminary detailed construction programme in bar chart form covering the whole of the Work.

The Engineer will, within fourteen (14) days, either approve the proposed construction programme or direct to modify it. Such modifications, and any subsequent modifications thereof, shall be incorporated into the approved construction programme within seven (7) days.

(1) Contractor's General Responsibilities

The Contractor shall execute and complete the Work and remedy any defects therein in accordance with the provisions of the Contract. The Contractor shall provide all superintendence, labor, materials, Plant, Contractor's Equipment and all other things, whether of a temporary or permanent nature, required in and for such execution, completion and remedying of any defects, so far as the necessity for providing the same is specified in or is reasonable to be inferred from the Contract.

(2) Site Operations and Construction Methods

The Contractor shall take full responsibility for the adequacy, stability and safety of all Site operations and construction methods.

(3) Work to be in Accordance with Contract

The Contractor shall execute and complete the Work and remedy any defects therein in strict accordance with the Contract to the satisfaction of the Engineer. The Contractor shall comply with and adhere strictly to the Engineer's instructions on any matter, whether mentioned in the Contract or not, touching or concerning the Work. The Contractor shall take instructions only from the Engineer or, subject to the provisions of Clause 2, from the Engineer's Representative.

5.2 Commencement of Work and Time for Completion

The Contractor shall commence the Work on Site within seven (7) days after the date of Contract, which shall be executed within 14 days after the date of the Letter of Acceptance or Award of the Contract. Thereafter, the Contractor shall proceed with the Work with due expedition and without delay.

5.3 Requirements of Construction Programme

The Contractor shall provide the construction programme of whole of the Work which shall be substantially completed by the specified date in the Contract.

Together with an estimated duration of the activities involved in the Work, the Contractor shall at least list the detailed work items including the followings:

- Mobilization and Demobilization of major equipment/Plants
- Major Temporary Works
- Collection of imported materials
- Collection of local materials including sandy materials for filling
- Excavation, leveling and mound making
- Core materials filling

- Armour rock placing and smoothing
- Fabrication of the Pre-cast concrete
- Installation of the bridge superstructure
- Installation of abutments
- Installation of piers
- Installation of concrete box culvert passages
- Installation of armour rock slope protection
- Coastal protection work
- Pavement work

For each activity with the estimated duration shall be divided into the following categories where applicable.

(a) Materials Order
(b) Delivery Materials to Site
(c) Construction with equipment
(d) Installation and/or Placement
(e) Testing

The Contractor shall consider earthquake, rough sea, high speed water flow, bad weather, holidays, difficult access and any other such factors as contingencies in his estimates of activity duration.

Addition to above, tight materials supply due to Work demands concentration in Maldives for reconstruction of damaged facilities shall be taken into account by the Contractor.

The construction programme shall clearly define the principal activities, the construction sequence, application for the relevant authority (if required), the allocation of resources, use of major equipment and the procurement of major materials.

5.4 Monthly Review of Construction Programme

The Contractor shall submit the Monthly Progress Report as specified in the Contract. If any event takes place which delays the Contractor in his execution of any part of the Work, it is the Contractor's responsibility to revise his construction programme in order to minimize the effect of any such delays.

In the report, the Contractor shall furnish to the Engineer the following information in writing:

(a) The actual starting dates of all activities during the period
(b) The actual dates of completion of all activities during the period
(c) The current status of all Work in progress at the time
(d) The reasons for any discrepancy between the approved construction programme and the actual progress as achieved under (a) to (c) above, together with the Contractor's proposals for ensuring that all keys and critical dates shall be achieved

The Contractor shall notify the Engineer fourteen (14) days prior to making major revisions in the construction programme. Any such revision shall be subject to the Engineer's approval.

The Engineer reserves the right to review the progress of the Work from time to time and the Contractor shall assist on such reviews. The Engineer reserves the right to instruct the Contractor to modify and update the construction programme at any time during the progress of the Contract to ensure the agreed date of completion. After such instruction,

any revisions shall be submitted to the Engineer within seven (7) days and be subject to the Engineer's approval.

5.5 Notice of Operations

The Contractor shall give the Engineer not less than twenty four (24) hours in advance of his intentions to enable the Engineer to make arrangements for the supervision of operations on the Site. He shall also notify the Engineer at least seven (7) days in advance notice of the preparation or manufacture, at a place not within the Site of any article or materials to be used in the Work, whether by himself or by Subcontractors, stating the time and place of preparation or manufacture so that the Engineer may arrange to make whatsoever inspection or tests he may require.

5.6 Returns of Labor and Contractor's Equipment

The Contractor shall, if required by the Engineer, deliver to the Engineer a return in detail, in such form and at such intervals as the Engineer may prescribe, showing the staff and the numbers of the several classes of labour from time to time employed by the Contractor on the Site and such information respecting Contractor's Equipment as the Engineer may require.

5.7 Alterations, Addition and Omissions

(1) Variations

The Engineer shall make any variation of the form, quality or quantity of the Work or any part thereof that may, in his opinion, be necessary and for that purpose, or if for any other reason it shall, in his opinion, be appropriate, he shall have the authority to instruct the Contractor to do and the Contractor shall do any of the following:

(a) increase or decrease the quantity of any work included in the Contract,
(b) omit any such work (but not if the omitted work is to be carried out by the another contractor),
(c) change the character or quality or kind of any such work,
(d) change the levels, lines, position and dimensions of any part of the Work,
(e) execute additional work of any kind necessary for the completion of the Work.

(2) Instructions for Variations

All the variation shall be associated with changes or modification in the Drawings and/or Specifications. The Contractor shall not make any such variation without an instruction of the Engineer.

5.8 Contractor's Equipment, Temporary Work and Materials

(1) Exclusive Use for the Work

All Contractor's Equipment, Temporary Work and materials provided by the Contractor shall, when brought onto the Site, be deemed to be exclusively intended for the execution of the Work and the Contractor shall not remove the same or any part thereof, except the purpose of moving it from one part of the Site to another, without the consent of the Engineer. Provided that consent shall not be required for vehicles engaged in transporting any staff, labor, Contractor's Equipment, Temporary Work, Plant or materials to or from the Site.

(2) Re-export of Contractor's Equipment

In respect of any Contractor's Equipment which the Contractor has temporarily imported for the purposes of the Work, the Contractor shall carry out necessary procedure upon the removal thereof pursuant to the terms of the Contract. When the Contractor so required, the End-User will use his best endeavors to assist the Contractor, where required, in procuring any necessary Government consent to the re-export of such Contractor's Equipment by the Contractor.

(3) Approval of Materials not Implied

The operation of this Clause shall be neither deemed to imply any approval by the Engineer of the materials or other matters referred to therein nor prevent the rejection of any such materials at any time by the Engineer.

5.9 Measurement of Quantities

Though the Contract base is Lump Sum System, the quantities set out in the Schedule I, Breakdown of Tender Price are for reference to evaluate the progress of the Work, and they are not to be taken as the actual and correct quantities of the Work to be executed by the Contractor in the fulfillment of his obligations under the Contract.

CLAUSE 6 SITE WORK

6.1 General

This section sets forth general provisions regarding the Site Works required under this Contract.

6.2 Mobilization and Demobilization

This Work hall consist of Mobilization and Demobilization of whole Temporary Works and construction equipment. Mobilization schedule and major contents shall be reported to the Engineer within seven (7) days after the receipt of Date of Contract. The Site shall be restored to equal or better than the conditions prior to the use by the Contractor, when Demobilization takes place.

Demobilization shall include the following:

(1) The dismantling, preparation and loading for removal and shipment of all Contractor's installations and equipment at the Site.

(2) The transportation of all above equipment and materials from the Site to the home station or somewhere else outside the Site

(3) Dismantling and removing of all temporary building structures

(4) The clean-up of the Site and working area in a satisfactory manner

6.3 Protection of Existing Features

The Contractor shall take all necessary measures to protect from accidental damage all existing notice boards, fences and lighting which are to remain during the Contract period subject to the instruction of removal or demolishing them by the End-Users.

6.4 Interference with Existing Work at Site

The Contractor shall not interfere in any way with any utilization of the existing causeway whether by the Employer or a third party, except where such interference is specifically described as part of the Work either in the Contract or in the Engineer's instruction.

The Contractor shall provide detour access, if the existing causeway is not for use of public transport by the construction activities. The Contractor shall submit his plan of detour access with temporary dike stability calculation sheets including the armour rock protection.

Special attention will be paid to prevent Project activities from interfering with fishing boat and dhonis operations, and other boat preparation work at the Fonadhoo Island harbour.

The Contractor shall ensure that the stability of existing causeway is in no way impaired as a result of his operations during the construction period and shall take all necessary precautions by means of such methods as may be approved to assure the stability of causeway which are affected by his operations until the Permanent Works are completed.

The Contractor shall submit his detailed proposals and causeway stability calculation sheets, in duplicate, to the Engineer for approval fourteen (14) days prior to carrying out any work which may affect the stability of the causeway.

The Contractor shall plan to prevent the Work from the flooding through openings before the completion of a bridged and concrete box culvert with slope and seabed strengthening against the high speed flow.

6.5 No Interference to the Aviation

The Contractor shall not interfere with the approaching course air limits of Kadhoo Airport. The Contractor shall get approval on his construction methods by Aviation Authority.

6.6 Transport of Labour, Plant and Materials

The Contractor shall submit to the Engineer and other appropriate authority for their approval his proposals for the transport of labour, Plant and materials to and from the Site including details of the vehicles to be used and their routing and timing to the Place.

The Contractor shall comply in all respects with any local regulations governing the guarding and lighting for road Work and the control of traffic.

6.7 Entry on Private or Other Property

The Contractor shall not enter upon or commence any work in or upon, across or through any land, building or place being private property until authorized in writing by the Engineer so to do.

6.8 Damage to Persons and Property

The Contractor shall indemnify the Employer against all losses and claims in respect of:

(1) death of or injury to any person, or

(2) loss of or damage to any property (other than the Work), which may arise out of or in consequence of the execution and completion of the Work and the remedying of any defects therein, and against all claims, proceedings, damages, costs, charges and expenses whatsoever in respect thereof or in relation thereto.

6.9 Abatement of Nuisance

The Contractor shall be responsible for adopting such measures as required by any local regulations and/or as required by the Engineer to minimize nuisance from vibration, dust, noise or other causes.

6.10 Interference with Traffic and Adjoining Properties

All operations necessary for the execution and completion of the Work and the remedying of any defects therein shall, so far as compliance with the requirements of the Contract permits, be carried on so as not to interfere unnecessarily or improperly with:

(1) the convenience of the public, or

(2) the access to, use and occupation of public or private roads and footpaths to or of properties whether in the possession of the End-User or of any other person

The Contractor shall save harmless and indemnify the Employer in respect of all claims, proceedings, damaged, costs, charges and expenses whatsoever arising out of, or in relation to any such matters insofar as the Contractor is responsible therefore.

6.11 Debris in Watercourses and Roads

The Contractor shall not discharge into watercourses or into the sea any oil, solid, noxious or floating materials, and all water discharged shall be reasonably free from impurities. The Contractor shall remove from the water, at his own expense, any debris therein arising out of the execution of the Work.

The Contractor shall be responsible for ensuring that no earth, debris, or mud is deposited on public or private rights of way during the execution of the Work, including any deposits arising from the transportation of Plants and vehicles. The Contractor shall provide sufficient labour, Plant, equipment, and etc. as is necessary and as required by the Engineer to ensure that deposits are kept to the absolute minimum and are cleaned and removed immediately.

6.12 Opportunities for Other Contractors

The Contractor shall, in accordance with the requirements of the Engineer, afford all reasonable opportunities for carrying out their work to:

(1) any other contractors employed by the Employer or End-User and their workmen,

(2) the workmen employed by the Engineer, and

(3) the workmen of any duly constituted authorities who may be employed in the execution on or near the Site of any work not included in the Contract.

6.13 Facilities for Other Contractors

On the written request of the Engineer, the Contractor shall:

(1) make available to any such other contractor, or any such authority, any roads or ways for the maintenance for which the Contractor is responsible, or

(2) permit the use, by any such, of Temporary Work or Contractor's Equipment on the Site, or

(3) provide any other service of whatsoever nature for any such.

And the Engineer shall determine an addition to the Contract Price in accordance with Clause 8 and shall notify the Contractor accordingly with a copy.

CLAUSE 7 MATERIALS AND WORKMANSHIP

7.1 General

This Section sets forth supplementary and additional provisions relating to materials, products, standards and workmanship required under this Contract.

7.2 Materials

(1) Unless otherwise specified or approved by the Engineer, all materials to be used for the Work shall be brand new (never used ones) of the best quality of their respective kinds as specified in the Specifications and Drawings and shall comply wherever possible with the appropriate current Standard Institute. All proprietary materials, Plant, or equipment to be employed for the Work shall be used, fixed or applied strictly in accordance with the manufacturers' instructions.

(2) In all cases where the name of a particular type or maker of equipment or materials is referred to in the Contract, this indicates the acceptable standard.

The Contractor may offer equipment or materials other than those specified and, in such cases, the offer shall be of at least equal quality. When alternatives are offered, the Contractor shall submit to the Engineer, for approval, a statement detailing the alternatives. The statement shall include full technical descriptions, Drawings and Specifications. The Contractor shall provide such further information as required to demonstrate to the Engineer that the alternatives are equivalent to the items specified.

7.3 Standards or Codes of Practice

(1) Any Standard or Code of Practice referred to in the Contract, or any other standard or code of practice that may be substituted therewith, shall be held to be the latest edition. All relevant particulars and conditions in any standard or code of practice referred to in the Contract related to materials, quality and workmanship shall be complied with and all tests specified shall be conformed to.

(2) Where any standard or code of practice is referred to in the Contract, other appropriate national or international equivalent may be substituted with the approval of the Engineer. Where other appropriate national or international equivalents are offered, the Contractor shall submit to the Engineer, for approval, a copy of the alternative standard or code of practice in English and shall provide such further information as required to enable the Engineer to demonstrate to the Employer that the alternative national or international equivalent may be substituted.

(3) Unless otherwise specified, the Japanese Industrial Standards or equivalents shall be utilized when and where applicable.

7.4 Acronyms Used

The following acronyms are used in these Specifications:

ASTM	American Society for Testing and Materials
AASHTO	American Association of State Highway and Transportation Officials
AWS	American Welding Society

ACI	American Concrete Institute
ASME	American Society of Mechanical Consultant
AISC	American Institute of Steel Construction
BS	British Standard
DIN	Deutsche Industries Norm (German Industry Standard)
ISO	International Organization for Standardization
JIS	Japanese Industrial Standard
SIS	Singapore Standard

7.5 Workmanship

(1) The workmanship employed in all Work shall be of first-class grade in terms of internationally recognized standards of practice and the Work shall be subject to the approval of the Engineer.

(2) The Contractor shall make available highly experienced and reliable foremen for materials borrowing work, earth filling work, armour rock placing work, concrete work, sheet pile driving work, pipe pile driving work, metal work, and equipment operators specially trained to handle such equipment.

7.6 Errors and Omission

The Contractor shall promptly inform the Engineer of any error, omission, fault, and other defect in the Drawings or Specifications for the Work which are discovered when reviewing the Contract Documents or in the process of execution of the Work. The Engineer shall prepare Drawings and Specifications to fill such as omission, not to give away delay in the construction schedule.

7.7 Local Materials and Services

The Contractor shall make the maximum use of locally available materials, equipment, Plant and services subject to compliance with the requirements of the Specifications.

7.8 Employment of Local Personnel

The Contractor is encouraged, to the extent practicable and reasonable, to employ staff and labour from sources within the Maldivians.

7.9 Reporting of Accidents

The Contractor shall report to the Employer details of any accident as soon as possible after its occurrence. In the case of any fatality or serious accidents, the Contractor shall notify the Engineer immediately by the quickest available means.

7.10 Health and Safety

Due precautions shall be taken by the Contractor, at his own cost, to ensure the safety of his staff and labour and, in collaboration with and to the requirements of the local health authorities, to ensure that medical staff, first aid equipment and stores, sick bay and suitable ambulance service are available at the camp, housing and on the Site at all times throughout the period of the Contract and that suitable arrangements are made for the prevention of epidemics and for all necessary welfare and hygiene requirements.

CLAUSE 8 TESTS AND INSPECTIONS

8.1 General

This section sets forth general provisions regarding test and inspections required under the Contract.

8.2 Inspection and Testing

(1) Inspection and Testing

The Engineer shall be entitled at all reasonable times access to the Contractor's premises or elsewhere and they shall be afforded every facility for making inspections and taking samples for testing and analysis. The Contractor shall provide free of charge, and to the satisfaction of the Engineer, all appliances required for convenient testing of the materials at the Contractor's premises and he shall supply samples and arrange the carriage thereof, to enable tests and analysis, if made, at the Site Laboratory or other laboratory approved by the Engineer. Such inspection, testing and analysis, if made, shall not release the Contractor from any obligation under the Contract.

Laboratory equipment shall cover, but not limited to, the following tests:

- Test of Concrete
  Slump Test/Air Content Test
  Compression Strength
- Aggregates and Rock Materials Test
- Compaction of Filling Materials

In addition to any special provision made herein as to sampling and testing materials by particular methods, samples of materials and workmanship proposed to be employed in the execution of the Work may be called for at any time by the Engineer and these shall be furnished without delay by the Contractor at his own cost.

(2) Test Pieces

The Contractor shall provide and prepare, at his own expense, such test pieces of the various materials, as the Engineer may from time to time require and so direct or as specified.

The entire testing shall be carried out in the presence of the Engineer and shall be performed in such a manner and by such process, at such premises and at such times as the Engineer may consider desirable.

(3) Provision of Survey Equipment and Assistance

The Contractor shall during the execution of the Work make available to the Engineer such equipment that may require for the supervision of the Work.

- 1 Theodolite
- 1 Level instrument
- 1 Leveling staff
- 1 Optical square
- 1 Tape 50m long

The Contractor shall further provide such chainmen, staff-men and other assistants as

required by the Engineer.

8.3 Manufacture's Certificate

Where specified, the Contractor shall obtain from the suppliers, manufacturers or fabricators certificates of tests, proof sheets, mill sheets, and etc., as applicable, showing that the materials has been tested in accordance with the requirements of the Specifications.

8.4 Ordering Materials

Should the Contractor desire to order any materials before the receipt of the relevant shop drawings, he shall obtain the written approval of the Engineer before placing such orders.

8.5 Assistance to the Engineer

(1) Cost of Assistance

The Contractor shall render such assistance with facilities, labour, constructional Plant, materials and other supporting staff as at any time may be required by the Engineer. Such assistance shall be the Contractor's own cost. The assistance to the Engineer includes, but not by way of, and limits the items specified in these Specifications.

(2) Labour

The experienced foremen are to be provided when necessary to the Engineer. The Contractor shall also provide, when required, tradesmen, labour, tools and equipment to assist the Engineer.

(3) Survey Equipment

The Contractor shall keep and maintain, surveying equipment at Site for use of the Engineer.

(4) Protective Items

The Contractor shall provide for the use of the End-User and the Engineer adequate protective items such as first-aid equipment, life-jackets, hard hats and other safety equipment as required by the Engineer in connection with the Contract.

8.6 Cost of Tests

The cost of making any test shall be borne by the Contractor, if such test is:

(1) clearly intended by or provided for in the Contract, or

(2) particularized in the Contract (in cases only of a test under load or of a test to ascertain whether the design of any finished or partially finished work is appropriate for the purposes which it was intended to fulfill) in sufficient detail to enable the Contractor to price or allow for the same in his Tender.

8.7 Inspection of Operations

The Engineer shall at all reasonable times have access to the Site and to all Workhops and places where materials or Plant are being manufactured, fabricated or prepared for the Work and the Contractor shall afford every facility and every assistance in obtaining the

right to such access.

8.8 Inspections and Testing

The Engineer shall be entitled, during manufacture, fabrication or preparation to inspect and test the materials and Plant to be supplied under the Contract. If materials or Plant are being manufactured, fabricated or prepared in Workhops or places other than those of the Contractor, the Contractor shall obtain permission for the Engineer to carry out such inspection and testing in those Workhops or places. Such inspection or testing shall not release the Contractor from any obligation under the Contract.

8.9 Dates for Inspection and Testing

The Contractor shall agree with the Engineer on the time and place for the inspection or testing of any materials or Plant as provided in the Contract. The Engineer shall give the Contractor not less than 24 hours notice of his intention to carry out the inspection or to attend the tests. If the Engineer, or his duly authorized representative, does not attend on the date agreed, the Contractor may, unless otherwise instructed by the Engineer, proceed with the tests, which shall be deemed to have been made in the presence of the Engineer. The Contractor shall forthwith forward to the Engineer duly certified copies of the test readings. If the Engineer has not attended the tests, he shall accept the said readings as accurate.

8.10 Rejection

If, at the time and place agreed in accordance with Sub-Clause 8.9, the materials or Plant are not ready for inspection or testing or if, as a result of the inspection or testing referred to in this Clause, the Engineer determines that the materials or Plant are defective or otherwise not in accordance with the Contract, he may reject the materials or Plant and shall notify the Contractor thereof immediately. The notice shall state the Engineer's objections with reasons. The Contractor shall then promptly make good the defect or ensure that rejected materials or Plant comply with the Contract. If the Engineer so requests, the test of rejected materials or Plant shall be made or repeated under the same terms and conditions and the cost of such test shall be borne by the Contractor.

8.11 Independent Inspection

The Engineer may delegate inspection and testing of materials or Plant to an independent inspector. Any such delegation shall be acceptable in accordance with Clause 1 B(5) and for this purpose such independent inspector shall be considered as an assistant of the Engineer. Notice of such appointment (not being less than 3 days) shall be given by the Engineer to the Contractor.

8.12 Examination of Work before Covering up

No part of the Work shall be covered up or put out of view without the approval of the Engineer and the Contractor shall afford full opportunity for the Engineer to examine and measure any such part of the Work which is about to be covered up or put out of view and to examine foundations before any part of the Work is placed thereon. The Contractor shall give notice to the Engineer whenever any such part of the Work or foundations is or are ready or about to be ready for examination and the Engineer shall, without unreasonable delay, unless he considers it unnecessary and advises the Contractor accordingly, attend for the purpose of examining and measuring such part of the Work or of examining such foundations.

8.13 Removal of Improper Work, Materials or Plan

The Engineer shall have authority to issue instructions from time to time, for:

(1) the removal from the Site, within such time or times as may be specified in the instruction, of any materials or Plant which, in the opinion of the Engineer, are not in accordance with the Contract,

(2) the substitution of proper and suitable materials or Plant, and

(3) the proper re-execution, notwithstanding any previous test thereof or interim payment therefore, of any work in respect of

i) materials, Plant or workmanship, or

ii) design by the Contractor for which he is responsible, is not, in the opinion of the Engineer, in accordance with the Contract.

CLAUSE 9 SUBMITTALS

9.1 General

This section sets forth general provisions regarding submittals required to the Contractor.

9.2 Regular Site Meeting

Throughout the duration of the Contract, the Contractor shall attend the Regular Site Meetings with the Engineer. The frequency of these Site Meetings shall be determined by the Engineer.

9.3 Reporting and Progress

The Contractor shall report all required information using forms approved by the Engineer, to the designated Engineer supervising the Work for review and approval that the Work are complete, and quality is acceptable.

The Contractor shall prepare the Daily Site Diary for equipment, machinery and manpower and others. Materials use shall also be reported.

The Engineer shall review and approve by signing all report forms, copies of which will be attached to the subsequent invoices.

The Contractor shall prepare weekly summary reports containing, but not limited to, a summary of the previous week's activities.

9.4 Documents Supplied by Contractor

The Contractor shall prepare and submit, to the Engineer for approval, the following documents in a manner specified herein, unless otherwise required under various sections of the Specifications or unless otherwise requested by the Engineer.

(1) Daily Site Diary

A daily Site diary shall be kept by the Contractor in detail:

- Date;
- weather conditions;
- equipment on Site;
- imported materials arrival;
- labour on Site;
- section being worked;
- communication to the Island Office;
- any difficulties, incidents, delays that may have occurred;
- any improvements against the request by the Engineer;
- signature of responsible person filling out the Daily Site Diary.

This diary shall be available to the Engineer at all times and shall be signed off by the Engineer after inspection.

(2) Monthly Progress Report Accompanied by Photographs

The Contractor shall submit to the Engineer seven (7) copies of monthly progress report accompanied by color photographs showing progress to date and progress during the previous period on all important items of each section or portion of the Work as may be

directed by the Engineer.

Special photographs showing particular features of the Work shall also be taken from time to time as required by the Engineer. A complete set of photographs of the finished Works shall be taken as directed by the Engineer.

The Contactor shall, within seven (7) days of beginning subsequent month, submit to the Engineer in an approved format a progress statement, showing in amount summarizing from the Breakdown of Tender Price:

- The estimated values of the Permanent Work executed up the end of that month;
- Any other sums to which the Contractor may consider himself to be entailed under this Contract.

(3) Shop Drawings

Unless otherwise specified elsewhere in the Specifications, the Contractor shall submit three (3) copies of shop drawings of any part of the Work to the Engineer for his approval at least in advance of fourteen (14) days prior to the commencement of the work to be detailed by said shop drawings.

Within seven (7) days after submission to the Engineer, the Engineer may, if necessary in his opinion, instruct the Contractor to modify or revise the proposed shop drawings. In case that the Contractor is instructed to revise or modify, he shall resubmit revised or modified shop drawings for the Engineer's approval within seven (7) days after such instruction is made.

The Contractor shall not commence the work whose shop drawings still require the approval by the Engineer.

The approval of the shop drawings by the Engineer shall, in no case, relieve the Contractor's responsibility to complete the Work in compliance with the Contract.

9.5 Drawings to be Kept on Site

One copy of the Drawings, purchased from the Engineer and shop drawings supplied by the Contractor as aforesaid, shall be kept by the Contractor on the Site and the same shall at all reasonable times be available for inspection and use by the Engineer and by any other person authorized by the Engineer in writing.

9.6 Supplementary Drawings and Instructions

The Engineer shall have authority to issue to the Contractor, from time to time, such supplementary Drawings and instructions as shall be necessary for the purpose of the proper and adequate execution and completion of the Work and the remedying of any defects therein. The Contractor shall carry out and be bounded by the same.

9.7 Contractor's Records

The Contractor shall at all times keep complete and accurate records related to the Work in accordance with sound engineering practices and to the satisfaction of the Engineer. All records related to the Work shall be made available to the Engineer and the Engineer's Representative at all times.

9.8 As-Built Drawings

Within thirty (30) days of the date of the Certificate of Completion of the Work, the Contractor shall submit to the Engineer for his approval, As-Built Drawings showing, describing, or specifying layouts, alignments, dimensions, finishing materials, products, fixing and other items which have been incorporated in the Work.

The Engineer may, if necessary in his opinion, within thirty (30) days after the submission of the As-Built Drawings instruct the Contractor to revise, modify, correct or add to the As-Built Drawings. In this case the Contractor shall within thirty (30) days after receipt of such instruction by the Engineer, submit the modified, corrected or added As-Built Drawings to the Engineer.

CLAUSE 10 ENVIRONMENTAL REQUIREMENTS

10.1 Introduction

During the construction and operation of the causeway, certain activities may cause impacts on the natural and social environment, especially without appropriate mitigation measures. The potential impacts are as follows.

Construction Phase:

(1) Disturbance or partial loss of the adjacent seagrass bed and corals through increase in suspended solids by activities such as dredging, excavation and backfilling.

(2) Disturbance to the local vehicle and motorbike traffic through the presence of construction related heavy vehicles, machinery, and etc.

(3) Generation of various construction wastes.

Operation Phase:

(1) Deterioration of seawater and sediment quality through restriction of water exchange.

(2) Possible alteration of adjacent seafloor and shoreline topography through the enhanced water exchange capability of the causeway.

10.2 Environmental Mitigation Measures

In order to minimize the above mentioned impacts on the natural and social environment, the Contractor shall employ appropriate mitigation measures. The Contractor shall submit the Environmental Mitigation Plan for the approval of the Engineer. Following are lists of mitigation measures that shall be followed by the Contractor.

(1) The seagrass and corals adjacent to the Project site shall be protected from excess sedimentation and turbidity through installation of silt protection curtain, during Works such as excavation, dredging, backfilling or any other Works that may disperse a certain amount of sediments.

(2) The End-User shall prepare a map on locations of possible sand borrow pits with its approximate area and shall obtain permission from the Ministry of Environment, Energy and Water. The sand borrow pits shall be chosen at a location where there are no significant seagrass and coral growth.

(3) Whenever possible, scheduling of dredging, excavation, backfilling or any other Works that may disperse a certain amount of sediments should be reported to the Engineer.

(4) Access of the causeway shall be maintained during the entire course of the construction, such as detour and other methods.

(5) Safety of the causeway users shall be secured during the entire course of the construction, through maintenance of the 6m-wide road for traffic movement.

(6) The Implementation Schedule shall be notified to the local public prior to the commencement of each work.

(7) Any waste generated during construction shall not enter directly to the sea.

(8) All wastes generated during construction must be disposed in a manner acceptable to the End-Users.

10.3 Environmental Monitoring by the Contractor

The Contractor shall conduct environmental monitoring, so to ensure that the construction activities will not cause adverse impacts on the environment and that the mitigation measures are effective in reducing the impacts. Monitoring will also be required in the post-construction phase to assess the effectiveness of such artificial passages as the box culverts and a18m-span bridge in improving the adjacent environment. Reference is made to the Technical Specifications Part B for detailed methodology of environmental monitoring.

CLAUSE 11 ENGINEER AND ENGINEER'S REPRESENTATIVE

11.1 Engineer's Rights and Authority

The Engineer on behalf of the Employer shall carry out his duties specified in the Contract.

(1) The Engineer may exercise the authority specified in or necessarily to be implied from the Contract, provided that the Engineer obtains the specific approval of the Employer for the execution of the Engineer's duties under this Contract. Notwithstanding the obligation to obtain the approval, if, in the opinion of the Engineer, an emergency occurs affecting the safety of life, the Work or adjoining property, he may, without relieving the Contractor of any of his duties and responsibilities under the Contract, instruct the Contractor to execute all such Work or to do such things, as may, in the opinion of the Engineer, be necessary to abate or reduce the risk. The Contractor shall forthwith comply, despite the absence of approval of the Employer, with any such instructions of the Engineer.

(2) Except as expressly stated in the Contract, the Engineer shall have no authority to relieve the Contractor of any of his obligations under the Contract.

11.2 Engineer's Representative

The Engineer's Representative shall be appointed by and be responsible to the Engineer and shall carry out such duties and exercise such authority as may be delegated to him by the Engineer.

11.3 Engineer's Authority to Delegate

The Engineer may from time to time delegate to the Engineer's Representative any of the duties and authorities vested in the Engineer and he may at any time revoke such delegation. Any such delegation or revocation shall be in writing and shall not take effect until a copy thereof has been delivered to the Employer and the Contractor.

Any communication given by the Engineer's Representative to the Contractor in accordance with such delegation shall have the same effect as though it had been given by the Engineer.

Provided that:

Any failure of the Engineer's Representative to disapprove any work, materials or Plant shall not prejudice the authority of the Engineer to disapprove such work, materials or Plant and to give instructions for the rectification thereof.

11.4 Appointment of Assistants

The Engineer or the Engineer's representative may appoint several number of persons to assist the Engineer' Representative in carrying out of his duties under Sub-Clause 2.2. He shall notify to the Contractor the names, duties and scope of authority of such persons. Such assistants shall have no authority to issue any instructions to the Contractor save insofar such instructions may be necessary to enable them to carry out their duties and to secure their acceptance to materials, Plant or workmanship as being in accordance with the Contract, and any instructions given by any of them for those purposes shall be deemed to have been given by the Engineer's Representative.

11.5 Instruction in Writing

Instructions given by the Engineer shall be in writing, provided that for any reason the

Engineer considers it necessary to give any such instruction orally, the Contractor shall comply with such instruction. Confirmation in writing of such oral instruction given by the Engineer, whether before or after carrying out the instruction, shall be deemed to be an instruction within the meaning of this Sub-Clause. Provided further that the Contractor, within three (3) days after such instruction, confirms in writing to the Engineer any oral instruction of the Engineer and such confirmation is not contradicted in writing within three (3) days after such confirmation by the Engineer, it shall be deemed to be an instruction of the Engineer.

PART-B TECHNICAL SPECIFICATIONS

PART-B TECHNICAL SPECIFICATIONS

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CLAUSE 1. MOBILIZATION AND DEMOBILIZATION

1.1 Mobilization of Equipment, Labour, Materials, and etc.

The provision of this section shall apply to transportation of imported Plants, equipment and materials necessary to complete the Work. The Contractor shall quote for transportation of Plants, equipment and materials from the place of their origin to the Site including any other incidental expenses in connection with the shipping, and cost for their returning after completion of the Work. It shall also include transportation of the Contractor's staff and construction of the Contractor's offices, workshops, stores, and etc.

The Contractor shall be responsible for locating and obtaining suitable land for camp yard. All of his field offices/buildings shall be properly maintained in good condition during the construction period.

1.2 Demobilization and Site Clean-up

The Work shall consist of Demobilization of the whole Temporary Works and landscaping of the Site and camp yard to the satisfaction of the Engineer. The Site shall be restored to equal or better than the condition prior to the use by the Contractor.

CLAUSE 2. TEMPORARY DIKE AND ACCESS

2.1 Description

It is estimated that the maximum current flow through the passage, in 15 m wide, will generate a four meter per second. This is due to the water head difference between the East and West of the causeway. East side is the ocean front and western areas are lagoon side. A 0.3meter water level difference was observed at the Project site in the middle of May, 2005.

2.2 Temporary Dike

It is recommended not to allow any unprotected water passage through the causeway before the completion of well protected box culverts and a bridge. For example, temporary dike (or cofferdam) shall be provided on either side, East or West, before the completion of box culverts and a bridge. This dike shall be equipped with the following conditions.

1) Crown width for keeping enough strength
2) Slope with temporary protection

The top of this dike could be widened for the traffic use of construction purpose.

2.3 Temporary Access

Temporary Work shall include provision for temporary access to the users throughout construction period. Such access shall be six meter wide with crown height of 1.7m or higher above the datum, LAT. Part of the Permanent Work could be used for the purpose subject to the Engineer's approval.

CLAUSE 3. GENERAL REQUIREMENTS FOR BASIC MATERIALS/WORKS

3.1 Rock Materials

3.1.1 General

All rock materials specified as rock Classes I, II and III shall be quarried rock of granite, basalt and equal igneous rock. The materials shall have an apparent specific gravity of not less than 26 kN/m³ with 90% of the rocks having a density of at least 25 kN/m³ when saturated and surface dry.

The average water absorption of quarry rock must be less than 2% and the water absorption of nine out of ten of the individual rocks shall be less than 2.5%.

The loss of magnesium sulfate soundness test shall be less than 12% for all rocks.

Quarried rock shall not contain visually observable or chemically detectable impurities or foreign matters in such quantities that these will damage the environment by the construction use of the quarried rocks.

The rock materials Classes I, II, and III shall be sound, compact, hard, durable, and resistant to action of seawater and free cracks and fissures detrimental for the proper performance of the materials.

3.1.2 Sources of Rock Materials

The Contractor shall select the sources of rocks and shall be responsible for quarrying, supply and transport to the Site of suitable rocks in sufficient quantities.

The suitability of the sources of rocks selected by the Contractor shall be subject to the approval of the Engineer. Approval of the quarries is only supplementary to other requirements of the rocks.

The Contractor shall submit for the approval of the Engineer an experienced geologist's determination of the type of rocks based on visual inspection of 10 representative samples.

3.1.3 Classification of Rock Materials

Rock materials for causeway slope revetment, abutment protection, passage bed riprap shall consist of the following rock classification specifying the minimum mean weight (or size) and the lower and the upper limit:

Rock Classification:

I:	Weight range: 400 kg to 700 kg Mean weight: Min. 500 kg
II:	Weight range: 200 kg to 400 kg Mean weight: Min. 300kg
III:	Weight range: 25kg to 40 kg Mean weight: Min. 30 kg
VI:	Coral rock

Rock Classes I, II and III shall not be coral rock. Rock materials shall be well graded between the specified limit and comply with the following filter criteria:

d85 equals to D15 or larger

Where d: the finer materials

D: the coarser materials

For rocks to be used for Classes I, II and III, the following additional requirements shall be applied:

(1) The rocks shall be rough and angular in shape.

(2) The maximum rock dimension (length) shall not exceed 2.5 times the minimum dimension (thickness) of the rock.

3.1.4 Testing of Materials

Inspection and testing of rock materials shall be carried out as an integral part of the Contractor's quality control programme to ensure the quality of all parts of the Work.

The requirements in the following subsections shall be understood as the minimum requirements. Extended testing of properties shall always be made when opening new quarry fronts and in connection with any significant change in the materials properties from the existing quarry front.

3.1.5 Basic Properties

From each quarry front, the following properties shall be tested and fully documented.

This shall be done prior to commencement of any production, in connection with any significant change of materials in the opinion of the Engineer and every 5,000 m^3 of delivery (all classification) from the quarry front.

(a) Density
(b) Water absorption
(c) Resistance to weathering
(d) Resistance to impact
(e) Resistance to abrasion

The test shall be carried out in accordance with the test Specifications accepted by the Engineer.

3.1.6 Testing of Rock Weights and Rock Gradations

The Contractor shall carry out test weighing of rocks and the determination of the gradations of rocks at any time during working hours by the direction of the Engineer as indicated below:

(1) Stone Classes I, II and III:

Test weighing of armour rocks will be carried out at random. The Contractor shall include in his unit prices one control weighing every 100 m^3 of armour rocks. Those rocks which do not meet the weight requirements shall not be counted.

(2) Stone Class VI:

A test of the weight distribution of stone classes IV will be carried out on a representative sample of not less than 1.5 m^3 which is spread out on a clean, hard surface (e.g. a floor of wooden boards or a concrete floor) provided by the Contractor. The Engineer will select 10 larger and 20 smaller stones, which are then weighed/ measured individually. The remaining stones are then weighed and counted and the mean weight will be determined.

If, during the progress of the Work, it is found that the rocks furnished by the Contractor do not fully meet the requirements of these Specifications, the Contractor shall be required to furnish other rocks of a quality acceptable to the Engineer. The Contractor shall dispose of all rejected rocks in a manner and at a location approved by the Engineer.

3.2 CONCRETE WORK

3.2.1 Description

This Work will be applied for all concrete work including footing, coping concrete bridge beam/slab, abutment/pier, and etc.

The Contractor shall:

(1) furnish all materials and manufacture, transport, place, finish, protect, cure and test the concrete

(2) construct, erect and dismantle forms

(3) furnish, shape and place steel reinforcement

3.2.2 Materials

(1) Cement

The cement used for all reinforced concrete work shall be:

- Normal Portland cements complying with JIS R5210 or equivalent cement suitable for the marine environment and subject to the Engineer's approval.
- High early strength cement shall not be used unless specifically approved by the Engineer in each and every case.
- All cement shall be supplied with proper certificates by the manufacturer and be complying with requirements of the relevant standards.
- At least 6 weeks before placing an order for purchase, the Contractor shall satisfy the Engineer that his source or sources of supply is able to deliver cement complying with the relevant standard and with proper certificates.
- Having obtained the Engineer's approval of the source of supply, transport storage and certificate of the cement, the Contractor shall not modify or change the agreed arrangements with the Engineer.
- The cement shall be delivered to the Site of the Work in sound and properly sealed bags and while being loaded and during transit to the concrete mixers, whether conveyed in vehicles or by mechanical means, shall be protected from the weather by effective coverings.

- The cement shall be stored in approved weatherproof and well ventilated sheds with a raised floor made of timber or concrete.
- All cement shall be used within six months from the date of manufacture.
- No cement shall be used in the Work until it has been passed as satisfactory for the Engineer, and all unsatisfactory cement shall be promptly removed from the Site at the Contractor's expense.

(2) Aggregates

Coarse aggregates for reinforced concrete shall be of granite, basalt or equal igneous rocks not including the marble, lime, coral, pumice and mica stone.

All materials used as aggregates shall be obtained from approved sources producing aggregates suitable for concrete in the respective class and shall be hard, tough, durable, and homogenous in quality, clean, free from adhering coatings, be chemically inert and of limited porosity with a density not less than 2,600 kg/ m^3 (2,400 kg/ m^3 for un-reinforced concrete)

Fine aggregates for concrete shall be clean sand.

Crushed sand may be added to natural sand in order to achieve the required grading. Crushed sand alone may only be used with the approval by the Engineer:

Aggregates shall be cleaned by washing if the content of clay is out of the limit.

Aggregates shall be free from organic impurities - measured and interpreted according to ASTM C 40-73, or other substances which may cause corrosion of steel or otherwise impair the strength or durability of the concrete.

Marine aggregates or other aggregates containing salt shall not be used in the concrete.

The total sulfate content shall not exceed 4.0% by weight of cement including the sulfate present in the cement.

The coarse and fine aggregates shall when mixed produce a well graded mixture from the largest to the smallest size specified.

All-in aggregates are not allowed.

The Contractor shall submit to the Engineer for his approval, representative samples of the fine and coarse aggregates intended to be used not later than 30 (thirty) days before the planned commencement of any work.

The samples shall been obtained from the sources requested to be approved and shall be accompanied by test certificates from an independent laboratory giving all information on relevant properties of the aggregates.

The Contractor shall control the following items of aggregates during execution of the Work:

Name and location of sources
Sieve analysis
Ten percent fines value
Chloride content

Approved samples of aggregates will be kept at all time during the course of the Contract in the Engineer's Site office and all concrete aggregates shall comply with such approved samples or shall whenever required by the Engineer be tested by the Contractor in compliance with these Specifications.

All aggregates for concrete shall be stored on closely fitted timber, steel or concrete stages of the approved design with drainage slopes or in bins of substantial construction in such a manner as to prevent jumbling or segregation of sizes and to avoid the inclusion of dirt and other foreign materials in the concrete. All such bins shall be emptied and cleaned at intervals as instructed by the Engineer. Each size of aggregates shall be stored separately.

At no time shall aggregates for use in concrete be allowed to dry out completely and freshwater shall be sprinkled from time to time lightly on the stored aggregates.

(3) Mixing Water

Mixing water shall be fresh water or desalinated water and be clean, free from harmful substance and from any unusual proportion of dissolved salts.

Water shall be sampled and tested at the maximum 4 weeks intervals.

(4) Admixtures

Plasticizers shall normally be used to achieve the required workability of high quality concrete.

When the minimum air content is specified for the concrete an air-entraining admixture shall be used.

No admixture will be considered for approval that is not being commercially used with satisfactory service and supplied with a detailed declaration of constituents. All requests for approval of admixture shall be submitted to the Engineer at least 30 (thirty) days before it is intended to be used. The Contractor shall submit with his request independent test data and adequate samples of the proposed admixture.

Calcium chloride or admixture containing calcium chloride shall not be used.

(5) Reinforcement

Steel reinforcement used in concrete shall be hot-rolled steel bars complying with JIS G 3112 SD295 or equivalent.

The consignment of steel reinforcement shall be accompanied with the manufacturer's certificate of tests.

Bars shall be stored in a way that will prevent deterioration.

Binding wire shall be black, annealed, mild steel and with d □ 1.5 mm.

3.2.3 Concrete Composition

(1) Mix proportions

Table 3.2.3-1 Concrete composition

Class		1	2	3
Grade		C24	C18	C10
Cube strength	N/mm^2	24	18	10
Max. aggregates size	mm	25-20	25-20	25-20
Standard cement content	kg	300	230	180
Max. water/cement ratio	-	0.45	0.50	0.55
Max. chloride ion content, by weight of cement	%	0.10	0.30	0.40
Min. concrete cover, unless noted otherwise	mm	50		

Class1; Reinforced Concrete
Class2; Un-reinforced Concrete
Class3; Lean Concrete

(2) Properties of Fresh Concrete

At the time of placement, the concrete shall be of a suitable slump and so proportioned that it can be worked readily into corners and angles of the forms and around reinforcement and embedded items without permitting the materials to segregate or an excessive amount of free water to collect on the surface of the concrete, taking into account of the requirements to placing and compaction.

The detailed requirements shall be established on the basis of concrete trials.

(3) Concrete Trials

At least 45 days before any concrete is placed in the Work, the Contractor shall submit to the Engineer for his approval full details of the mixes proposing to use for each grade of concrete together with their anticipated average strength. These mixes shall be based on the results of trial mixes. The programme of trial mixes shall be subject to the approval by the Engineer, and the Engineer shall be kept informed of the progress of the tests.

The mixes shall be designed with due regard to the workability necessary to allow the Contractor to place and compact the concrete with the equipment he proposes to use in any particular situation.

Before any change to materials or mix proportions is introduced the Contractor shall provide all evidence to the satisfaction of the Engineer that the new mix will meet this Specification.

3.2.4 Production of Concrete

(1) Equipment

The Contractor shall submit within 45 days after Award of the Contract information on the proposed Plant for batching and mixing the concrete.

Those surfaces of the measuring, mixing and transporting equipment that will be in contact with concrete shall be clean at the commencement of the mixing operation.

Before each pouring the Contractor shall check the performance of his equipment, the accuracy of scales, and etc.

(2) Delivery and Storage of Materials

All concrete materials shall be stored and handled with care to avoid any pollution or unintended mixing of foreign materials.

All bins and containers with materials shall be unambiguously marked.

(3) Batching

The materials shall be so measured out as to give the required mix proportions. Cement and aggregates shall be batched by weight where aggregates may be weighed cumulatively and water shall be batched by weight or by volume. Admixture shall be batched using suitable dispenser. The Contractor shall measure the moisture content of aggregates as frequently as required and at least once a day during times of concrete production, and he shall adjust the quantity of mixing water according to the results of these tests if required. The observation of moisture in the aggregates shall be sufficiently frequent and accurate to keep the mixing water in the batch within the limits specified.

Delivery of materials from the batching equipment shall be within the following limits of accuracy:

Cement and Water: ± 2%

Aggregates: ± 3%

Admixtures: ±3%

(4) Mixing

The concrete shall be mixed in the mixer until the materials are uniformly distributed and shall be discharged completely before the mixer is recharged.

The operator of the mixer shall currently be able to make a visual assessment of the concrete properties as well as the achieved discharge of concrete from the mixer.

(5) Transportation

The concrete shall be transported from the mixer to the place of the final deposit by means which will prevent segregation or loss of materials and not permit the concrete to stiffen.

The means and duration of transport shall be subject to the approval by the Engineer.

3.2.5 Testing

(1) Testing materials

Cement

All relevant properties of the supplied cement shall be stated in detail in the certificate from the supplier, for checking the compliance with the relevant standards.

Aggregates

Gradation tests and description of the nature of the aggregates including content of harmful matters for which limits are specified in this document or pertaining standards shall be made prior to the concrete trials.

Additional control testing shall be made in case of changes or as specified.

Water

The specific requirements shall be documented.

Admixture

Pre-testing shall include the verification of the content of the declarations of the materials. The suitability of the admixture shall be tested in connection with the concrete trials.

(2) Testing of composition

After the approval of documentation of materials the composition of the concrete shall be fixed and documentation of the following properties shall be established by calculation:

- water/cement ratio
- content of cement and their constituents
- content of fines
- air content
- saturated and dry density
- content of chlorides and possible other harmful matters

(3) Concrete Trials and Testing of Strength

A visual inspection shall be made of the storage conditions of materials and the equipment available. The accuracy of the batching shall be established.

The duration of batching and the succession of materials added to the mixer shall be recorded.

The time for mixing shall be recorded.

The achieved properties of the fresh concrete shall be tested by slump tests, air content tests and chlorides content tests by screening of samples of the fresh concrete.

The concrete strength shall be determined by compression tests of concrete cubes:

- minimum one sampling per 20 m3 or 40 batches for concrete Classes 1 and 2
- minimum one sampling per 40 m3 or 40 batches for concrete Class 3

From each trial mix at least three specimens for the 28 days test and two specimens for the 7 days test shall be prepared unless otherwise directed by the Engineer.

(4) Data and inspection

The Engineer shall be furnished one copy of all test results without delay and within 2 working days. Also the Engineer shall be free to inspect at any time

during working hours all equipment used and all records made for the verification of these requirements.

3.2.6 Formwork

(1) General

Formwork shall be such that the finished surface of all concrete work shall be sound, solid and free from honeycombs, protuberances and blemishes.

The Contractor will be responsible for the design and execution of all formwork. Drawings and calculations shall be prepared and presented to the Engineer at least 2 weeks before the commencement of formwork.

(2) Design and construction

All formwork and false work shall be adequately designed, built to sustain construction loads and maintained to be so tight and rigid that no displacements will occur. All forms shall be treated with approved oil, and wooden forms shall be thoroughly drenched with water immediately before placing concrete.

Only form clamps of reputable makes and proper steel form ties and spacers shall be used. Separators shall remain embedded in the concrete and they shall terminate not less than 50 mm inside the formed face of the concrete. The fasteners (form ties) on the ends of separators shall be firmly fixed so that their removal will leave holes of regular shape. These holes shall be filled with mortar (compo) subject to the Engineer's approval.

Panels shall have true edges to permit accurate alignment and provide a neat line with adjacent panels and at all construction joints. All panels shall be fixed with their joints either vertically or horizontally. Chamfering is subjected to the direction and approval of the Engineer.

(3) Cleaning and Treatment

Before concrete is placed, forms shall be cleaned.

Discoloration or any other harmful agents besides the use of release agents shall be prevented.

(4) Construction Tolerances

Tolerances for formed surfaces of cast-in place and pre-cast reinforced concrete are:

(a) Cross-sectional dimensions of beams, slabs, walls, and etc.: 0 mm to + 20 mm
(b) Longitudinal dimensions less than 30 m of same members: +20 mm
(c) Size and location of penetrations, recesses, and etc.: +5 mm
(d) Location of in Site structure generally, relative to established reference lines, module lines and levels: ± 20 mm
(e) Holding-down bolts, etc. as group: ± 5 mm
(f) Inserts, brackets, steel members, and etc. to be embedded and those which the Drawings shows to be flush with the concrete surface: ± 1 mm
(g) Or as otherwise specified.

(5) Inspection and approval

The Engineer shall be given adequate notice and time - min. 24 hours or as otherwise agreed with the Contractor - for inspection of all formwork, including steel reinforcement, prior to placing of concrete.

(6) Stripping of Formwork

The stripping of formwork shall be carried out in accordance with agreement and approval by the Engineer. Formwork shall not be struck less than 48 hours after casting.

3.2.7 Reinforcement

(1) General

The Contractor shall furnish, cut, bend and place all steel reinforcement.

The Contractor shall provide at his own cost and to the approval by the Engineer working drawings of all reinforcement accompanied by bending schedules.

The working drawings and bending schedules shall be submitted to the Engineer at least 45 days prior to commencing actual work.

(2) Handling, Cutting and Bending

The steel shall be decently stored on the work site in a way as to avoid contamination and/or corrosion to the extent possible. Reinforcement bars affected by severe rust will be rejected.

(3) Placing and Fixing

At the time concrete is placed, reinforcement shall be free from loose rust or loose mill scale, dirt, mortar spillage, salt, oil, grease or other coating which might destroy or impair the bond between the concrete and the reinforcement. Rust will not be considered loose if, on rubbing with a finger, it leaves only a stain thereon.

All reinforcement is to be sized, shaped and placed in exactly accordance with the Drawings provided by the Contractor and approved by the Engineer and kept in the correct position in the forms without displacement during the process of vibrating, tamping and ramming the concrete in place.

The Contractor shall provide all necessary distance pieces and space bars to maintain the reinforcement in the correct position. Spacers shall be of such materials and design as will be durable, not lead to corrosion of the reinforcement.

Any ties, links or stirrups connecting the bars shall be taut so that the bars are properly braced, and the inside of their curved parts shall be in actual contact with the bars around which they are intended to fit. Bars shall be bound together, in at least every other point of intersection, with best black annealed mild steel wire or other approved binders. Binding wire shall be bent inwards.

Bars shall be neither displaced laterally from the specified position by more than half a bar diameter spacing nor into the specified cover zone in order to clear embedded items or penetrations unless permitted by the Engineer.

(4) Welding

Welding of reinforcement bars is not generally permitted and shall in all case be subject to the Engineer's approval.

(5) Embedded Items

All embedded items such as inserts, holding-down bolts, frames, sleeves, pipes and conduits shall be placed accurately and secured against displacement before concreting commences, and voids formed shall be protected from being clogged with concrete.

3.2.8 Concrete Placement

(1) Placing

The concrete shall be placed in accordance with the following restrictions:

(a) Concrete shall be deposited as nearly as practicable to its final position in such a manner as to avoid segregation due to re-handling or flowing. The vertical drops shall be not more than 1.7 meters. The concrete shall be placed in approximately horizontal layers of no more than 0.40 m thickness.

(b) Concrete shall be placed at a rate that will permit proper compaction.

(c) Concrete shall not be placed if it has partially hardened or has been contaminated by foreign materials.

(d) Concrete in each section of the Work between the approved construction joints shall be placed in a continuous operation so that new concrete is placed against plastic concrete to produce a monolithic mass.

(e) Where mortar is liable to be lost from a preceding concrete placement, as where reinforcement is congested, batches of mortar should be as follows;

i) containing the same proportions of cement and sand, i.e. as the concrete discounted the coarse aggregates, and

ii) having the similar consistency to that of the new mix, which shall be deposited to a depth of at least 30 mm immediately before the new mix is placed and the resulting concrete shall then be compacted to form a monolithic mass.

(f) Adequate protection shall be at hand to protect the fresh concrete from sudden rain

(g) When strong winds are likely to be experienced, additional precautions to ensure protection from driving rain and dust shall also be taken. The Engineer may withhold the approval of commencement of concreting until he is satisfied that full and adequate arrangements have been made

(h) Where fresh concrete shall be placed below the high water level flooding shall be prevented by

i) coordination with tidal variations

ii) installation of adequate water barriers

(i) Where concrete is to be placed against an earth surface, the surface shall be sealed by a blinding layer of 50 to 100 mm concrete to form an even, hard surface below reinforcement and to minimize loss of water and prevent fouling

(j) Where approval has been given to carry out concreting operations at night or in places where daylight is excluded, the Contractor is to provide adequate lighting at all points where mixing, transportation and placing of concrete are in progress.

(2) Compaction

All concrete shall be thoroughly compacted by vibrators of the immersion type during placement and shall be thoroughly worked around the reinforcement and embedded fixtures and into the corners of the forms. The use of external vibrators is not permitted. Vibrators shall be of approved type and design. Spare vibrators shall always be available at the Site of casting.

The vibration shall continue until the air bubbles cease to appear on the concrete surface and stop immediately with the appearance of bleeding and not carried on to a degree that may cause segregation of the concrete. The working of the concrete by vibrators to make it flow laterally is not permitted, and vibrators shall always be extracted slowly to prevent forming of voids.

(3) Construction Joints

Construction joints shall be executed in accordance with the following restrictions:

(a) Construction joints shall be located and shaped as shown on the Drawings. The location and method concerned for other construction joints, desired by the Contractor, shall be subject to the Engineer's approval.

(b) Before fresh concrete is placed against a hardened concrete surface at a construction joint, the surface shall be cleaned so that all loose or soft materials, free water, foreign matter and cement skin are removed, while at the time of the placement the surface shall be damp.

(c) Projecting reinforcement and embedded items, such as water-stops, dowels, inserts, fabricated steel members and pipes shall be carefully located, fixed and sealed in the form of the construction joints.

(d) The formwork shall be tightly secured against previously cast or hardened concrete to prevent stepping or ridges to exposed surfaces.

(e) All construction joints between existing and new concrete shall be treated for prevention of possible water penetration/seepage through the joints.

3.2.9 Treatment and Curing

(1) Upper Surfaces

The upper surface of concrete structures shall be adjusted to the required shape and tolerance by application of a board. The necessary surface adjustment of the slab shall be made with beam vibrators.

(2) Moist Curing

All concrete shall be under the condition of moist curing for a period of time equivalent to 7 days at 20° by a suitable method. Alternatively the forms shall remain in place for this period of time.

The curing shall be commenced no later than one hour from the time of pouring.

(3) Protection

During the curing period the concrete shall be protected from the harmful effects of sunshine, drying winds, rain, wave action, or running water. The protection shall be applied as soon as practicable after the completion of concrete placing.

Also during the curing period, the concrete shall be protected from damaging mechanical disturbance, such as load stresses, heavy shock, and excessive vibration.

All finished concrete surfaces shall be protected from damage caused by construction equipment, materials or methods, such as spraying water colder than the concrete, application of adverse curing procedures and rain or running water. Self-supporting structures shall not be loaded in such a way as to overstress the concrete.

(4) Hot Weather Requirements

The following requirements shall apply when concreting in hot weather:

(a) Precautions shall be taken to avoid premature stiffening of the fresh mix and to reduce water absorption and evaporation losses.

(b) If the temperature of the surrounding air is between 32° and 35° C, the following measures shall apply unless otherwise directed by the Engineer:

i) The formwork shall be continuously sprayed with cold freshwater in advance of the concreting and excess water shall be removed from inside of the forms immediately prior to the placement of concrete.

ii) The reinforcement, and the form work if metal forms are used, shall be protected from the effects of hot winds and direct sunlight.

iii) Suitable barriers shall be provided to protect the freshly placed concrete from wind, until the concrete has hardened sufficiently to allow it to be covered according to paragraph (5) below

iv) The concrete shall be held to a temperature not higher than 35° C when placed by

A. using chilled mixing water, or

B. spraying the coarse aggregates with cold water (adjusting the amount of mixing water accordingly), or

C. covering the container in which the concrete is transported to the forms, or

D. using any combination of these methods

v) The concrete shall be mixed, transported, placed and compacted as rapidly as possible and shall then be covered with:

A. an impervious membrane, or

B. hessian, kept wet, until moist curing begins

vi) Curing compounds shall not be used as an alternative to the requirements of paragraphs iv) and v)

(c) Concreting when the surrounding air temperature exceeds 35°C shall be with the Engineer's approval only.

(5) Hardened Concrete

The Contractor shall immediately notify the Engineer if, after the removal of formwork, faults or adverse geometry is revealed.

Patching, plastering or cement washing of defective areas such as honeycombs and cracks shall not be permitted except with the approval by the Engineer. However, such approval is not required for the repair of holes left by the extraction of form ties or cored samples.

(6) Concrete Deemed Not to Comply

In any case where test results or the quality of hardened surfaces do not comply with the requirements remedial measures shall be decided by the Engineer on the basis of the Contractor's proposal.

Any remedial work or demolition and reconstruction of rejected work shall be carried out on the Contractor's account.

3.3 GEOTEXTILE FILTER FABRIC

3.3.1 Description

This Work shall consist of furnishing and placing geotextile filter fabric in the back side of the revetments and bridge abutment protection work, and the outer part of box culvert joints, in order to keep the backfill soil particles at their original position when they are under dynamic water flow. The geotextile fabric shall be laid at the place where shown on the Drawings.

3.3.2 Materials

The geotextile filter fabric shall be nonwoven polyester or polypropylene materials conforming to the following.

Table 3.3.2-1 Filter Fabric

Property	Requirement
Grab Tensile Strength (MD/CD) in N	700 -min
Thickness (mm)	1.7 min
Flow Rate ($L/m^2/sec$)	220 min
Permittivity (S-1)	2.~ min

Before ordering the geotextile filter fabric, the Contractor shall submit the factory's explanatory leaflet and get using approval from the Engineer.

The filter fabric shall be accompanied with a test certificate from an approved testing laboratory with actual identification test results.

The fabric shall be protected from exposure to ultraviolet rays and stored on clean dry surfaces free from foreign substances such as grease, oil, cement, and etc.

3.3.3 Construction

Until the time of installation of a geotextile in the Permanent Work it shall be stored so that it is not exposed to sunlight preferably not exceeding 4 hours. Total exposure to direct sunlight in excess of 2 days of a piece of geotextile will lead to rejection. Before installation of the geotextile the surface of the placing shall be trimmed and cleared for obstruction, which may damage the geotextile.

The geotextile shall be of minimum 4.5 m width. The geotextile shall be placed perpendicular to the longitudinal direction of the structure with an overlap of at least 0.75 m.

The geotextile shall be in one piece from the bottom to the top of the structure.

When correctly placed on the slope the geotextile shall be smooth and kept in place by weights (e.g. stone or iron bars) preventing the sheet from floating.

No rock materials shall be placed on the geotextile before the placing has been accepted by the Engineer.

Placing of subsequent layers shall be carried out in a manner, which will not damage the preceding geotextile.

Any damage caused to geotextile shall result in replacement of the damaged section by the Contractor at no additional cost.

At the time of completion, the following tolerances shall be respected unless otherwise indicated or directed by the Engineer.

Slope of core/fill	± 0.1
Filter layer, thickness of individual layer	- 50 / +50 mm
Armour layer	-0.0 / +T / 6
(T = nominal thickness of armour layer)	
Crest	-0.1 m / +0.2 m

The surface of each filter layer shall be leveled before construction of the next layer in order to ensure that excess thickness of one layer shall not reduce the thickness.

CLAUSE 4. EARTHWORK

4.1 Description

This Work shall consist of restoring the existing causeway by filling.

4.2 Materials

Collection the materials in location and transportation means shall be solely the responsibility of the Contractor. The End-User will provide the available data for the sand borrow pit areas and other Sites nearby where may generate excess soil and earth suitable to the Work, if any. The Contractor shall consult with the End-User on this aspect.

The Contractor shall prepare necessary documentation to clear the environmental examination of screening and submit it to the Ministry of Environment through the End-User.

Fill materials will be obtained locally, either from approved locations, sea bed dredging adjacent to the islands, borrow pits, structure excavation, or road excavation, but it must be able to achieve a compaction of 92% Maximum Modified Dry Density (MMDD). The Engineer will require an inspection of the fill materials prior to filling and compacting.

4.3 Construction

The Contractor shall be responsible for finalizing the horizontal and vertical alignment along the nominated routes. The alignment shall be positioned as shown in the Drawings.

Satisfactory materials shall be used for fills to the lines and grades indicated and for replacing any unsatisfactory materials. Satisfactory materials shall be free from roots and other organic matter, trash and debris. Silt contents of filling materials shall be less than ten percents (10%).

Heavy equipment for spreading and compacting backfill shall not be operated closer to the structures including abutments and box culverts and shall be compacted to the

required thickness with power-driven hand compactors suitable to materials being employed. Backfill shall be placed carefully around pipes embedded to avoid damages. As far as practicable, filling near the existing dike earth shall be brought up to stick together with harmony.

For backfilling above the sea water level, coral materials shall be placed in level, horizontal layers not exceeding 200mm thickness and be compacted before the next layer is placed. Effective spreading equipment shall be applied in each layer to obtain a uniform thickness prior to compacting.

Fill materials shall be placed and compacted in layers not exceeding 200mm thickness. The fill shall be free from all vegetation and other deleterious materials.

Embankment formation shall be constructed at appropriate slopes to ensure stability. The slope will be dependent upon the nature of the materials, however, shall not be steeper than 1 vertical to 1.5 horizontal.

Fill materials shall be placed and compacted in layers. The level of compaction shall be suitable for the purpose of construction as follows:

- General fill 92% (Standard dry density)
- Sub grade (top 150mm) 95% (Standard dry density)
- Embankment fill (below top 200mm) 92% (Standard dry density)
- Select backfill to structures 95% (Standard dry density)

The Contractor shall report the details of this composition test for Engineer's approval.

CLAUSE 5. REMOVAL OF EXISTING REVETMENT AND REUSE

5.1 Description

This Work shall consist of removing the existing coral rock revetment and filter sheet on the east side of the causeway as shown on the Drawings, including clearing and stripping of all objectionable materials. All existing coral rock revetment shall be removed. It shall also include the demolition, removal and disposal of structures that obstruct the Work except where otherwise provided.

5.2 Reuse of Removed Coral Rocks

The Contractor shall reuse these removed materials for the foot protection work of revetment as indicated in the Drawings. For this purpose, the removed coral rocks shall be temporarily stored near the causeway.

5.3 Construction

The thickness or depth of the stripping shall generally be 500 mm and 0.5m below LAT.

The materials excavated from these stripping operations shall be transported to the areas designated by the Engineer.

CLAUSE 6. EXCAVATION AND BACKFILL FOR STRUCTURES

6.1 Description

This Work shall consist of the removal of all materials, of whatever nature, necessary for the construction of revetments and other structures under seabed in accordance with the Drawings. It shall include the placement of necessary backfill as specified

hereinafter. It shall also include the stockpiling of excavated materials, which is not suitable for backfill, at sites approved by the Engineer.

6.2 Construction

The Contractor shall clear the Site in compliance with the requirements to the limits of foundation as specified. After clearing, the Contractor shall set out true lines, grades, slopes and sections as shown on the Drawings. The Contractor shall execute the work as indicated in the Drawings. In case the water depth is deeper than that indicated in the Drawings, The Contractor shall consult with the Engineer on this matter.

6.3 Excavation and Backfill

Excavation shall be carried out in the Specification for Earthwork.

All spaces excavated and not occupied by structure or other Permanent Works shall be filled with backfill materials up to the surface of the surrounding ground, with a sufficient allowance of settlement. Materials used for backfill shall be of selected granular quality acceptable to the Engineer. All backfill materials shall be placed in horizontal, uniform layers not exceeding 200mm in thickness at one time before compaction and shall be brought up uniformly on all sides of the structure. Each layer of backfill shall be compacted to a density of not less than 92% MMDD unless otherwise instructed by the Engineer.

CLAUSE 7. BITUMINOUS PAVEMENT WORK

7.1 Description

This work shall include the following construction items for bituminous pavement of the causeway:

Subbase course (100mm thickness)
Base course (150mm thickness)
Bituminous surface layer (30mm thickness)
Filling of shoulder

Bituminous pavement shall be constructed on a prepared subgrade in conformity with the lines, grades, and thickness as shown on the Drawing.

7.2 Materials

(1) Fill materials

Fill materials under the pavement shall consist of clean sand and/or coral materials free from organic matter obtained from approved locations.

The clean fill materials are to have a particle size distribution within the following limits:

Sieve size (mm)	% passing (by mass)
150	100
0.075	0 to 10

(2) Subbase

The subbase layer shall be placed on the surface of the completed fill or subgrade.

The subbase shall be constructed from clean coral and sand obtained from approved locations. The clean fill materials shall have a particle size distribution within the following limits:

Sieve size (mm)	% passing (by mass)
50	100
20	50 to 90
5	15 to 60

(3) Base course

The base course shall be placed on the surface of the completed subbase.

Base course is to be constructed from clean coral and sand obtained from approved location. The clean fill materials shall have a particle size distribution within the following limits;

Sieve size (mm)	% passing (by mass)
50	100
20	50 to 90
5	15 to 60
2	5 to30

The materials shall be free from organic and other deleterious materials.

(4) Bituminous surface materials

The bitumen for sealing could be hot residual bitumen, bitumen emulsion or cut back asphalt.

Before ordering the bituminous surface, the Contractor shall submit the factory's explanatory leaflet and get using approval from the Engineer.

(5) Asphalt treatment B

The primed base course and bitumen penetrated surface of the causeways shall be sealed with 15 mm aggregates seal covered with a sand seal.

Aggregates (coral) and sand materials for asphalt treatment B shall be clean, free from clay. Also aggregates shall not include dirt and organic.

It is to be sprayed onto the prepared primed or bitumen penetrated surface.

(6) Asphalt treatment A

The primed base course and bitumen penetrated surface of the causeways shall be sealed with 15 mm aggregates seal covered with a sand seal.

Aggregates and sand materials for asphalt treatment (A) sealing shall be clean, hard, tough, durable, uncoated grains, homogeneous in quality, free from clay. Also aggregates shall not include dirt and organic, mica, coral, lime marble, and other easy soluble materials.

Reference is made to Asphalt treatment B of this Specification.

(7) Water

All water used in pavement construction for compaction and related purposes is to be potable water. The use of seawater is to be prohibited.

(8) Road marking paint

Road marking to separate carriageways and pedestrian lanes shall be traffic sign marking paint.

Before ordering the road marking paint, the Contractor shall submit the factory's explanatory leaflet and get using approval from the Engineer.

7.3 Construction

7.3.1 Subgrade preparation

Where the causeway alignment requires the removal of the existing scrub, all vegetable matter is to be cleared from the surface and all roots with a diameter in excess of 50 mm grubbed upt.

The upper 150 mm to 200 mm of top soil is to be stripped and windrowed to the edges. The topsoil shall be protected during construction period and reused on the verges of the causeway where grass will be planted.

Where silty materials have accumulated in low areas along the existing causeway, it is to be removed prior to placing fill materials. The materials in such areas shall be removed to a sufficient depth including all materials with an excess of silt that will be churned up by traffic. The removed materials may be used on the verges of the causeway where grass will be planted.

Old coconut and other tree stumps in the proposed roadway shall be removed. The holes left shall be backfilled as per the fill requirements.

The subgrade shall be compacted so that the upper 150 mm is at least 95% of the maximum modified dry density determined by the modified compaction test. Any depressions caused by such compaction shall be filled in accordance with the requirements for fill.

7.3.2 Fill

The fill under the pavement shall be compacted to at least 95% of the maximum modified dry density determined by the modified compaction test. The surface of the fill may be compacted through the subbase.

The surface of the subgrade shall be a level such that when the base and subbase are constructed they are of the specified thickness and the road surface is at the correct level. This may require finishing the fill above its finished level to allow further compaction through the pavement layers.

Since in the flanks adjacent to the pavement the fill may contain topsoil, silty and other materials shall be removed from the roadway prior to filling.

7.3.3 Subbase

The specified particle size distribution is required in the finished pavement and may be partially or wholly produced by rolling during compaction.

The subbase materials shall have a soaked CBR when compacted to 95% of the maximum modified compaction of at least 30%.

The subbase layer is to be compacted to at least 95% of the maximum dry density determined by modified compaction or saturated vibration test whichever gives larger value.

The subbase layer shall be more than the specified thickness of 100mm at any location.

The surface of the subbase shall be parallel to and 150 mm below the finished road design surface. It shall not deviate from a 2 m straight edge placed on the surface, except across the crown of the road by more than 15 mm.

7.3.4 Base course

The specified particle size distribution is required in the finished pavement and may be partially or wholly produced by rolling during compaction.

The base course materials shall have a soaked CBR when compacted to 95% of the maximum modified dry density of at least 80%.

The base course layer shall be compacted to at least 97% of the maximum modified dry density determined by the modified compaction test.

The average thickness of the base course layer shall not be less than the thickness specified and shall not be 15 mm thinner than the specified thickness of 150 mm at any location.

The surface of the base course shall conform to the finished road design surface shape and level.

The surface of the base course shall be smooth and free from loose materials.

7.3.5 Bituminous surface prime

The base course surface shall be swept clean and primed over an area extending 150 mm beyond each side of the area to be sealed.

The prepared base course shall be primed with cut back bitumen or bitumen emulsion. Cutback bitumen shall be grade AMCO. Bitumen emulsion for priming shall be anionic slow setting, diluted with potable water so that the bitumen content of the diluted materials is 30%.

The application rate of primer will be determined on Site having regard to the surface conditions.

The application rate for cutback bitumen will be in the range 0.5 to 1.1 ℓ/m2. The cutback bitumen shall only be applied when rain is not expected within an hour of spraying.

The application rate for the diluted bitumen emulsion is to be in the range of 1.2 to 1.4 ℓ/m2 to give a residual bitumen application of 0.36 to 0.42 ℓ /m2.

Bitumen emulsion shall only be applied when the pavement surface is free from water, in good dry conditions and rain is not expected within an hour of the emulsion breaking.

The prime is to be left for at least 2 days prior to sealing. During that time the prime shall not be trafficked.

The areas of bitumen that are likely to be picked up on wheels are to be blinded with sealing sand prior to public use. If the surface is damaged prior to sealing it must be re-primed prior to sealing.

7.3.6 Asphalt treatment B

The application rate for the first coat of anionic rapid setting bitumen emulsion shall be 1.1ℓ/m2. For the second coat if applied after the aggregates (coral) have been

incorporated into the first coat, the application rate will depend on the average least dimension (ALD) of the sealing aggregates (coral) and shall be in the range 1.3 to 2.0ℓ/m2.

The sealing aggregates (coral) shall be incorporated with the sprayed binder and rolled.

The completed aggregates (coral) seal is to be covered with a sand seal. The application rate of residual bitumen binder shall be 0.5ℓ/m2. The sealing sand shall be incorporated with the binder and rolled.

7.3.7 Asphalt treatment A

Reference is made to Asphalt treatment B of this Technical Specifications

7.3.8 Trial pavement

The Contractor is to conduct a trial pavement of at least 200 m length on a side road (location to be determined) prior to undertaking any Works on the Project road. Each feature of the trial pavement (surface preparation, fill, subbase, base, prime and seal) is to be satisfactorily completed prior to commencement of each type of similar work on the Project road.

7.3.9 Quality control

The Specification will outline the minimum requirements for quality control and the supply of survey and testing equipment and facilities.

CLAUSE 8 MEDIAN

8.1 Description

This work shall consist of a strip of median along the center of the causeway for dividing traffic flows and installation of road facilities. The median has continuous concrete curb stones at its both sides and sand filling inside as shown on the Drawings.

The Work shall be carried out in accordance with this Technical Specification. The Contractor shall place the fill materials in accordance with the Drawing.

8.2 Materials

Class 2 Concrete shall be used for the concrete curb stone work.

Reference for the filling work is made to Item 4.2 of CLAUSE 4 (EARTHWORK) of this Technical Specification.

CLAUSE 9. GUARD BLOCK

9.1 Description

Guard blocks are structures to prevent pedestrians/vehicles from falling into the sea. The structures shall consist of coral stone boulders incorporated with cement mortar as shown on the Drawings.

9.2 Materials

Stone shall be of Class VI (durable coral stone) with a dimension of no less than 70mm and shall be subject to the Engineer's approval.

Cement mortar shall consist of 1 part cement to 3 part of clean sand mixed with potable water to form a workable mixture.

9.3 Construction

(1) Placing stone

Stones shall be hand-placed, interlocked and rammed with mortal into the bed to give an even finished surface so that they are firmly bedded in layers. All opening and interstices shall be filled with mortar to a depth of at least 30mm from the surface.

(2) Cleaning of exposed faces

All face stone shall be thoroughly clean free mortar stains and shall be kept clean until the Work completed.

(3) Setting of Guard Blocks

As shown on the Drawings, guard blocks shall be installed on the top of the revetment.

CLAUSE 10. REVETMENT WORK

10.1 Description

This Work shall consist of rock revetments on both slopes for protection of the causeway from wave scouring. The revetments on the causeway slope shall be constructed as shown on the Drawings.

10.2 Materials

(1) Armour Rocks

Class II (300kg) rock shall be used for the revetments.

Reference is made to Sub-Clause 3.1 of this Technical Specification.

(2) Geotextile Filter Fabric

Reference is made to Item 3.3 of CLAUSE 3 (GENERAL REQUIREMENTS FOR BASIC MATERIALS AND WORKS) of this Technical Specification.

10.3 Construction

Armour rocks shall be placed in two layers. Placed armour stones shall consist of rough unhewn rocks approximately rectangular, placed directly on the prepared slope or seabed. Rocks shall weigh between 200and 400 kg. At least 60% of them shall weigh more than 300kg.

The Contractor shall request an inspection to the Engineer after finishing the first layer of the armour rocks.

Before any revetments are placed, the surface to be covered shall be fully compacted and graded to the required slope. Revetments on slopes shall be commenced from the trench below the toe of the slope and shall be progressed upward, while each rock being laid by crane assisted with hand normal to the slope with the long dimension horizontal, firmly bedded against the slope and against the adjoining rocks, with ends in contact, and with well-broken joints.

The finished surface of the revetments shall present an even and tight surface. The difference of the revetment thickness shall be less than 5cm at any point of the finished revetment surface.

CLAUSE 11. BRIDGE ABUTMENT PROTECTION WORK

11.1 Description

This Work shall consist of armour revetments on the both sides of the causeway bridge abutments for the protection from wave scouring and core rocks under armour rocks. The bridge protection for abutments shall be constructed as shown on the Drawings.

11.2 Materials

(1) Rock

Class I Rock (500kg) shall be used for bridge abutment protection work.

Reference is made to Item 3.1 of Clause 3 (General Requirements for Materials and Works)

(2) Geotextile Filter Fabric

Reference is made to Item 3.3 of Clause 3 (General Requirements for Materials and Works).

11.3 Construction

Armour rock shall be placed in two layers as indicated on the Drawings.

Placed armor rocks for bridge abutment protection shall consist of rough unhewn rocks approximately rectangular, and they shall be placed directly on the prepared slope or seabed. Rocks shall weigh between 400 and 600 kg per piece. At least 60% of them shall weigh more than 500kg per piece.

11.4 Materials for Core Rocks

(1) Rocks

Rocks class III (30kg) shall be used for core materials under the bridge abutment protection work. Reference is made to Item 3.1 of Clause 3 (General Requirement for Materials and Works).

(2) Construction

Core rocks shall be installed as shown in the Drawings. Core rocks shall rest on the under-layer of the passage bed riprap, (500kg, Class I).

CLAUSE 12. PASSAGE BED RIPPAP WORK

12.1 Description

This Work shall consist of a riprap layer on the passage seabed under the causeway bridge for protection from tidal current. The riprap layer has a thickness of 1.0m and width of 28m or more. The riprap shall be constructed as shown on the Drawings.

12.2 Materials

(1) Riprap Rocks

Class I (500kg) rocks shall be used for the passage bed riprap layer.

Reference is made to Item 3.1 of Clause 3 (General Requirements for Materials and Works).

12.3 Construction

Dredging down to 1.5m below the datum (LAT) shall be carried out for the riprap. This dredging shall be undertaken under protection of the cofferdam dike. Placing the rocks close to the driven sheet pile wall and pipe piles shall be carefully carried out to prevent piles from damages.

Riprap rocks shall be placed in two layers with a thickness of approximately 0.5m each.

Placed riprap rocks shall consist of rough unhewn stone boulders approximately rectangular and they are placed directly on the prepared seabed. Pocks shall weigh between 400 and 600 kg per piece. At least 60% of them shall weigh more than 500kg per piece.

The finished riprap surface shall present even and tight and the level difference of any point on the surface should be less than 10 cm.

CLAUSE 13. CULVERT APRON WORK

13.1 Description

This Work shall consist of the apron riprap work at the both ends of reinforced concrete culverts to prevent the culvert foundation from scouring by wave and flow. The culvert apron shall be constructed with a width of 10.3m and a thickness of 1.0m as shown on the Drawings.

13.2 Materials

(1) Stone

Class II (300kg) rocks shall be used for the culvert apron.

Reference is made to Item 3.1 of Clause 3 (General Requirements for Materials and Works).

13.3 Construction

Apron stones shall be placed in two layers.

Culvert apron rocks to be placed crane assisted with hand shall consist of rough unhewn stone boulders approximately rectangular and they are placed directly on the prepared seabed. Rocks shall weigh between 200and 400 kg per piece. At least 60% of them shall weigh more than 300kg per piece.

The finished culvert apron surface shall present even and tight and the level difference of any point on the surface should be less than 5 cm.

The Surface where box culverts will be placed shall be smooth by blinding.

CLAUSE 14. COBBLE STONE WORK

14.1 Description

This Work shall consist of constructing cobble stone layer for smooth foundation of box culverts as shown on the Drawings.

14.2 Materials

The materials box culvert bedding shall be free from organic and other deleterious materials. Cobble stones shall generally conform to the following characteristics.

Grading limits

Size (mm)	Percentage passing weight
120	100
75	60-100
37.5	30-60
19.0	10-30
9.0	10

14.3 Construction

Prior to construction of cobble stone layer, the Contractor shall shape and compact the box culvert surface of sandy layer.

The Contractor shall form a cobble stone layer 150mm wider than the actual width of the box culvert structure. Then the Contractor shall compact the cobble stone layer.

CLAUSE 15. REINFORCED BOX CONCRETE CULVERT WORK

15.1 Description

This Work shall consist of producing, transporting, placing the pre-cast culvert of cast-in-place concrete culvert under the causeway embankment as shown on the Drawings. In case of pre-cast concrete work, the Contractor shall prepare his shop drawings indicating the unit length and details of joints and submit it for Engineer's approval.

15.2 Materials

Reinforced Concrete and Cobble Stone

References are made to Item 3.2 of CLAUSE 3 (CONCRETE WORK) and Clause 14 (COBBLE STONE WORK) of this Technical Specification.

15.3 Construction

(1) Excavation

Before the placement of culverts, the Contractor shall obtain the Engineer's approval for setting out. Reference is made to CLAUSE 4. (EARTHWORK) of this Technical Specification..

(2) Bedding of Cobble Stone

The Contractor shall place cobble stone layer with a thickness of 0.15m and a width of 0.15m wider at each side than that of the culverts.

(3) Laying Box culvert

The Contractor shall carefully place the reinforced concrete culverts on the cobble stone layer by appropriate means, in case that pre-cast concrete work is employed.

(4) Joints

Joints of the reinforced concrete culverts shall be carefully covered with a sheet of geotextile filter fabric in order to prevent the culvert structures from the backfill soil particles intruding when the backfill is affected by the dynamic tidal current or traffic passage. Before commencement of the construction work, the Contractor shall obtain the Engineer's approval for the construction method of the reinforced concrete culverts with the Specification of the joint sealing materials.

(5) Cutoff Wall Construction

The Contractor shall install cutoff walls at each end of culvert as shown in the Drawings.

(6) Back-filling

Back-filling material shall be placed on the reinforced concrete culvert and each back-filling layer is compacted with a thickness of less than 150mm.

CLAUSE 16. BRIDGE SUBSTRUCTURE WORK

16.1 Description

The Work specified in this Clause comprise of the construction of two bridge piers and two abutments of reinforced concrete structures supporting by steel sheet piles/pipe piles.

16.2 Materials

All steel materials for the substructure work are subject to the Engineer's approval.

(1) Steel Sheet Piles and Steel Pipe Piles

The sheet piles used for the abutment shall hot-rolled sheet pile (Type III) complying with JIS A 5528 SY295 or equivalent, while the steel pipe piles used for pier foundation shall hot- rolled steel pipe pile (wall thickness: 9 mm) complying with JIS A 5525 STK400 or equivalent.

The steel sheet piles/pipe piles shall be straight, sound, true and, unless otherwise directed, with no joints. No protective coating needs to be applied.

The manufacturer's test certificate (works certificate) shall be supplied for all steel sheet piles/pipe piles delivered to the Site and all piles/pipe piles shall be properly marked for identification.

The Contractor shall carefully examine the steel sheet piles/pipe piles at the time of delivery and all damaged piles shall be repaired or replaced.

The Contractor shall prepare the shop drawing indicating the alignment of the steel sheet piles and submit it to the Engineer for approval. Especially on the four corners of steel sheet piles' foundation, T-shaped steel sheet piles shall be installed to ensure tight interlocking of the sheet piles' joints. These T-shaped steel sheet piles can be manufactured at the supplier's facility or at the Site by welding.

The Contractor shall get the approval of the Engineer for the length of piles before placing an order.

(2) Tie Rods and Walings

The tie rods and walings shall be made of steel complying with grades SS400 specified in the Drawings.

The manufacturer's test certificate (works certificate) shall be supplied with all tie rods delivered to the Site and individual steel item shall be properly marked for identification.

(3) Bolts and Nuts

Fixing bolts, backing plates and tie rods, all including nuts and washers, need not be hot dip galvanized.

(4) Capping beam of abutment and pier for bridge

The capping shall be of reinforced concrete as shown on the Drawings

16.3 Construction

(1) Preparation

Holes for bolts through sheet pile walls, at all levels, may either be made by drilling full-size or by burning an undersize hole and reaming it to the final size. Burning of full-size holes will not be permitted and holes in sheet piles for bolts shall be located accurately in order that backing plates may bear fully and evenly.

Holes for lifting shall be avoided. Unavoidable lifting holes shall be carefully repaired to the quality and dimension of the original sheet pile.

(2) Pile Driving

Before driving, all steel sheet piles (pipe piles) shall be clearly marked and numbered at one-meter intervals from toe to top.

The Contractor shall submit to the Engineer for approval his proposal for the driving of steel sheet piles (pipe piles) at least thirty (30) days before the work is due to commence.

It is emphasized, however, that the Engineer's approval of the equipment and methods shall not relieve the Contractor in any way of his full responsibility for all temporary and permanent structures and any claim with reference to the Engineer's approval will be rejected.

The Engineer shall be notified 24 hours before the commencement of driving.

Records for the steel sheet pile (pipe pile) driving work shall be taken and kept by the Contractor and one copy hereof shall be submitted to the Engineer at the end of each day of driving.

The record of driving sheet piles shall be made for the last 1 m, and for every 10 piles the records shall be made for the full length of driving.

Water jetting of the steel sheet piles shall not be permitted below the specified dredging level.

The top of the completed sheet piles shall be brought to specified levels by driving or burning-off of excess length. Damaged piles tops shall be removed by burning-off, as required by the Engineer.

Extension of sheet piles, which for any reason are found to be too short to fit the specified height of wall, shall be spliced by butt welding with the approval of the Engineer.

All piles shall be subject to the approval by the Engineer before and after installation. Piles, which may have been damaged, cracked, located out of line or tolerance, incorrectly fabricated, marked, stored or handled, or lengthened in a way that is not approved shall not be accepted by the Engineer. Rejected piles shall be substituted with other piles as directed by the Engineer, and rejected piles shall promptly be removed from the Site as directed by the Engineer.

Where, in the opinion of the Engineer, incorrectly placed, inaccurately installed or damaged piles can result in the necessity for installing additional piles or altering the coping arrangement, all such additional materials, labour, Plant, and etc. as may be required, shall be provided by the Contractor at his own expense.

(3) Toe Levels

The toe of steel sheet pile (15m long) and steel pipe piles (15m long) shall penetrate into the bearing stratum as directed by the Engineer. The specified toe levels for 15m long pile reflect the design assumption that piles are founded in the bearing stratum.

Unless otherwise directed by the Engineer, the piles shall be installed to the lines and levels and in the positions shown on the Drawings.

If, during the course of installation, the Engineer decides that greater penetration is necessary, he may order the piles be installed to a deeper penetration and the piles should be lengthened accordingly.

(4) Tie Rods

The tie rods shall be installed prior to the backfill or dredging in front of the wall. Until the sand fill supports the weight of tie rods, temporary supports with the maximum spacing of 3.0 m shall be provided. In the permanent structure, these temporary supports shall be removed to a level at least 0.5 m below the tie rods.

(5) Tolerances

(a) Sheet Piles (Pipe piles)

The centre line of the wall at cut-off level shall be not deviated by more than ± 25 mm from the specified alignment.

The sheet pile wall shall be deviated from plumb by more than 1:100. The maximum inclination in the direction of the sheet pile wall of any single pile shall be less than 1:50.

The allowable tolerances on the specified cut-off level and toe level shall be ± 10 mm and 100 mm respectively.

(b) Waling, Tie Rods

The steel profiles constituting the waling shall be parallel.

The tolerance on the specified level of the waling shall be not more than 30 mm.

CLAUSE 17. BRIDGE SUPERSTRUCTURE WORK

17.1 Description

This Work shall consist of reinforced concrete slab and beams of the bridge superstructure.

17.2 Materials

Class 1 Concrete shall be used for the slab and beams and handrail.

Class 2 Concrete shall be used for the pavement of slab.

The Drawings indicate a preliminary sketch of the bridge shoes and the Contractor shall develop his shop drawing, which is subject to the Engineer's approval.

Before ordering the shoes in 48 numbers, the Contractor shall submit the factory's explanatory leaflet for the Engineer' approval. The shoes shall be made of rubber and reinforcement steel in total thickness of 30 mm or more.

17.3 Construction

Bituminous Pavement Work is applied on the backfill of the abutments.

Reference is made to Bituminous Pavement Work of these Specifications.

The Pavement concrete shall be placed and compacted using the Concrete Class 2 with minimum thickness of 30mm on the slab of the bridge considering the crossfall for the slab.

The handrail on the bridge shall be reinforced concrete structure in 200 mm width. The height of the handrail is 900 mm at the end and 500 mm near the Median respectively. The handrail shall be tightly incorporated with the slab.

Reference is made to Concrete Work of these Specifications.

CLAUSE 18. ROAD LIGHTING WORK

18.1 Description

Drawings and quantity of lighting poles shown in Schedule-I, Part-I, Volume-II indicate the required works at the condition of the middle of May, 2005. The Contractor shall survey the latest condition of poles and prepare his cost estimate enough to provide all poles in the entire length of the Causeway.

The Contractor may reuse the removed poles, if equivalent to new one and accepted by the Engineer. The Contractor shall consult with the End-User on the existing condition and removed poles.

In case of new installation, the Contractor shall supply and install the new road lighting system complete with lamps, cabling (including underground and through-the-bridge cabling and conjunction to the existing road lighting system), the foundations, and etc.

In case of reuse, the Contractor shall reuse the existing road lighting system complete with lamps, cabling (including underground and through-the-bridge cabling and conjunction to the existing road lighting system), the foundations, and etc.

18.2 Materials

A road lighting system similar to the existing one or equivalent shall be installed. Before ordering the road lighting system, the Contractor shall confirm to the type of the existing lighting system and equipment to the End-User or at the relevant Atoll office. The system is subject to the Engineer's approval. The Contractor shall supply and install a complete earth system.

18.3 Construction

The road lighting pole shall be erected in the foundations (0.5m x 0.5mx 0.5m) made of Class 2 concrete by means of planted anchor bolts. The electric supply cables for the system shall be drawn in conduits from cable trench. The Contractor shall undertake the necessary wiring connection to the nearest existing terminal specified by the End-User and the proposed lighting poles.

CLAUSE 19 ENVIRONMENTAL CONSIDERATION

19.1 Environmental Monitoring Plan

To ensure that the construction activities will not cause adverse impacts on the local environment, the Contractor shall conduct environmental monitoring. The Contractor shall submit the Environmental Monitoring Plan for the approval of the Engineer. If any significant adverse impacts are identified through the monitoring, remedial actions shall be taken.

Based on the identified environmental impacts, monitoring shall be conducted by the Contractor on the following parameters. The purpose of the monitoring is also described.

1) **Seagrass:** To confirm that the construction works do not lead to any loss or disturbance to the adjacent seagrass bed.
2) **Corals:** To confirm that the construction works do not lead to any loss or disturbance to the adjacent corals.
3) **Suspended Solids (SS):** To confirm that the construction activities are not dispersing significant amount of sediments to the adjacent seagrass and corals.
4) **Water exchange:** To confirm the effectiveness of the culverts and bridge in enhancing water exchange.
5) **Water and sediment quality:** To confirm the effectiveness of the culverts and bridge in improving the deteriorated water and sediment quality near the causeway.
6) **Seafloor and shoreline topography:** To confirm how the new culverts and bridge affects the seafloor and shoreline topography through alteration of the local current regime.

19.2 Baseline Survey

The baseline survey for these parameters shall be conducted by the Contractor prior to the commencement of the construction. The methods of the baseline survey are as follows.

1) Seagrass

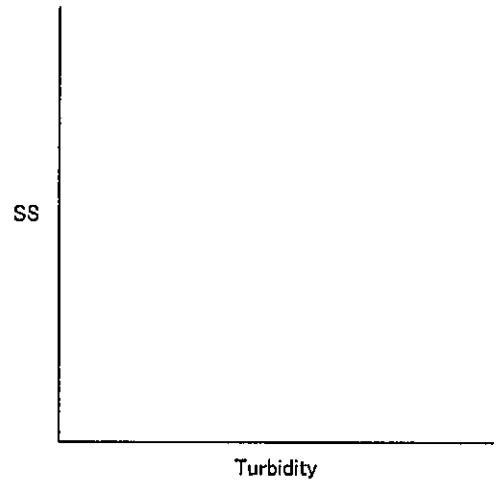
Identify the distribution of seagrass on the reef flat adjacent to the causeway and sand dredging Site through analysis of aerial photography, diving survey or other appropriate methods. The scope of the survey should be 300m from the causeway and sand dredging Site.

2) Corals

Identify if there are any major coral communities on the reef flat adjacent to the causeway and sand dredging Site through analysis of aerial photography, diving survey or other appropriate methods. The scope of the survey should be 300m from the causeway and sand dredging Site.

3) Suspended Solids (SS)

Quantify the linear relationship between SS and turbidity through comparison of SS and turbidity values at different turbid conditions. The linear relationship could be quantified by plotting the following graph. Quantification of the relationship of SS and turbidity is required since monitoring of SS is conducted by using turbidity meter.



4) Water Exchange

Calculate the total flow rate achieved through the current pipe culverts by measurement of the flow rate of each pipe culvert. Measurement of flow rate should be conducted during flood tide when the flow direction through the pipe culverts is from east to west.

5) Seawater Quality

Conduct seawater quality analysis for the following parameters. Conduct sampling in the middle layer of the water column during high tide. The proposed sampling locations are shown in Diagram. The exact locations should be determined at the Site but should be relatively close to the causeway (e.g. within 20 – 30m).

- Water temperature
- Salinity
- SS
- Turbidity
- DO
- COD

The obtained SS and turbidity values could also be used for the quantification of SS and turbidity relationship.

6) Sediment Quality

Conduct sediment quality analysis for the following parameters. The sampling locations are the same with water quality.

- Total sulfer (TS)
- Ignition loss

7) Seafloor and Shoreline Topography

Conduct particle size analysis of the sediments collected in the sediment quality survey.

19.3 Monitoring Requirements during the Construction Phase

1) Seagrass and Corals

In order to confirm whether the adjacent seagrass and coral communities are not being adversely affected by the construction works, the health of the seagrass and corals, and

SS of the water column shall be monitored regularly. Table 1 and 2 provides details of the monitoring method of seagrass and corals respectively. Monitoring of corals could be cancelled if no major coral communities are found in the baseline survey.

Table 1 Monitoring Plan of Adjacent Seagrass during the Construction Phase

Method	Location	Frequency	Remedial Action
Observe the percentage coverage of seagrass inside the quadrat (1mx1m) by taking underwater photography.	Representative Sites of the seagrass community of the area. The exact locations should be determined in accordance to the baseline survey.	Once a week when either dredging, excavation or backfilling work is conducted.	Reevaluate the method of construction and the silt curtain usage.
Measurement of turbidity with turbidity meter. Convert the value into SS unit (mg/ℓ) based on the linear relationship found in the baseline survey.	Same location with the quadrat survey.	Once a day during high tide when either dredging, excavation or backfilling work is conducted.	Reevaluate the method of construction and the silt curtain usage when the SS value increases over 10mg/ℓ of the background concentration.

Table 2 Monitoring Plan of Adjacent Corals during the Construction Phase

Method	Location	Frequency	Remedial Action
Observe the live coral coverage inside the quadrat (1mx1m) by taking underwater photography.	Representative Sites of the coral community of the area. The exact locations should be determined in accordance to the baseline survey.	Once a week when either dredging, excavation or backfilling work is conducted.	Reevaluate the method of construction and the silt curtain usage
Measurement of turbidity with turbidity meter. Convert the value into SS unit (mg/ℓ) based on the linear relationship found in the baseline survey.	Same location with the quadrat survey.	Once a day during high tide when either dredging, excavation or backfilling work is conducted.	Reevaluate the method of construction and the silt curtain usage when the SS value increases over 10mg/ℓ of the background concentration.

19.4 Monitoring Requirements in the Post-Construction Phase

1) Water Exchange

The new bridge and culverts should improve the water exchange between the east and west side of the causeway. To quantify its effectiveness, the water exchange rate through the new bridge and culverts should be measured using the same method as the

baseline survey. Measurement should be made after the completion of the causeway, when the tidal, weather and current conditions are similar to that of the baseline survey.

1) Water and Sediment Quality

The new bridge and culverts should improve the water and sediment quality near the causeway through the enhancement of water exchange. To quantify its effectiveness, the water and sediment quality of the post-construction phase will be compared with the values of the baseline survey. Measurement should be made 1 month after the completion of the causeway when the tidal, weather and current conditions are similar to that of the baseline survey.

2) Seafloor and Shoreline Topography

Conduct sediment particle size analysis from the same location as the baseline survey and compare the particle size distribution. Large difference in the particle size distribution could imply alteration in the topography. Measurement should be made 1 month after the completion of the causeway when the tidal, weather and current conditions are similar to that of the baseline survey.

19.5 Submission of Monitoring Reports

The Contractor shall submit Monitoring Reports and Data to the Ministry of Environment and Construction (MEC) and the Employer in accordance to Table 3. During the construction period the Contractor shall submit only the monitoring data. The Contractor may be required to adjust their method of construction in accordance to the comment of the MEC and the Employer.

Table 3 Reports or Data to be Submitted to MEC and the Employer

	Frequency	No. of Copies	Contents
Baseline Survey Report	1 (Submit before the commencement of construction)	5	Provide all the results of the baseline survey including the methodology of the survey. The location of the seagrass and coral monitoring for the construction period must also be stated based on the findings of the baseline survey.
Monitoring Data (Report not required)	4 (Once every 2 months)	-	Provide photos of the seagrass and coral monitoring. Provide results of the SS monitoring.
Final Report	1 (Submit after the post-construction monitoring)	5	Provide results of water exchange, water and sediment quality, and topography survey. Summarize the results of the seagrass / coral and SS monitoring.

THE PROJECT FOR RECOVERY AND DEVELOPMENT OF CAUSEWAY IN LAAMU ATOLL

DRAWING LIST

DRAWINGS

Sheet No.	Sheet Title
CW-01	Causeway No. 1 (Kadhoo-Maandhoo) General Plan
CW-02	Causeway No. 1 (Kadhoo-Maandhoo) Profile
CW-03	Causeway No. 1 Typical Cross Section
CW-04	Causeway No. 2 (Fonadhoo-Kadhoo) General Plan
CW-05	Causeway No. 2 (Fonadhoo-Kadhoo) Profile
CW-06	Causeway No. 2 Typical Cross Section
CW-07	Causeway No. 2 Section of Bridge and Pier
CW-08	Plan and Longitudinal Section of Bridge
CW-09	General Structural Layout of Bridge
CW-10	Pile and Passage Protection Arrangement of Bridge
CW-11	Cross Section and Structural Section of Abutment (1)
CW-12	Cross Section and Structural Section of Abutment (2)
CW-13	Plan and Section of Abutment Pile Foundation
CW-14	Cross Section of Sheet Pile Double Wall of Abutment
CW-15	Reinforcing Bar Arrangement of Bridge Structure (Cross Section)
CW-16	Traffic Facilities and Safety Measures
CW-17	Plan and Section of Concrete Box Culvert
CW-18	Bar Arrangement of Box Culvert
CW-19	Location of Water Sediment Quality Analysis for Causeway No. 1 and Causeway No. 2
CW- 20	Causeway No. 1 Boring Stratum Chart

REFERENCE INFORMATION

Sheet No.	Sheet Title
CW- REF-1	Preliminary Survey Data for Reference Information Causeway No.1 (Kadhoo-Maandhoo)
CW- REF-2	Preliminary Survey Data for Reference Information Causeway No.1/Section 1/4
CW- REF-3	Preliminary Survey Data for Reference Information Causeway No. 1/Section 5/8
CW- REF-4	Preliminary Survey Data for Reference Information Causeway No. 2 (Kadhoo-Fonadhoo) General Plan No. 1 (Existing)
CW- REF-5	Preliminary Survey Data for Reference Information Causeway No. 2 (Kadhoo-Fonadhoo) General Plan No. 2 (Existing)
CW- REF-6	Preliminary Survey Data for Reference Information Causeway No. 2/Section 1/4
CW- REF-7	Preliminary Survey Data for Reference Information Causeway No. 2/Section 2/4
CW- REF-8	Preliminary Survey Data for Reference Information Causeway No. 2/Section 3/4
CW- REF-9	Preliminary Survey Data for Reference Information Causeway No. 2/Section 4/4
CW- REF-10	Preliminary Survey Data for Reference Information Sea Level Measurement Causeway No. 1 / Causeway No. 2, 1/2
CW- REF-11	Preliminary Survey Data for Reference Information Sea Level Measurement Causeway No. 1 / Causeway No. 2, 2/2

③ The Sewerage System Facility List of Site 2 Isdhoo Area

	Items	Quantity	Note
1.	150 φ V.P. Pipe with connection, leveling 1/200 Refilling, Finishing of road surface	m	Existing road : Sand compaction finish
2	150 φ V.P.	m	From toilet until main piping using 100 φ
3	50 φ V.P.	m	From pump station to Reach Field
4	Junction box 150 φ	pc	
5	Home type Septic Tank 1.5ton	184pc	Concrete type or FRP type
6	Communal Septic Tank 2.5ton	6pc	Concrete type only
7	Connection work to existing pipe	0pc	Recipient matter
8	Communal Septic tank 25ton	1pc	School
9	Connection work to existing pipe	0pc	Recipient matter
10	Sewage pump station with pit	24pc	
11	Sewage pump D40A-2, 220/250V, 50Hz, 3.5A, 1 φ 0.4kw	24pc	DAVEY40 or equivalent Sewage Pump
12	2nd Septic Tank with pump	7unit	Aeration chamber with charcoal filter
13	Mounted Leach Field Dual Step Treatment Bed	7unit	
14	Sludge Drying Bed with polycarbonate folded roof, 2 units	1pc	
15	Slant soil treatment system	184+6pc	1pc for 1facility except school
16	Connection work to existing pipe	0pc	Recipient matter
17	Electrical works	1unit	Power supply from existing distribution board to newly installed panel is recipient side matter
	Others	1unit	

④ The Sewerage System Facility List of Site 3 Health Centre & Temporary Office Area

	Items	Quantity	Note
1.	150 φ V.P. Pipe with connection, leveling 1/200 Refilling, Finishing of road surface	m	Existing road : Sand compaction finish
2	100 φ V.P.	m	From toilet until main piping using 100 φ
3	50 φ V.P.	m	From pump station to Reach Field
4	Junction box 150 φ	pc	
5	Home type Septic Tank 1.5ton	0pc	Concrete type or FRP type
6	Communal Septic Tank 2.5ton	1pcs	Concrete type only
7	Connection work to existing pipe	0pc	Recipient side matter
8	Communal Septic tank 25ton	0pc	
9	Connection work to existing pipe	0pc	Recipient side matter
10	Sewage pump station with pit	2pc	
11	Sewage pump D40A-2, 220/250V, 50Hz, 3.5A, 1 φ 0.4kw	2pc	DAVEY40 or equivalent Sewage Pump
12	2nd Septic Tank with pump	1pc	Aeration chamber with charcoal filter
13	Mounted Leach Field Dual Step Treatment Bed	1pc	
14	Sludge Drying Bed with polycarbonate folded roof, 2 units	0pc	
15	Slant soil treatment system	2pcs	
16	Connection work to existing pipe	0pc	Recipient side matter
17	Electrical works	1unit	
18	Vacuum car	1unit	
19	Others	1unit	

JICA JAPAN INTERNATIONAL COOPERATION AGENCY

REPUBLIC OF MALDIVES
MINISTRY OF FOREIGN AFFAIRS
MINISTRY OF PLANNING AND NATIONAL DEVELOPMENT

NOTES:

THE STUDY ON TSUNAMI RECOVERY, REHABILITATION AND DEVELOPMENT OF ISLANDS IN MALDIVES

YEC YACHIYO ENGINEERING CO.,LTD.
NIPPON KOEI CO.,LTD.

	PREPARED BY	CHECKED BY	APPROVED BY
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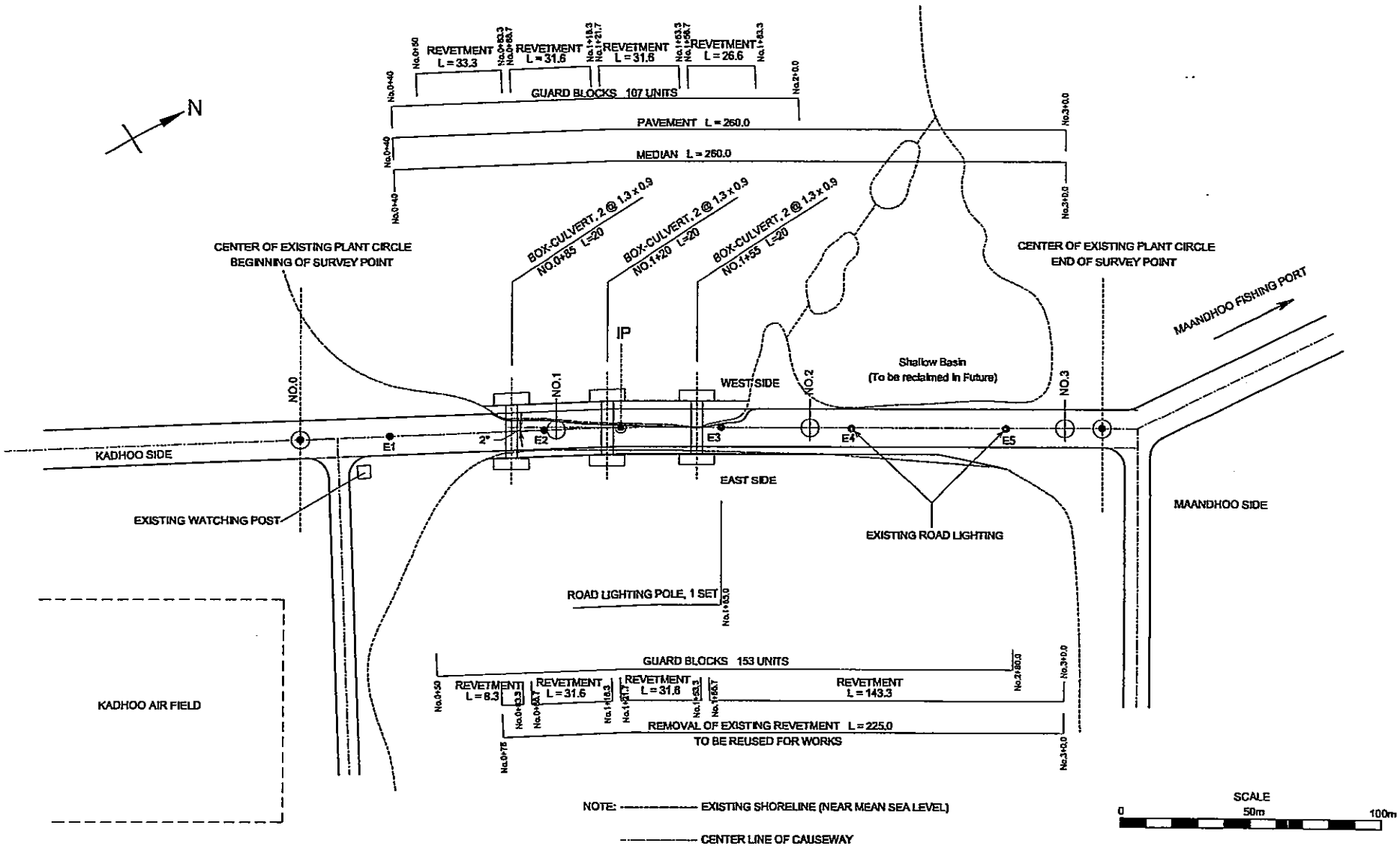
SIGNATURE			
DATE	July 20, 2005	July 20, 2005	July 30, 2005

DRAWING TITLE
Isdhoo Island
Upgrading of Sewerege System
The Sewerage System Facility List 2/2

SCALE	SHEET NO.	REV. NO.
--------	P-25	

CAUSEWAY NO.1 (KADHOO-MANDHOO) GENERAL PLAN



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MINISTRY OF PLANNING AND NATIONAL DEVELOPMENT

NOTES:
1. The Contractor shall execute the topographic survey to confirm the existing conditions.
2. All dimentions in Meters.
3. Inter angle (2°) shall be verified as directed by the Engineer.

THE STUDY ON TSUNAMI RECOVERY, REHABILITATION AND DEVELOPMENT OF ISLANDS IN MALDIVES

YACHIYO ENGINEERING CO.,LTD.
NIPPON KOEI CO.,LTD.

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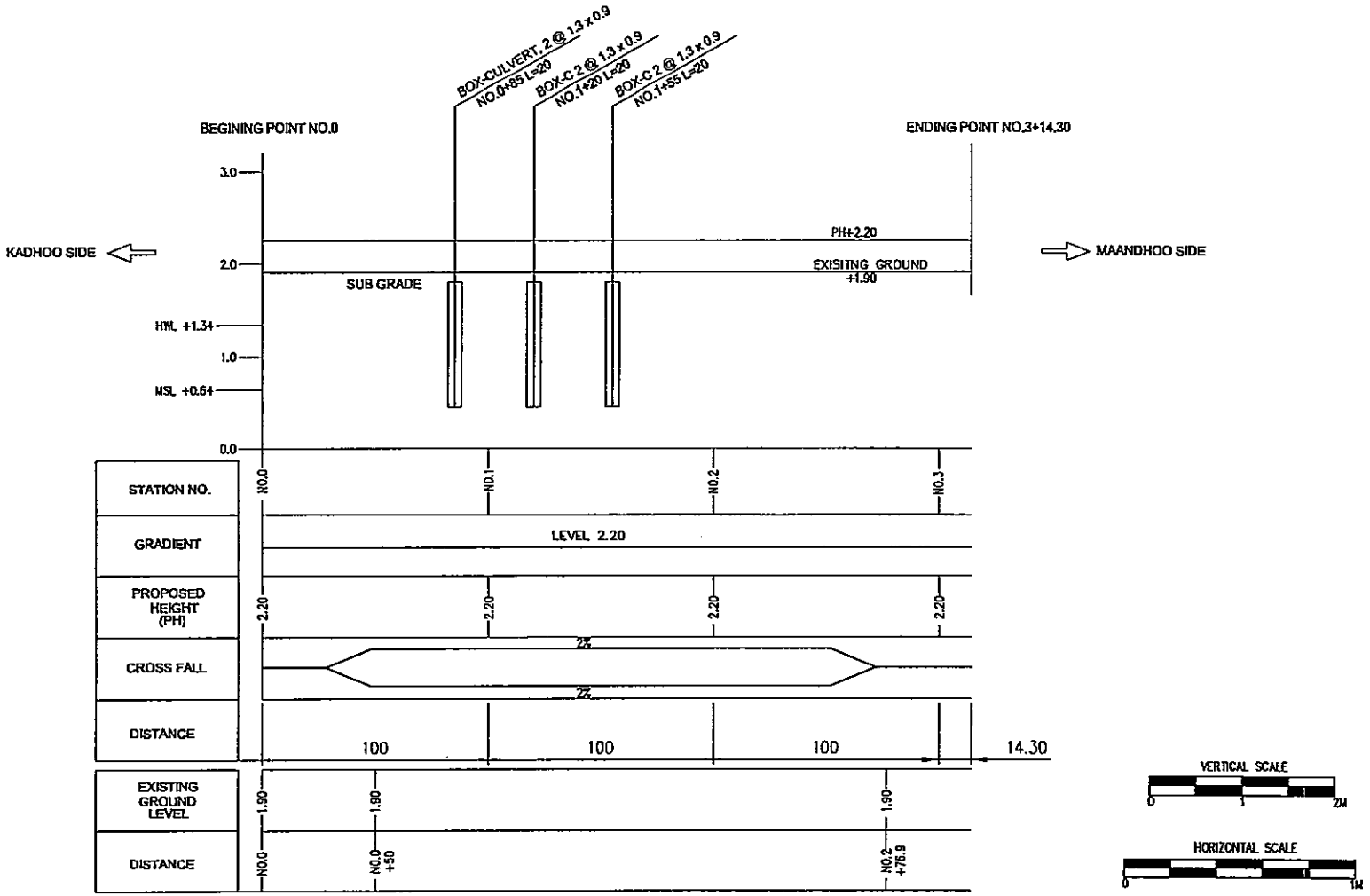
SIGNATURE			
DATE	July 20, 2005	July 20, 2005	July 30, 2005

DRAWING TITLE
CAUSEWAY NO.1
(KADHOO-MAANDHOO)
GENERAL PLAN

SCALE	SHEET NO.	REV. NO.
1 : 1500	CW-01	REV.02_JULY.13

CAUSEWAY NO.1 (KADHOO-MANDHOO) PROFILE



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MINISTRY OF PLANNING AND NATIONAL DEVELOPMENT

NOTES:
1. All dimension in meter.
2. Existing ground level indicates approximate figure measured in May, 2005.

THE STUDY ON TSUNAMI RECOVERY, REHABILITATION AND DEVELOPMENT OF ISLANDS IN MALDIVES

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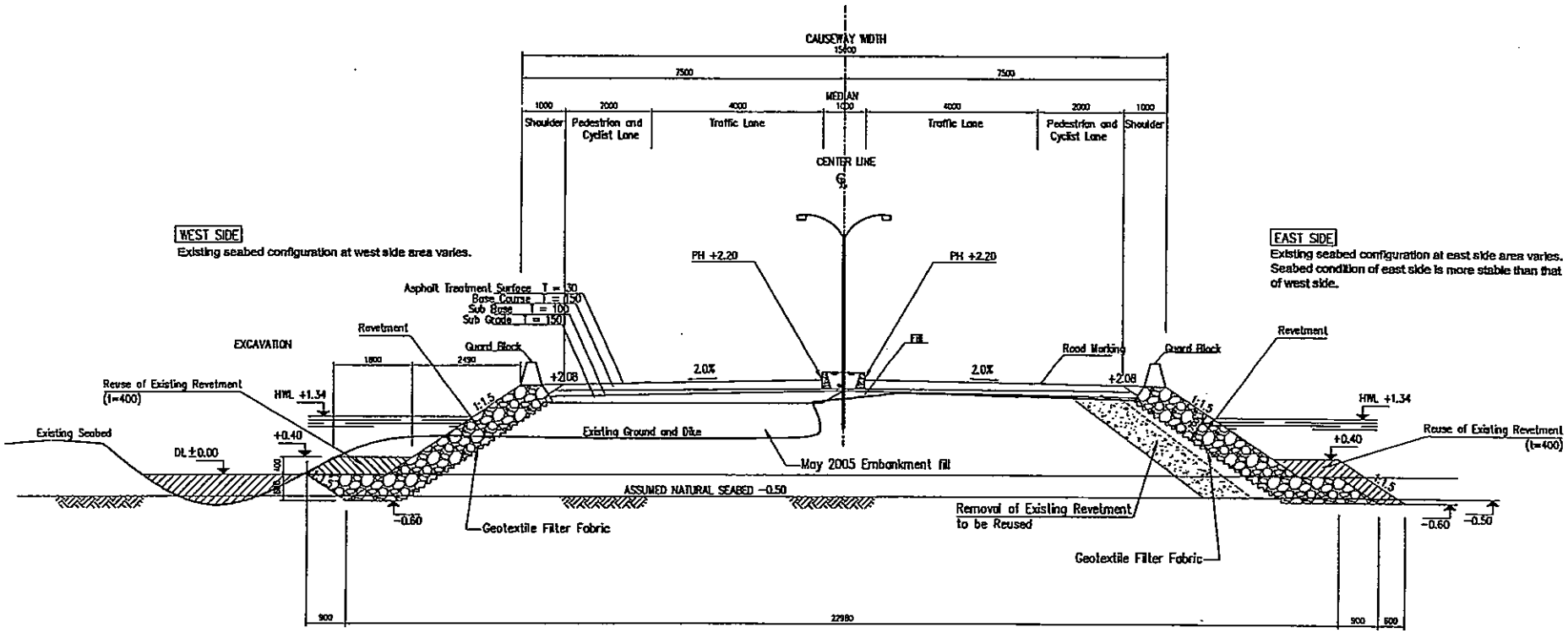
SIGNATURE			
DATE	July 20, 2005	July 20, 2005	July 30, 2005

DRAWING TITLE
CAUSEWAY NO.1
(KADHOO-MANDHOO)
PROFILE

SCALE	SHEET NO.	REV. NO.
1 : 50	CW-02	REV.01, JUNE.19

CAUSEWAY NO.1 TYPICAL CROSS SECTION



SCALE

0m 1m 2m 3m 4m 5m

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REPUBLIC OF MALDIVES
MINISTRY OF FOREIGN AFFAIRS
MINISTRY OF PLANNING AND NATIONAL DEVELOPMENT

NOTES:

1. Dimension in millimetar.
2. Elevation in meters.
3. Water level difference in 0.3m between the West and East was observed in ordinary climatic conditions May, 2005.
4. This existing ground and dike formation indicates the most damaged area. (May 2005)

THE STUDY ON TSUNAMI RECOVERY, REHABILITATION AND DEVELOPMENT OF ISLANDS IN MALDIVES

YACHIYO ENGINEERING CO.,LTD.
NIPPON KOEI CO.,LTD.

	PREPARED BY	CHECKED BY	APPROVED BY
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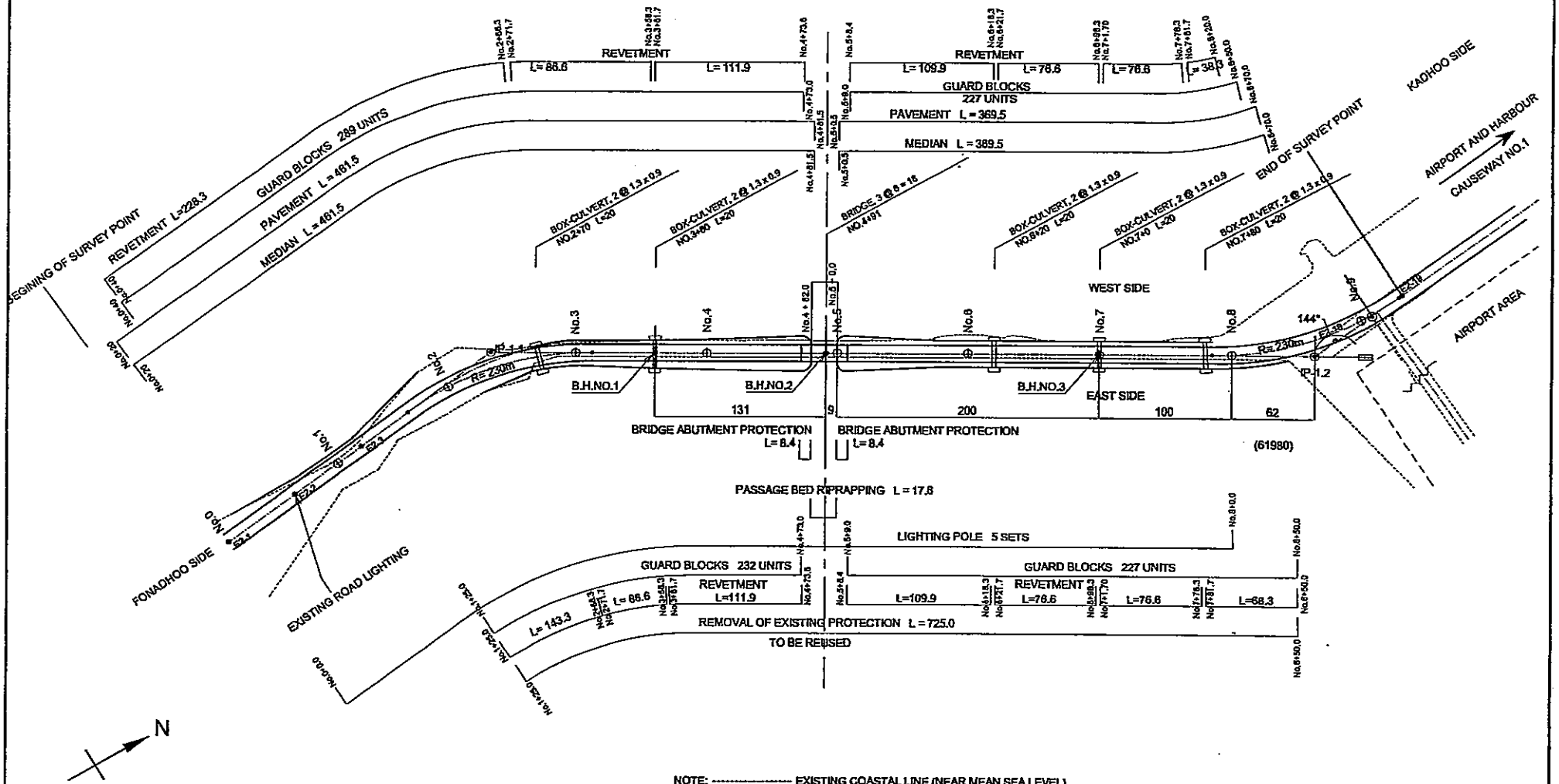
SIGNATURE			
DATE	July 20, 2005	July 20, 2005	July 30, 2005

DRAWING TITLE
CAUSEWAY NO.1
TYPICAL CROSS SECTION

SCALE	SHEET NO.	REV. NO.
1 : 100	CW-03	REV.02_JULY.13

CAUSEWAY NO.2 (FONADHOO-KADHOO) GENERAL PLAN



JICA JAPAN INTERNATIONAL COOPERATION AGENCY

REPUBLIC OF MALDIVES
MINISTRY OF FOREIGN AFFAIRS
MINISTRY OF PLANNING AND NATIONAL DEVELOPMENT

NOTES:

1. All dimensions in Meters.
2. The Contractor shall execute the topographic survey to confirm the existing conditions.
3. Boring location indicated the sheduled point, July 2005.
4. Center line of causeway between IP 1.1and 1.2 was shifted to the East by seven (7) meters.
5. Damaged lighting poles shall be replaced by new ones.

THE STUDY ON TSUNAMI RECOVERY, REHABILITATION AND DEVELOPMENT OF ISLANDS IN MALDIVES

YACHIYO ENGINEERING CO.,LTD.
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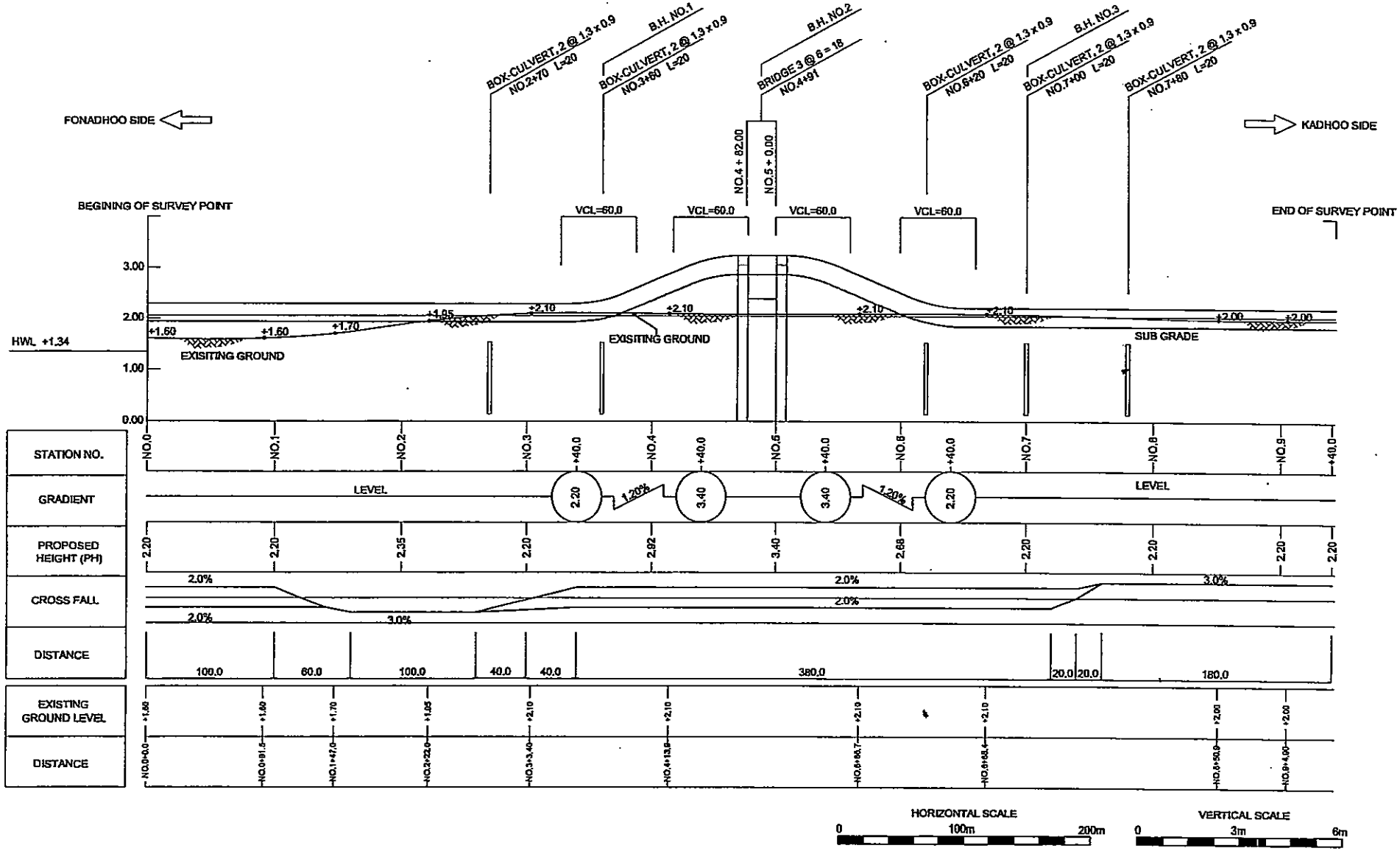
NAME	F. Shtomi, T. Hotta	S. Kubo, M. Amemiya	M. Komiya
SIGNATURE			
DATE	July 20, 2005	July 20, 2005	July 30, 2005

DRAWING TITLE
CAUSEWAY NO. 2
(FONADHOO-KADHOO)
GENERAL PLAN

SCALE	SHEET NO.	REV. NO.
1 : 3000	CW-04	REV.02...JULY.13

CAUSEWAY NO.2 (FONADHOO-KADHOO) PROFILE



JICA JAPAN INTERNATIONAL COOPERATION AGENCY

REPUBLIC OF MALDIVES
MINISTRY OF FOREIGN AFFAIRS
MINISTRY OF PLANNING AND NATIONAL DEVELOPMENT

NOTES:
1. All dimensions in Meters.
2. Existing ground level indicates approximate figure measured in May, 2005.

THE STUDY ON TSUNAMI RECOVERY, REHABILITATION AND DEVELOPMENT OF ISLANDS IN MALDIVES

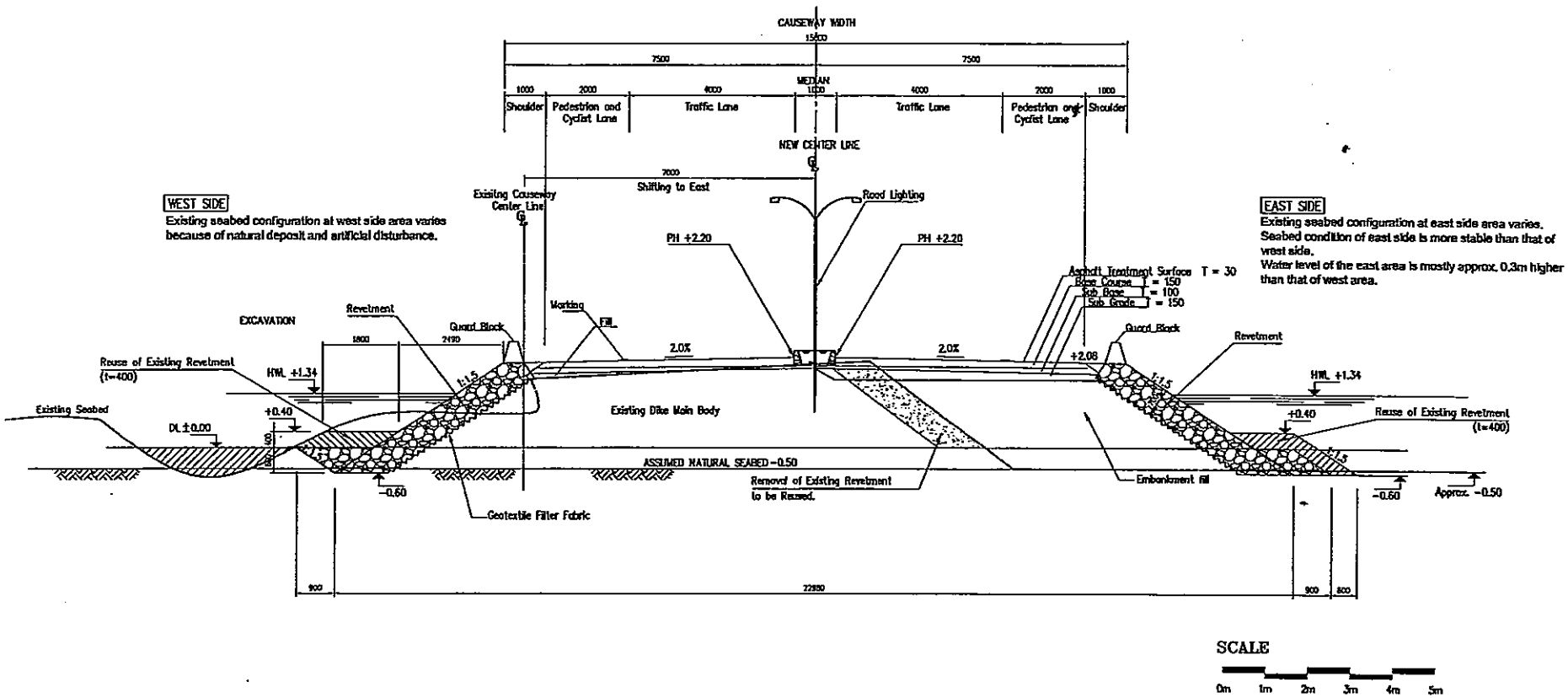
YACHIYO ENGINEERING CO.,LTD.
NIPPON KOEI CO.,LTD.

	PREPARED BY	CHECKED BY	APPROVED BY
NAME	F. Shiomi, T. Hotta	S. Kubo, M. Amemiya	M. Komiya
SIGNATURE			
DATE	July 20, 2005	July 20, 2005	July 30, 2005

DRAWING TITLE: CAUSEWAY NO.2 (FONADHOO-KADHOO) PROFILE

SCALE	SHEET NO.	REV. NO.
1 : 3000	CW-05	REV.02_JULY.13

CAUSEWAY NO.2 TYPICAL CROSS SECTION



SCALE

0m 1m 2m 3m 4m 5m

JICA JAPAN INTERNATIONAL COOPERATION AGENCY

REPUBLIC OF MALDIVES
MINISTRY OF FOREIGN AFFAIRS
MINISTRY OF PLANNING AND NATIONAL DEVELOPMENT

NOTES:
1. Dimension in millimeter.
2. Elevation in meters.
3. Center of causeway between IP1.1 and IP1.2 shall be shifted seven (7) m to East.
4. Water level difference in 0.3m between the East and West was observed in ordinary climatic conditions May 2005.

THE STUDY ON TSUNAMI RECOVERY, REHABILITATION AND DEVELOPMENT OF ISLANDS IN MALDIVES

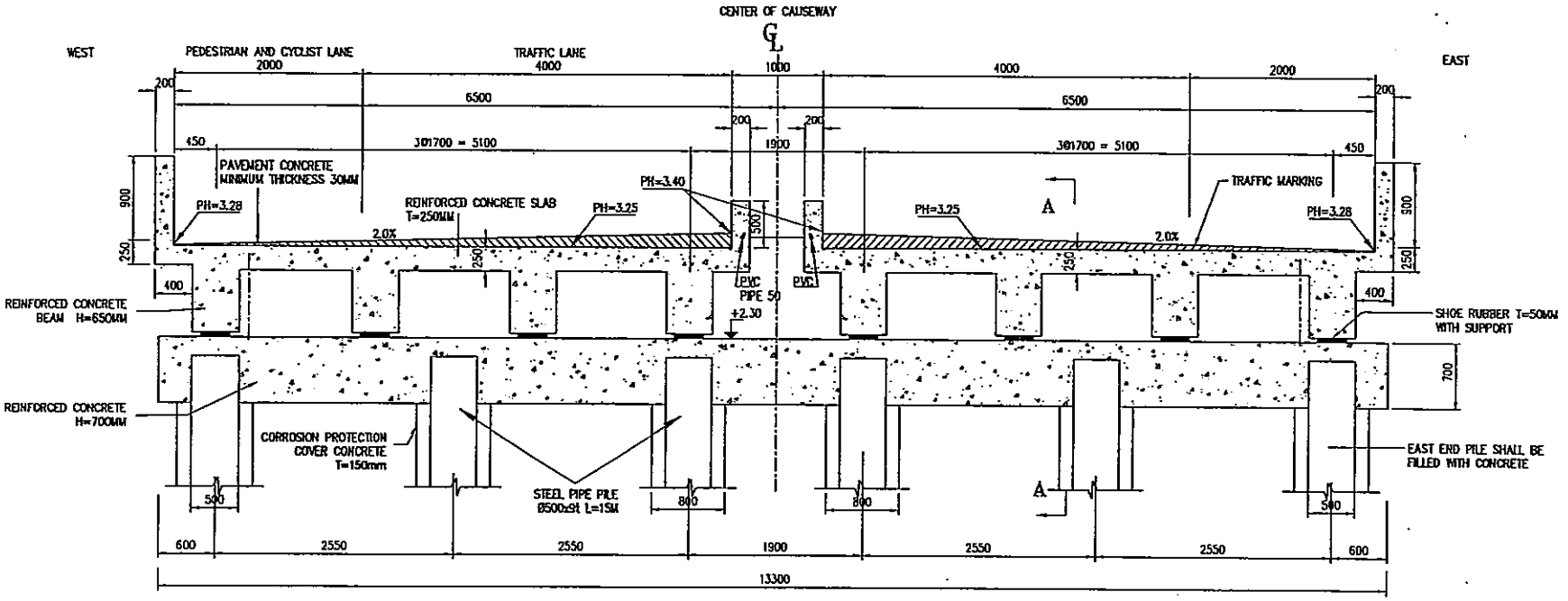
YACHIYO ENGINEERING CO.,LTD.
NIPPON KOEI CO.,LTD.

	PREPARED BY	CHECKED BY	APPROVED BY
NAME	F. Shiomi, T. Hotta	S. Kubo, M. Amemiya	M. Komiya
SIGNATURE			
DATE	July 20, 2005	July 20, 2005	July 30, 2005

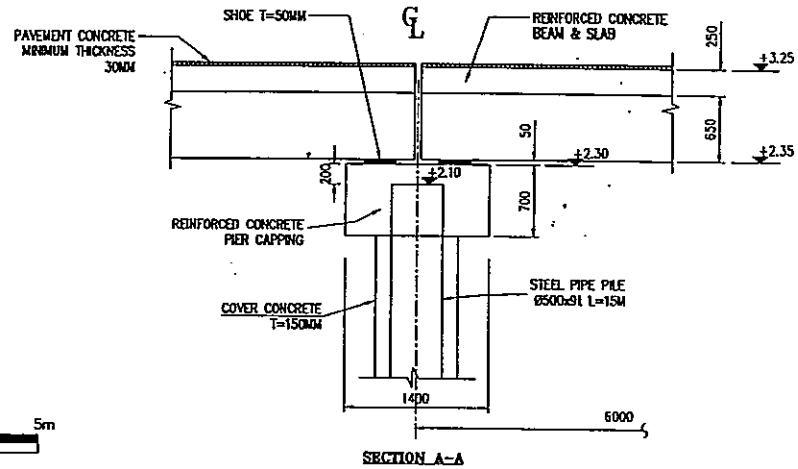
DRAWING TITLE
CAUSEWAY NO.2
TYPICAL CROSS SECTION

SCALE	SHEET NO.	REV. NO.
1 : 100	CW-06	REV.02, JULY.18

CAUSEWAY NO.2 SECTION OF BRIDGE AND PIER



SECTION OF BRIDGE AND PIER



SECTION A-A

SCALE

0 1m 2m 3m 4m 5m

JICA JAPAN INTERNATIONAL COOPERATION AGENCY

REPUBLIC OF MALDIVES
MINISTRY OF FOREIGN AFFAIRS
MINISTRY OF PLANNING AND NATIONAL DEVELOPMENT

NOTES:

1. Handrail shall be reinforced concrete unifying with bridge super structure.
2. The contractor shall prepare shop drawings of shoes for Engineer's approval. Shoe type shall be shoe rubber T=50 or equivalent.

THE STUDY ON TSUNAMI RECOVERY, REHABILITATION AND DEVELOPMENT OF ISLANDS IN MALDIVES

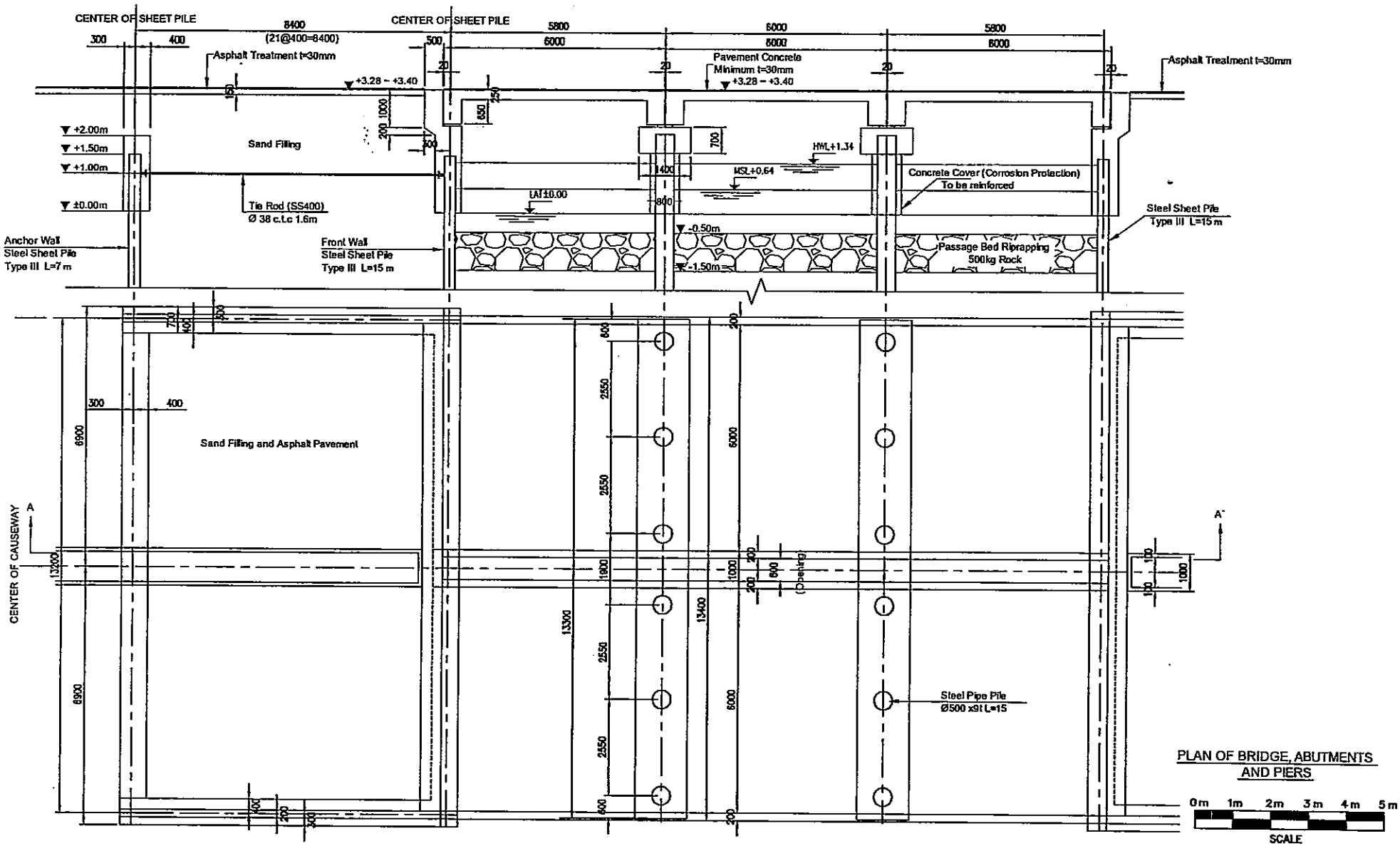
YACHIYO ENGINEERING CO.,LTD.
NIPPON KOEI CO.,LTD.

	PREPARED BY	CHECKED BY	APPROVED BY
NAME	F. Shiomi, T. Hotta	S. Kubo, M. Amemiya	M. Komiya
SIGNATURE			
DATE	July 20, 2005	July 20, 2005	July 30, 2005

DRAWING TITLE
CAUSWAY NO.2
SECTION OF BRIDGE AND PIER

SCALE	SHEET NO.	REV. NO.
1 : 100	CW-07	REV.02...JULY.13

PLAN & LONGITUDINAL SECTION OF BRIDGE (SECTION A-A)



JICA JAPAN INTERNATIONAL COOPERATION AGENCY

REPUBLIC OF MALDIVES
MINISTRY OF FOREIGN AFFAIRS
MINISTRY OF PLANNING AND NATIONAL DEVELOPMENT

NOTES:

1. The Contractor shall get Engineer's approval for the pile length before placing its order.
2. The Contractor shall prepare shop drawings indicating the detail of concrete cover to piles.
3. The Contractor shall get Engineer's approval for treatment of pile tip covering connection between concrete structure and pile.

THE STUDY ON TSUNAMI RECOVERY, REHABILITATION AND DEVELOPMENT OF ISLANDS IN MALDIVES

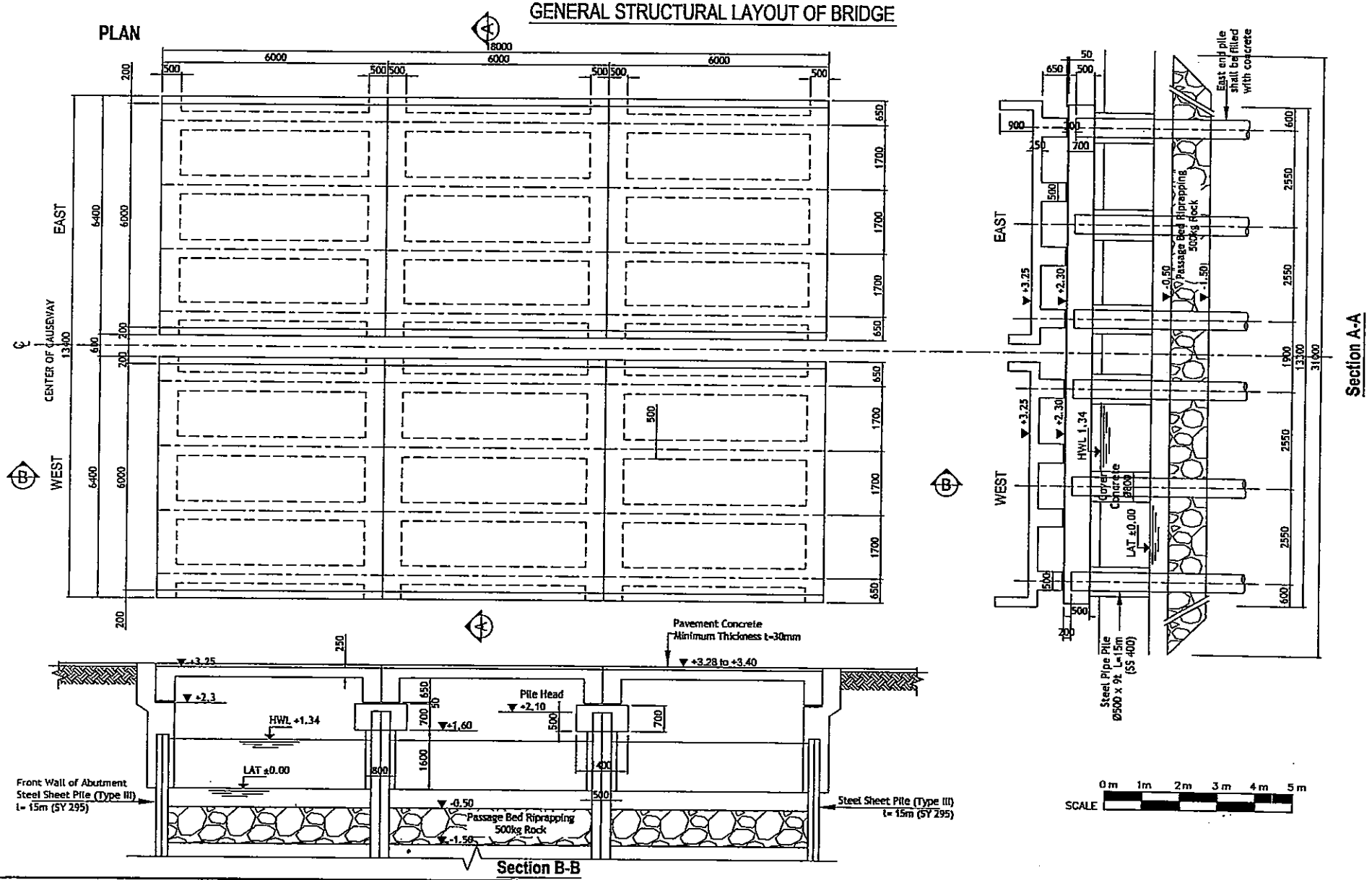
YACHIYO ENGINEERING CO.,LTD.
NIPPON KOEI CO.,LTD.

DRAWING TITLE: PLAN & LONGITUDINAL SECTION OF BRIDGE

	PREPARED BY	CHECKED BY	APPROVED BY
NAME	F.Shiomi, T.Hotta	S.Kubo, M.Amemiya	M. Komiya
SIGNATURE			
DATE	July 20, 2005	July 20, 2005	July 30, 2005

SCALE	SHEET NO.	REV. NO.
1 : 100	CW-08	REV.02..JULY.18

GENERAL STRUCTURAL LAYOUT OF BRIDGE



JICA JAPAN INTERNATIONAL COOPERATION AGENCY

REPUBLIC OF MALDIVES
MINISTRY OF FOREIGN AFFAIRS
MINISTRY OF PLANNING AND NATIONAL DEVELOPMENT

NOTES:

1. Proportion of pavement concrete shall be approved by Engineer.

THE STUDY ON TSUNAMI RECOVERY, REHABILITATION AND DEVELOPMENT OF ISLANDS IN MALDIVES

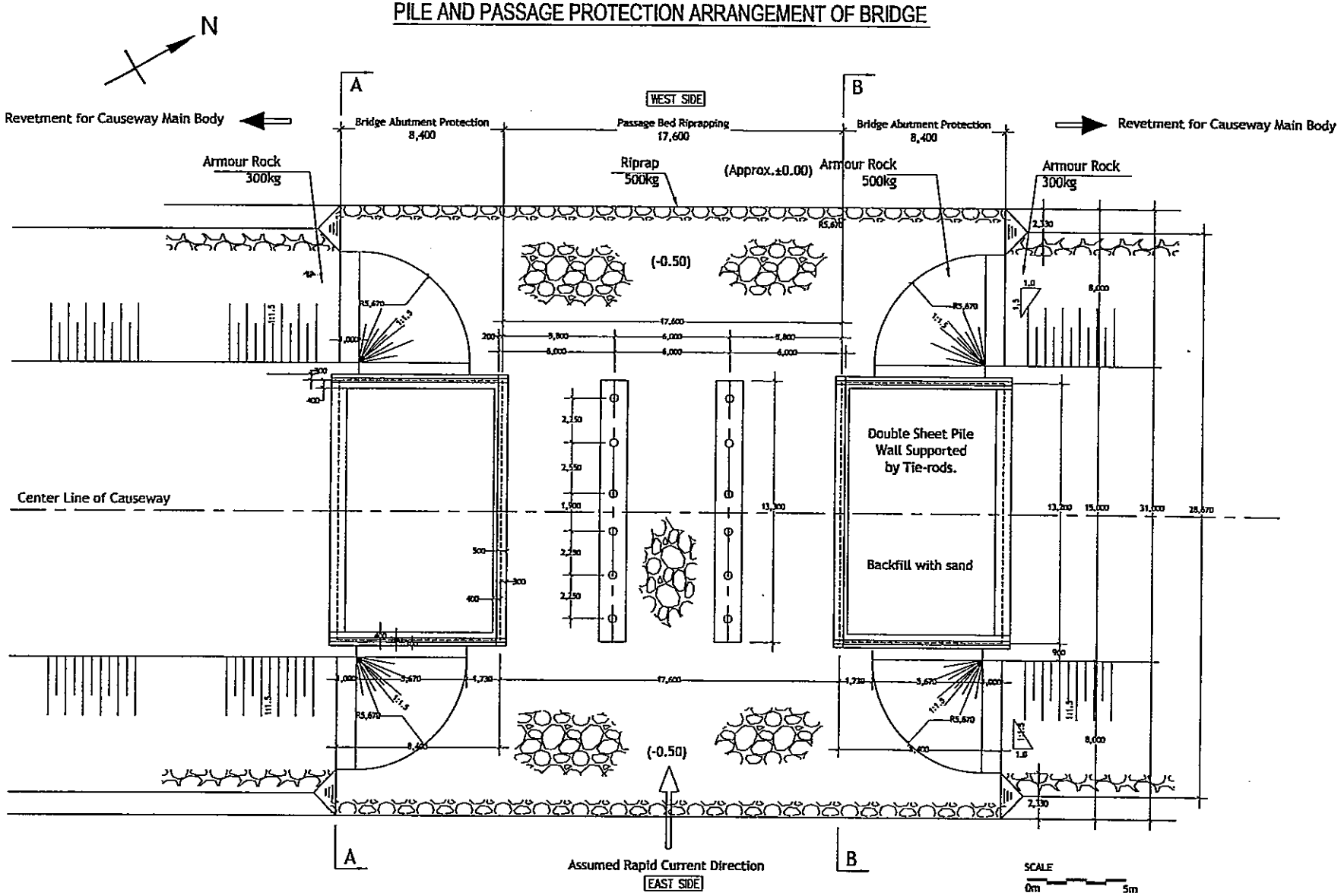
YACHIYO ENGINEERING CO.,LTD.
NIPPON KOEI CO.,LTD.

	PREPARED BY	CHECKED BY	APPROVED BY
NAME	F. Shiomi, T. Hotta	S. Kubo, M. Amemiya	M. Komiya
SIGNATURE			
DATE	July 20, 2005	July 20, 2005	July 30, 2005

DRAWING TITLE: GENERAL STRUCTURAL LAYOUT OF BRIDGE

SCALE	SHEET NO.	REV. NO.
1 : 100	CW-09	REV.02..JULY.18

PILE AND PASSAGE PROTECTION ARRANGEMENT OF BRIDGE



JICA JAPAN INTERNATIONAL COOPERATION AGENCY

REPUBLIC OF MALDIVES
MINISTRY OF FOREIGN AFFAIRS
MINISTRY OF PLANNING AND NATIONAL DEVELOPMENT

NOTES:

1. Dimension in millimeter.
2. Elevation in meters.
3. The Contractor shall prepare temporary works under high current 4m/sec or more once opening the passage.
4. Temporary dike shall be provided to close any opening during bridge sub-structure construction.

THE STUDY ON TSUNAMI RECOVERY, REHABILITATION AND DEVELOPMENT OF ISLANDS IN MALDIVES

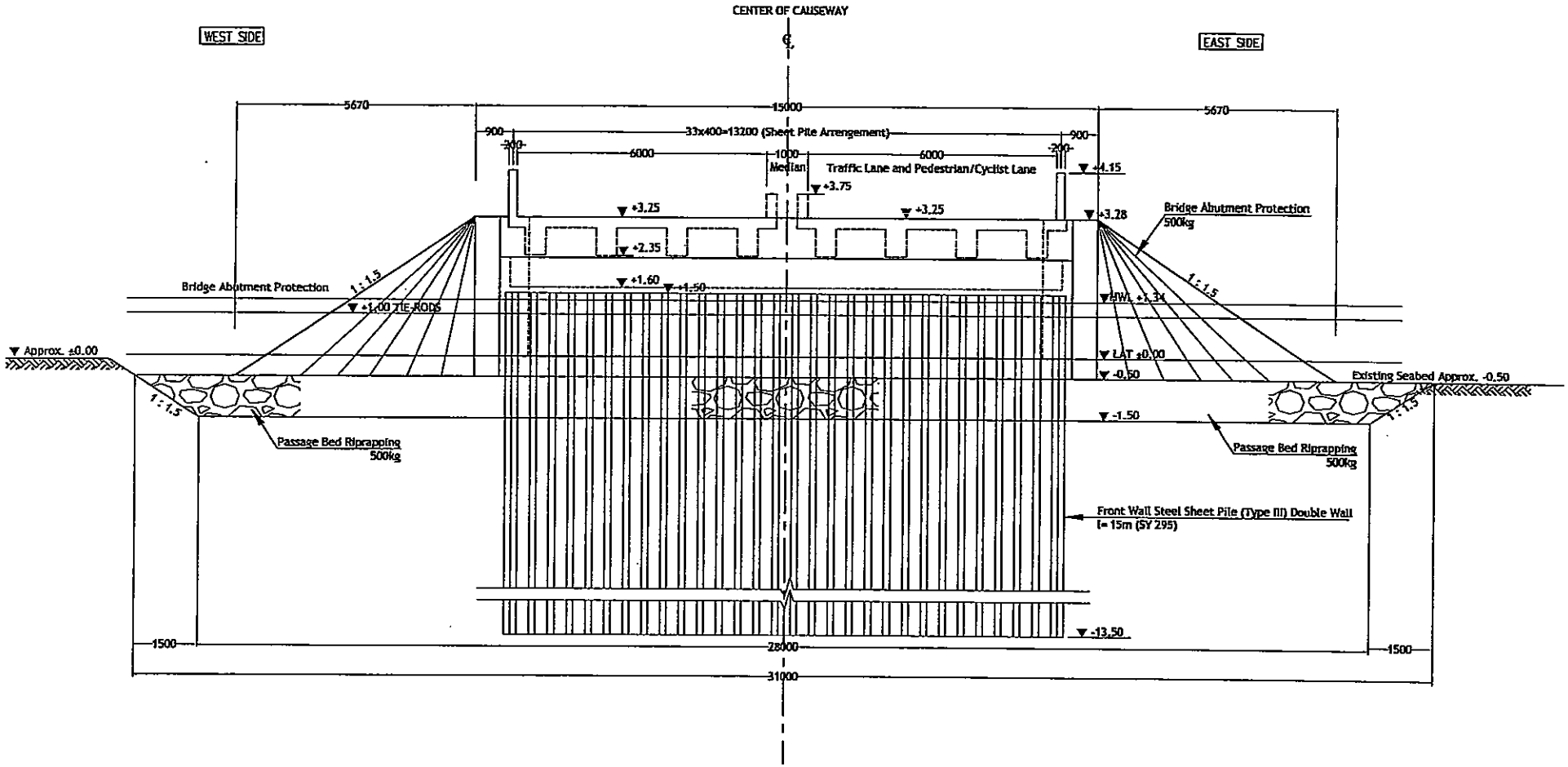
YACHIYO ENGINEERING CO.,LTD.
NIPPON KOEI CO.,LTD.

	PREPARED BY	CHECKED BY	APPROVED BY
NAME	F.Shiomi, T.Hotta	S. Kubo, M. Amemiya	M. Komiya
SIGNATURE			
DATE	July 20, 2005	July 20, 2005	July 30, 2005

DRAWING TITLE
PILE AND PASSAGE PROTECTION ARRANGEMENT OF BRIDGE

SCALE	SHEET NO.	REV. NO.
1 : 100	CW-10	REV.02. JULY.18

CROSS SECTION AND STRUCTURAL SECTION OF ABUTMENT (1)



SECTION B-B
(Refer to DWG No. CW-10)

SCALE

0m 1m 2m 3m 4m 5m

JICA JAPAN INTERNATIONAL COOPERATION AGENCY

REPUBLIC OF MALDIVES
MINISTRY OF FOREIGN AFFAIRS
MINISTRY OF PLANNING AND NATIONAL DEVELOPMENT

NOTES:

1. The Contractor shall pay attention to a high speed current once openning passage.
2. Refer to notes in DWG No. CW-03.
3. Data of new three borings will be available soon for review.
4. The Contractor shall collect and review all natural conditions including soil data.

THE STUDY ON TSUNAMI RECOVERY, REHABILITATION AND DEVELOPMENT OF ISLANDS IN MALDIVES

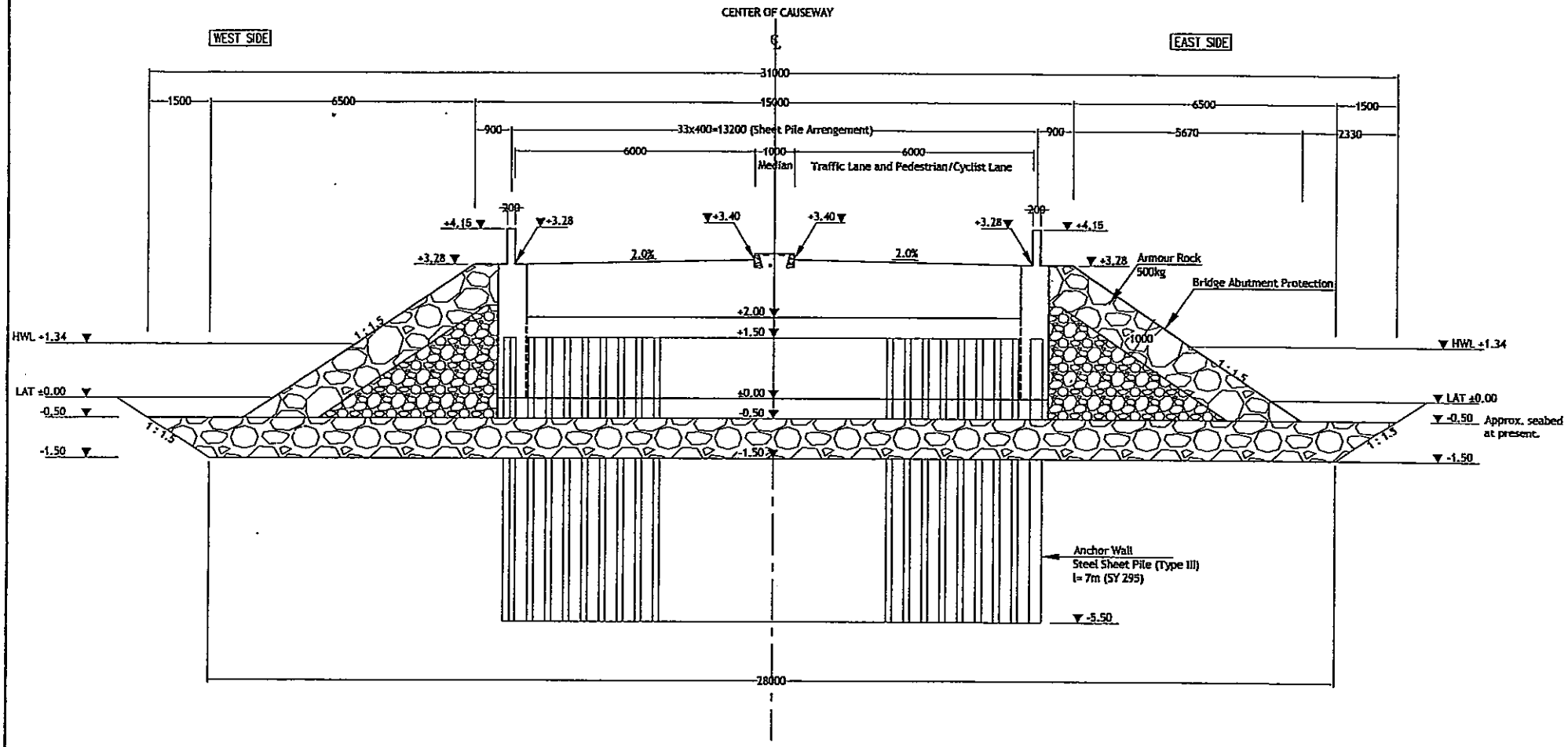
YACHIYO ENGINEERING CO.,LTD.
NIPPON KOEI CO.,LTD.

	PREPARED BY	CHECKED BY	APPROVED BY
NAME	F.Shiomi, T.Hotta	S. Kubo, M. Amemiya	M. Komiya
SIGNATURE			
DATE	July 20, 2005	July 20, 2005	July 30, 2005

DRAWING TITLE
CROSS SECTION AND STRUCTURAL SECTION OF ABUTMENT (1)

SCALE	SHEET NO.	REV. NO.
1 : 100	CW-11	

CROSS SECTION AND STRUCTURAL SECTION OF ABUTMENT (2)



SECTION A-A
(Refer to DWG No. CW-10)

SCALE
0m 1m 2m 3m 4m 5m

JICA JAPAN INTERNATIONAL COOPERATION AGENCY

REPUBLIC OF MALDIVES
MINISTRY OF FOREIGN AFFAIRS
MINISTRY OF PLANNING AND NATIONAL DEVELOPMENT

NOTES:

THE STUDY ON TSUNAMI RECOVERY, REHABILITATION AND DEVELOPMENT OF ISLANDS IN MALDIVES

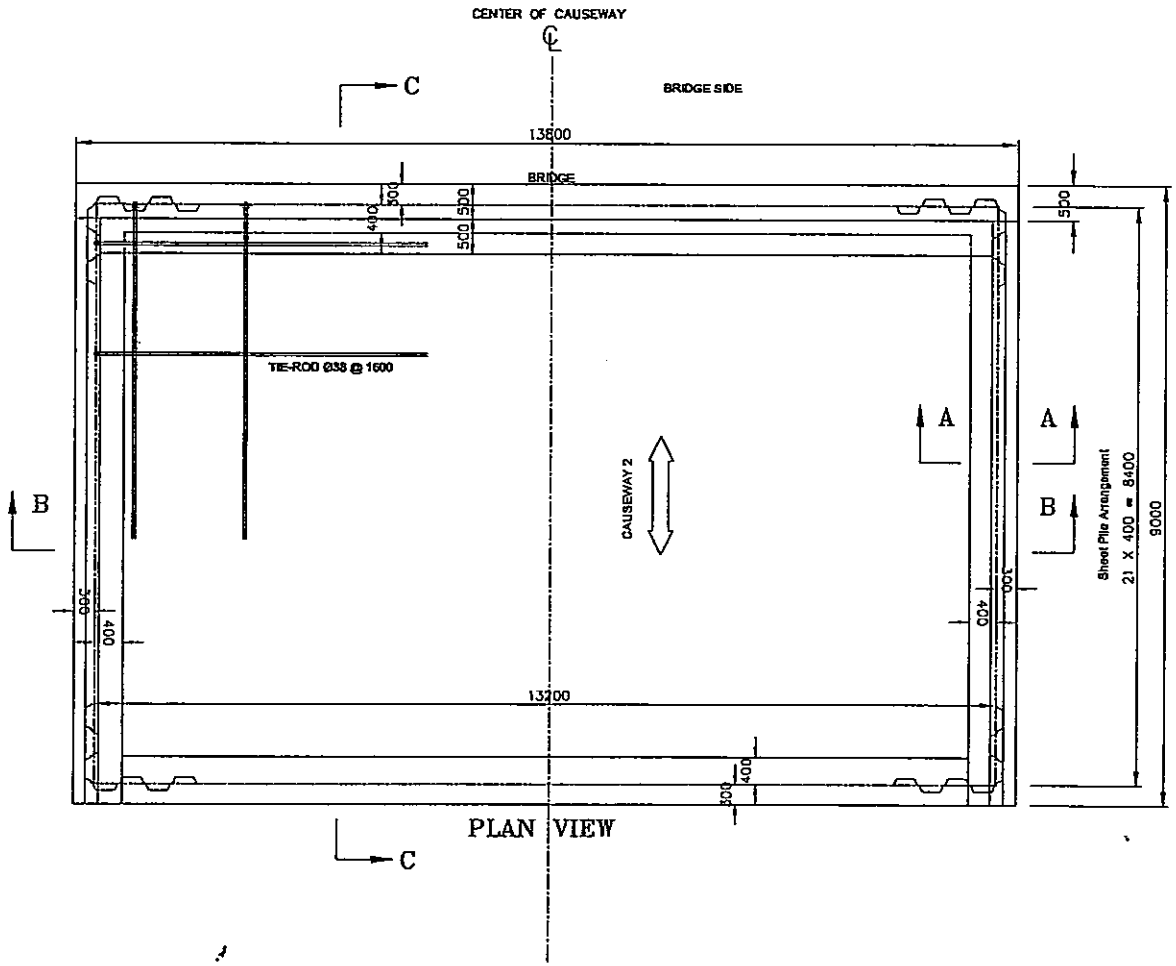
YACHIYO ENGINEERING CO.,LTD.
NIPPON KOEI CO.,LTD.

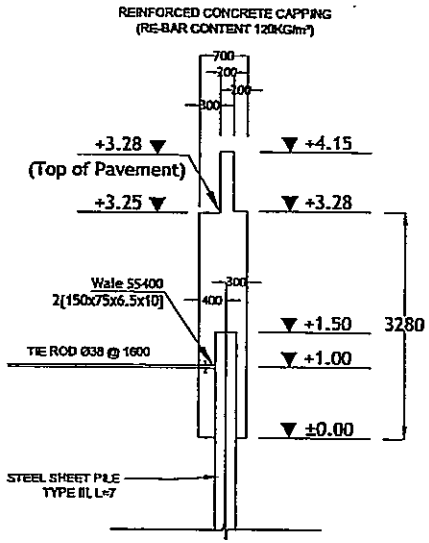
	PREPARED BY	CHECKED BY	APPROVED BY
NAME	F. Shioml, T. Hota	S. Kubo, M. Amemiya	M. Komiya
SIGNATURE			
DATE	July 20, 2005	July 20, 2005	July 30, 2005

DRAWING TITLE
CROSS SECTION AND STRUCTURAL SECTION OF ABUTMENT (2)

SCALE	SHEET NO.	REV. NO.
1 : 100	CW-12	REV.02 JULY.18

PLAN AND SECTION OF ABUTMENT SHEET PILE FOUNDATION





SECTION A–A

SCALE

0m 1m 2m 3m 4m 5m

JICA JAPAN INTERNATIONAL COOPERATION AGENCY

REPUBLIC OF MALDIVES
MINISTRY OF FOREIGN AFFAIRS
MINISTRY OF PLANNING AND NATIONAL DEVELOPMENT

NOTES:
1. The Contractor shall get approval on the sequence of pile driving.
2. The Contractor shall prepare shop drawings of sheet pile arrangement for Engineer's approval.
3. The Contractor shall get Engineer's approval on the pile length before placing its order.

THE STUDY ON TSUNAMI RECOVERY, REHABILITATION AND DEVELOPMENT OF ISLANDS IN MALDIVES

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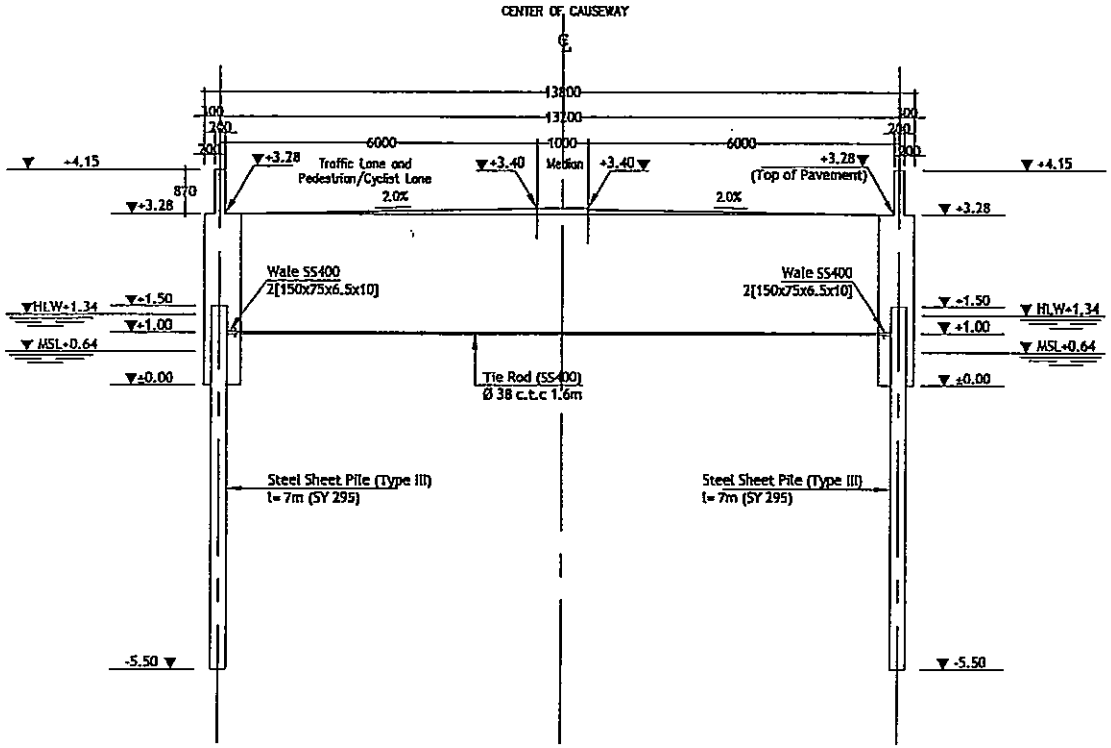
NIPPON KOEI CO.,LTD.

	PREPARED BY	CHECKED BY	APPROVED BY
NAME	F. Shiomi, T. Hotta	S. Kubo, M. Amemiya	M. Komiya
SIGNATURE			
DATE	July 20, 2005	July 20, 2005	July 30, 2005

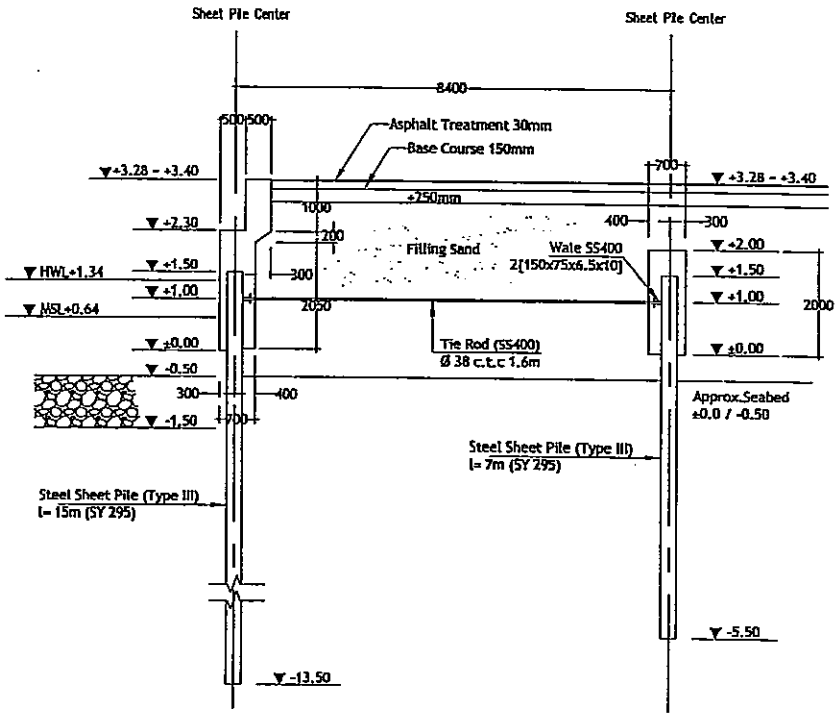
DRAWING TITLE
PLAN AND SECTION OF ABUTMENT SHEET PILE FOUNDATION

SCALE	SHEET NO.	REV. NO.
1:75	CW-13	REV.02...JULY.13

CROSS SECTION OF SHEET PILE DOUBLE WALL OF ABUTMENT



SECTION B-B
CROSS SECTION OF ABUTMENT
(STEEL SHEET PILE DOUBLE WALL)
(Refer to DWG No. CW-13)



SECTION C-C
CROSS SECTION OF ABUTMENT
(STEEL SHEET PILE DOUBLE WALL)
(Refer to DWG No. CW-13)

SCALE

0m 1m 2m 3m 4m 5m

JICA JAPAN INTERNATIONAL COOPERATION AGENCY

REPUBLIC OF MALDIVES
MINISTRY OF FOREIGN AFFAIRS
MINISTRY OF PLANNING AND NATIONAL DEVELOPMENT

NOTES:
1. Dimension in millimeter.
2. Elevation in meters.
3. The Contractor shall get Engineer's approval as the pile length before placings its order.

THE STUDY ON TSUNAMI RECOVERY, REHABILITATION AND DEVELOPMENT OF ISLANDS IN MALDIVES

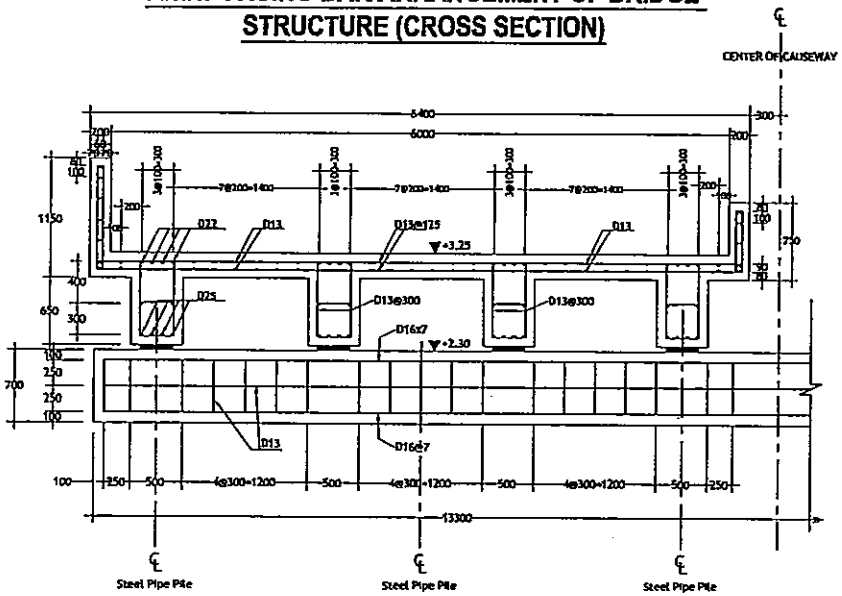
YACHIYO ENGINEERING CO.,LTD.
NIPPON KOEI CO.,LTD.

	PREPARED BY	CHECKED BY	APPROVED BY
NAME	F. Shiomi, T. Hotta	S. Kubo, M. Amemiya	M. Komiya
SIGNATURE			
DATE	July 20, 2005	July 20, 2005	July 30, 2005

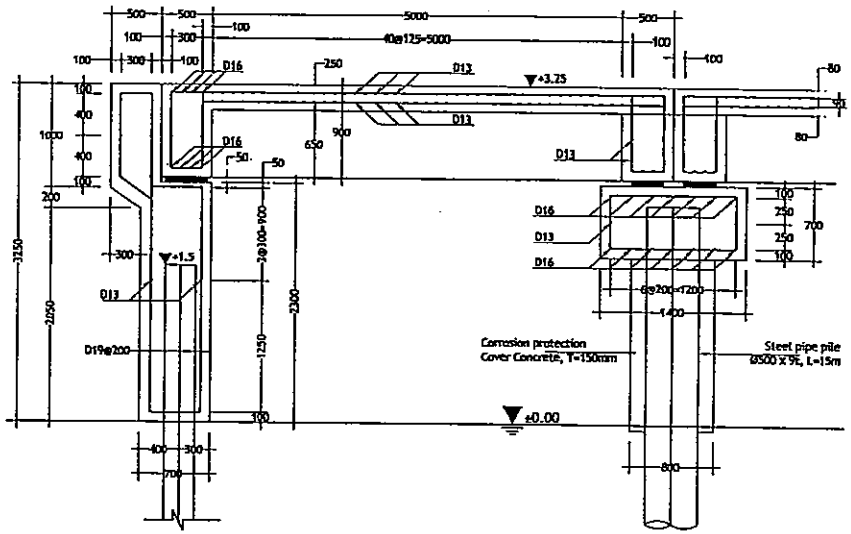
DRAWING TITLE
CROSS SECTION OF SHEET PILE DOUBLE WALL OF ABUTMENT

SCALE	SHEET NO.	REV. NO.
1 : 100	CW-14	REV.02..JULY.18

REINFORCING BAR ARRANGEMENT OF BRIDGE STRUCTURE (CROSS SECTION)



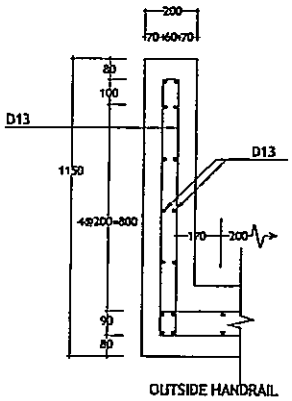
REINFORCING BAR ARRANGEMENT OF BRIDGE STRUCTURE (LONGITUDINAL SECTION)

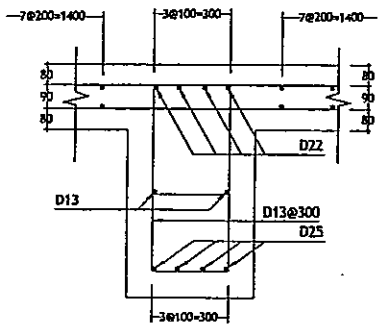


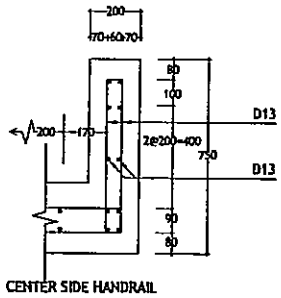
SCALE

0 1m 2m 3m

DETAIL OF BRIDGE SLAB AND HANDRAIL


OUTSIDE HANDRAIL


BEAM AND SLAB


CENTER SIDE HANDRAIL

SCALE

0 0.5 1m

JICA JAPAN INTERNATIONAL COOPERATION AGENCY

REPUBLIC OF MALDIVES
MINISTRY OF FOREIGN AFFAIRS
MINISTRY OF PLANNING AND NATIONAL DEVELOPMENT

NOTES:

1. The Contractor shall prepare shop drawings for details of Bridge, Abutment and Piers including shoes for Engineer's approval.

THE STUDY ON TSUNAMI RECOVERY, REHABILITATION AND DEVELOPMENT OF ISLANDS IN MALDIVES

YEC YACHIYO ENGINEERING CO.,LTD.
NIPPON KOEI CO.,LTD.

	PREPARED BY	CHECKED BY	APPROVED BY
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SIGNATURE			
DATE	July 20, 2005	July 20, 2005	July 30, 2005

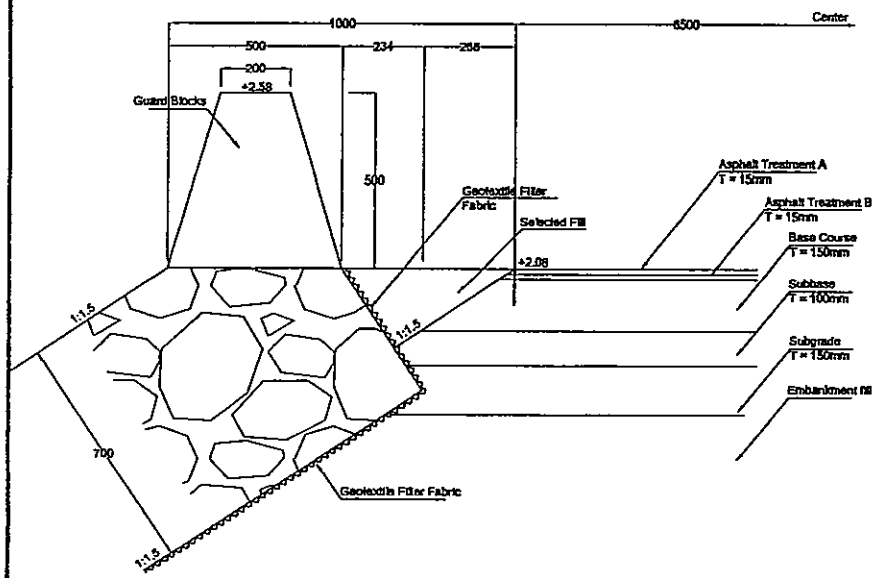
DRAWING TITLE

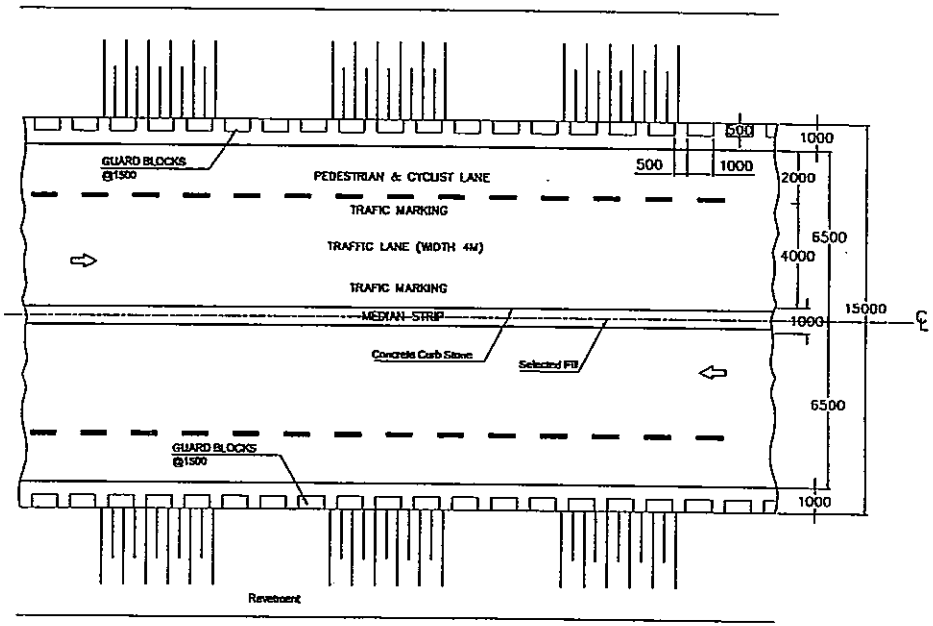
REINFORCING BAR ARRANGEMENT OF BRIDGE STRUCTURE (CROSS SECTION)

SCALE	SHEET NO.	REV. NO.
AS GIVEN	CW-15	REV.02...JULY.13

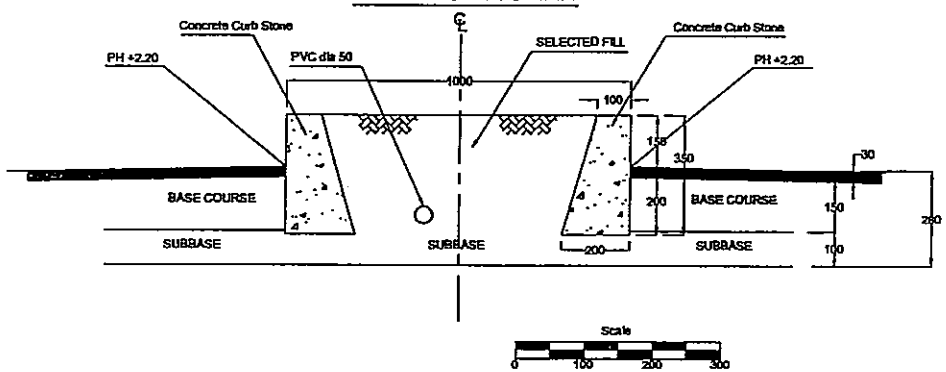
TRAFFIC FACILITIES AND SAFETY MEASURES

GUARD BLOCK AND SHOULDER





DETAIL OF MEDIAN



JICA JAPAN INTERNATIONAL COOPERATION AGENCY

REPUBLIC OF MALDIVES
MINISTRY OF FOREIGN AFFAIRS
MINISTRY OF PLANNING AND NATIONAL DEVELOPMENT

NOTES:
1. Dimension of curb should be adjusted at the box culvert area.
2. The Contractor shall prepare shop drawing showing the details of guard block and its foundation for Engineer's approval.
3. Between the curbs selected fill material suitable for planting shall be provided as directed by the Engineer.

THE STUDY ON TSUNAMI RECOVERY, REHABILITATION AND DEVELOPMENT OF ISLANDS IN MALDIVES

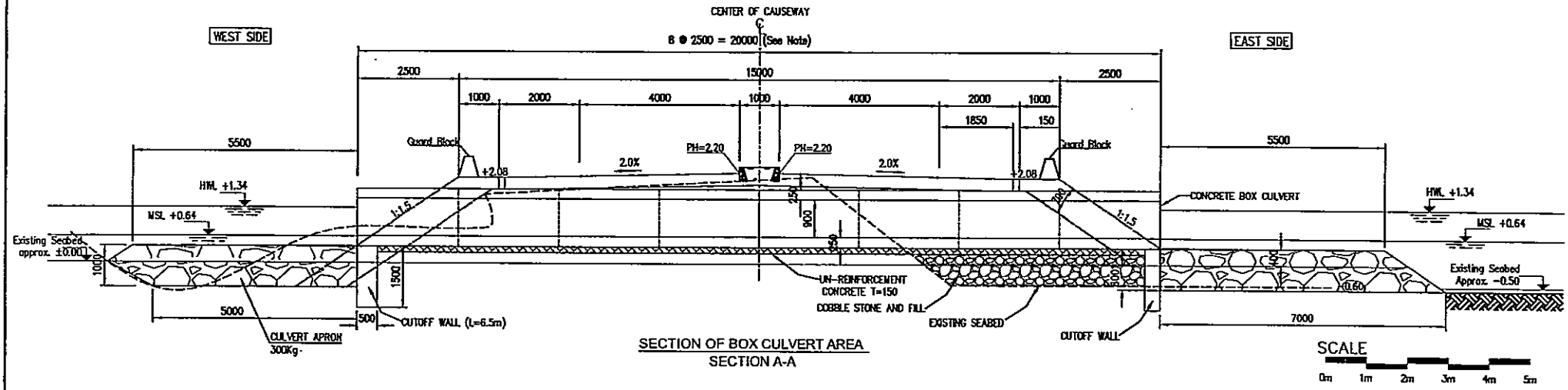
YACHIYO ENGINEERING CO.,LTD.
NIPPON KOEI CO.,LTD.

	PREPARED BY	CHECKED BY	APPROVED BY
NAME	F. Shiomi, T. Hotta	S. Kubo, M. Amemiya	M. Komiya
SIGNATURE			
DATE	July 20, 2005	July 20, 2005	July 30, 2005

DRAWING TITLE: TRAFFIC FACILITIES AND SAFETY MEASURES

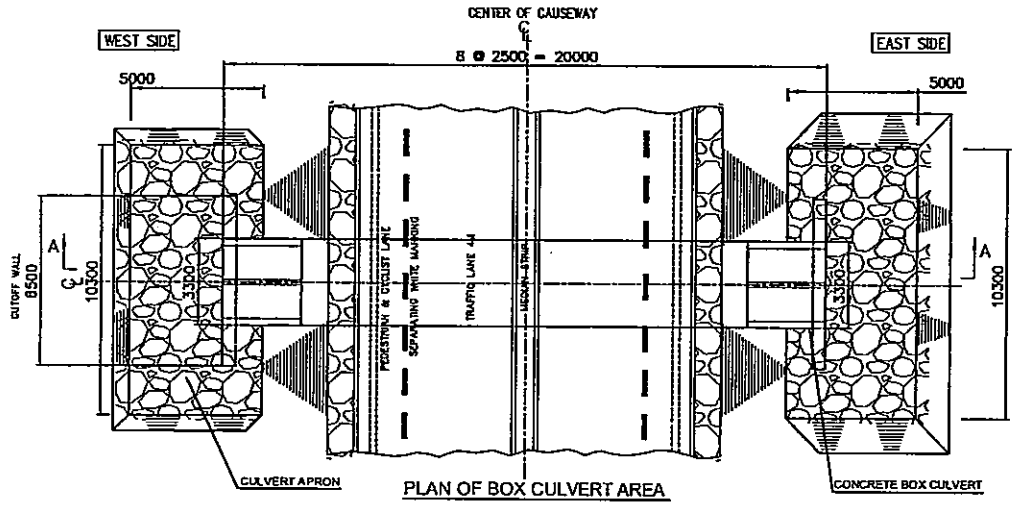
SCALE	SHEET NO.	REV. NO.
1 : 200/ 1 : 15	CW-16	REV.02, JULY.13

PLAN AND SECTION OF CONCRETE BOX CULVERT



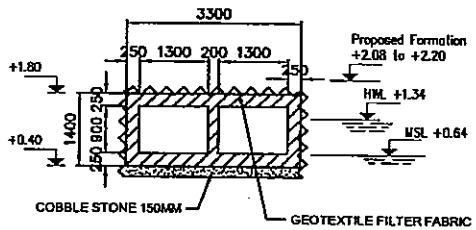
SECTION OF BOX CULVERT AREA
SECTION A-A

SCALE
0m 1m 2m 3m 4m 5m



PLAN OF BOX CULVERT AREA

SCALE
0m 5m 10m



CULVERT SECTION

SCALE
0 1 2 3 4 5m

JICA JAPAN INTERNATIONAL COOPERATION AGENCY

REPUBLIC OF MALDIVES
MINISTRY OF FOREIGN AFFAIRS
MINISTRY OF PLANNING AND NATIONAL DEVELOPMENT

NOTES:
1. Dimension of guard blocks or curb shall be proposed by the Contractor at the box culvert area for Engineer's approval.
2. The Contractor shall prepare in high current 4m/sec or more once opening the passage.
3. Temporary dike shall be provided to close any opening during box culverts construction.
4. Cobble stone and fill shall be provided within the room under the culvert. Effective width of this shall be five meters or more.
5. Steel anchor bars should be planted at the top of the Cutoff Wall.

THE STUDY ON TSUNAMI RECOVERY, REHABILITATION AND DEVELOPMENT OF ISLANDS IN MALDIVES

YACHIYO ENGINEERING CO.,LTD.
NIPPON KOEI CO.,LTD.

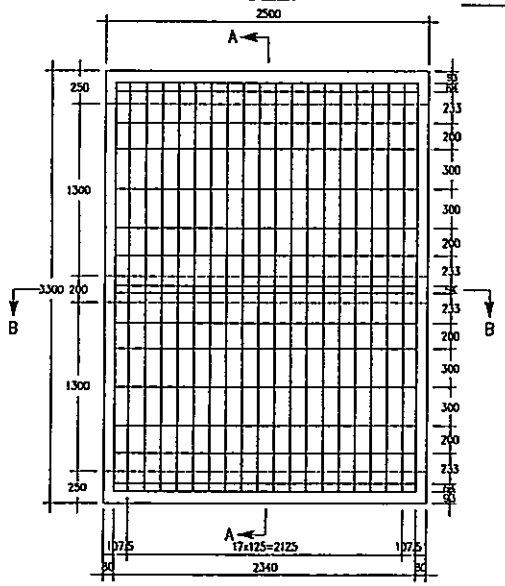
	PREPARED BY	CHECKED BY	APPROVED BY
NAME	F.Shiomi, T.Hotta	S.Kubo, M.Amemiya	M. Komiya
SIGNATURE			
DATE	July 20, 2005	July 20, 2005	July 30, 2005

DRAWING TITLE
PLAN AND SECTION OF CONCRETE BOX CULVERT

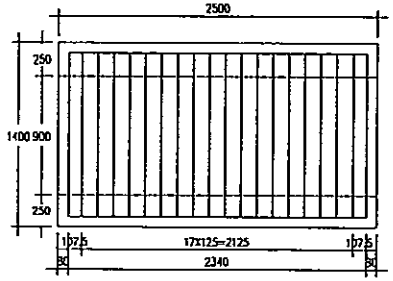
SCALE	SHEET NO.	REV. NO.
1 : 100 / 1:200	CW-17	

BAR ARRANGEMENT OF BOX CULVERT

PLAN

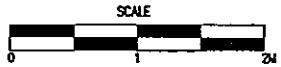


SIDE SECTION B–B

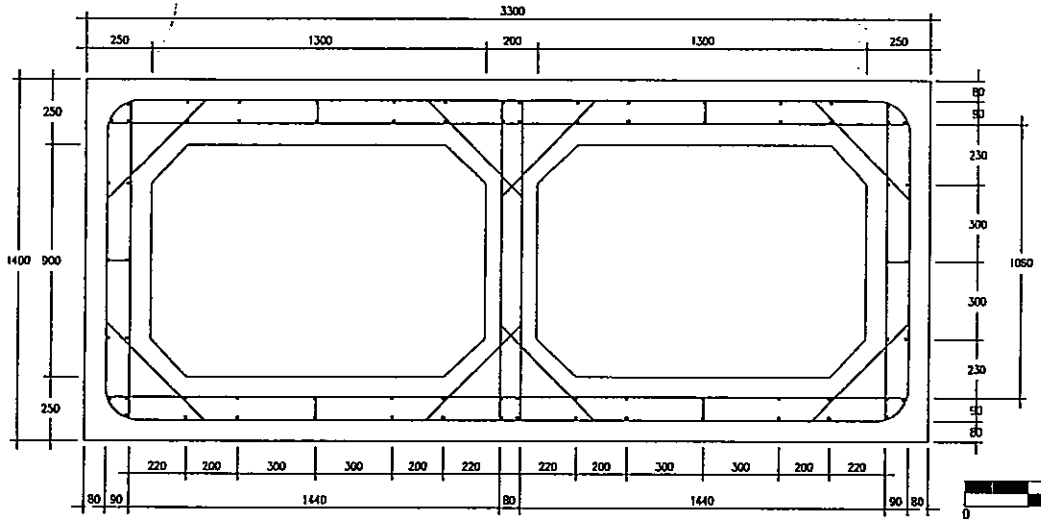


SCALE

SCALE



CROSS SECTION A–A



SCALE

JICA JAPAN INTERNATIONAL COOPERATION AGENCY

REPUBLIC OF MALDIVES
MINISTRY OF FOREIGN AFFAIRS
MINISTRY OF PLANNING AND NATIONAL DEVELOPMENT

NOTES:

1. The diameter of all reinforcing bar is Ø13mm.
   Type of reinforcing bar is SD295 (Allowable tensile stress is 160N/mm²).
2. The Contractor shall prepare shop drawing for the details including unit length, metal fitting for hanging points and joints.

THE STUDY ON TSUNAMI RECOVERY, REHABILITATION AND DEVELOPMENT OF ISLANDS IN MALDIVES

YACHIYO ENGINEERING CO.,LTD.
NIPPON KOEI CO.,LTD.

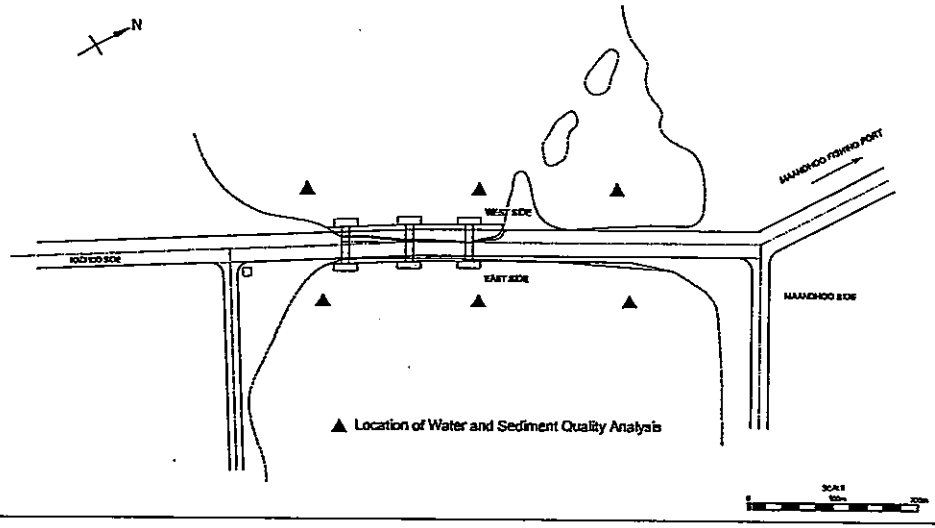
	PREPARED BY	CHECKED BY	APPROVED BY
NAME	F. Shiomi, T. Hotta	S. Kubo, M. Amemiya	M. Komiya
SIGNATURE			
DATE	July 20, 2005	July 20, 2005	July 30, 2005

DRAWING TITLE
BAR ARRANGEMENT OF BOX CULVERT

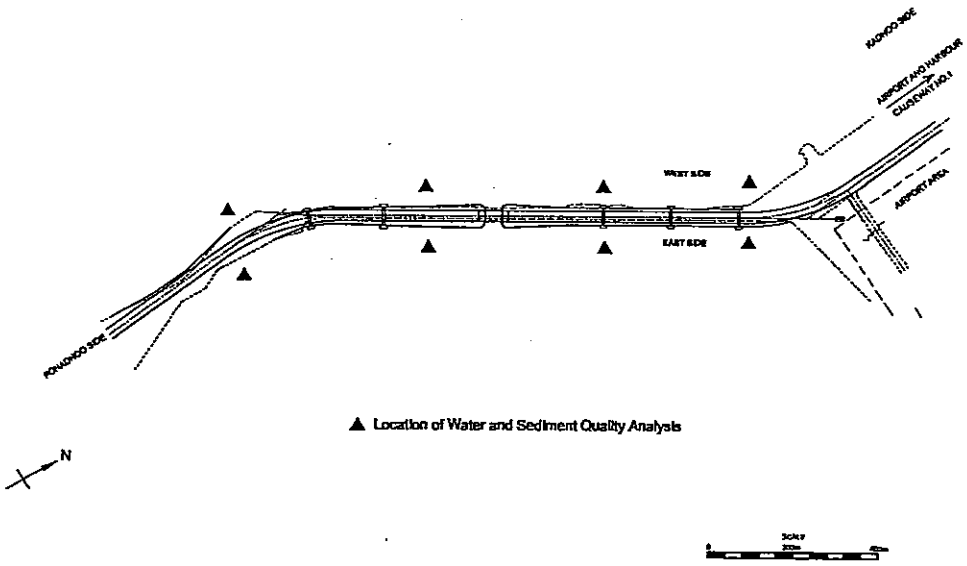
SCALE	SHEET NO.	REV. NO.
1 : 100	CW-18	REV.02....JULY.13

LOCATION OF WATER AND SEDIMENT QUALITY ANALYSIS FOR CAUSEWAY NO.1 & NO.2

CAUSEWAY NO.1



CAUSEWAY NO.2

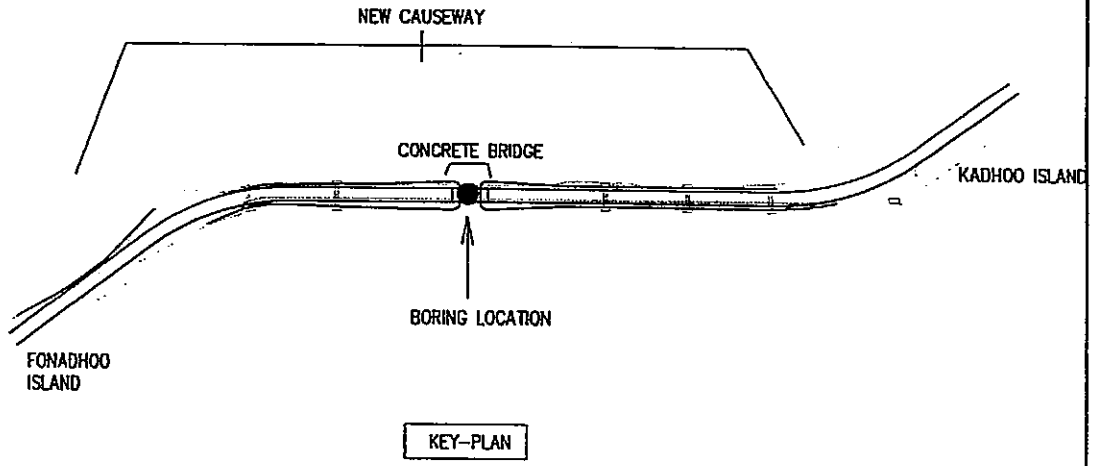


JICA JAPAN INTERNATIONAL COOPERATION AGENCY	NOTES: 1. The exact sampling location shall be determined at the site by the Engineer.	THE STUDY ON TSUNAMI RECOVERY, REHABILITATION AND DEVELOPMENT OF ISLANDS IN MALDIVES	
REPUBLIC OF MALDIVES MINISTRY OF FOREIGN AFFAIRS MINISTRY OF PLANNING AND NATIONAL DEVELOPMENT		YACHIYO ENGINEERING CO.,LTD. NIPPON KOEI CO.,LTD.	DRAWING TITLE: LOCATION OF WATER AND SEDIMENT QUALITY ANALYSIS FOR CAUSEWAY NO.1 & NO.2

	PREPARED BY	CHECKED BY	APPROVED BY	SCALE	SHEET NO.	REV. NO.
NAME	T. Sato	M. Amemiya	M. Komiya	1:3000 / 1:6000	CW-19	REV.02_JULY.13
SIGNATURE						
DATE	July 20, 2005	July 20, 2005	July 30, 2005			

BORING STRATUM CHART

DESCRIPTION OF STRATA	Reduced Level (m)	Legend	Depth (m)	SPT (Standard Penetration Test) N- Value 0 10 20 30 40 50
WHITE, OFF WHITE,YELLOWISH WHITE SLIGHTLY SILTY FINE TO MEDIUM CORAL SAND WITH CORAL FRAGMENT OF COARSE GRAVEL SIZE	-0.020		1 2	4
MEDIUM DENSE WHITE, OFF WHITE SLIGHTLY SILTY FINE TO MEDIUM CORAL SAND WITH COARSE GRAVEL SIZE CORAL FRAGMENTS AND SHELL FRAGMENTS 4.50-5.00mm HIGH CONTENT OF CORAL FRAGMENTS	-4.200		3 4 5 6	20 21 19
MEDIUM DENSE WHITE, OFF WHITE SILTY MEDIUM TO COARSE CORAL SAND WITH CORAL FRAGMENTS AND SHELL FRAGMENTS	-8.200		7 8 9 10	29 20
WHITE, OFF WHITE, SLIGHTLY SILTY FINE CORAL SAND AND MEDIUM TO COARSE GRAVEL SIZE CORAL FRAGMENTS	-13.200		11 12 13 14 15	21 19 18
MEDIUM DENSE WHITE, OFF WHITE SILTY MEDIUM TO COARSE CORAL SAND COARSE GRAVEL SIZE CORAL FRAGMENTS	-18.200		16 17 18 19 20	23 19 23



JICA JAPAN INTERNATIONAL COOPERATION AGENCY

REPUBLIC OF MALDIVES
MINISTRY OF FOREIGN AFFAIRS
MINISTRY OF PLANNING AND NATIONAL DEVELOPMENT

NOTES:
1. Dimension in millimeter.
2. Elevation in meters.
3. Water level difference in 0.3m between the West and East was observed in ordinary climatic millions May, 2005.

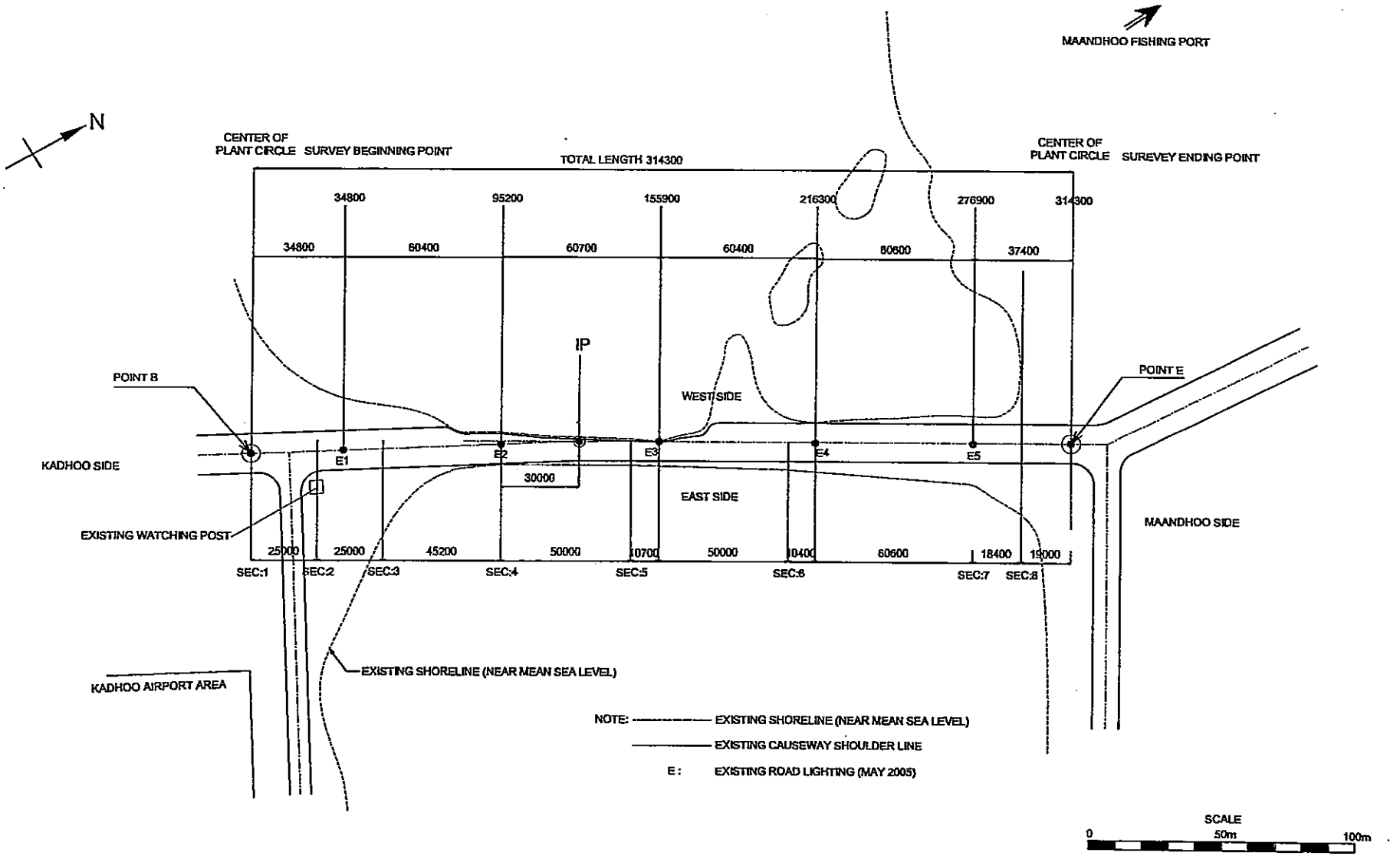
THE STUDY ON TSUNAMI RECOVERY, REHABILITATION AND DEVELOPMENT OF ISLANDS IN MALDIVES

YACHIYO ENGINEERING CO.,LTD.
NIPPON KOEI CO.,LTD.

	PREPARED BY	CHECKED BY	APPROVED BY
NAME	Y. Horigome	Y. Horigome	M. Komiya
SIGNATURE			
DATE	July 20, 2005	July 20, 2005	July 30, 2005

DRAWING TITLE
CAUSEWAY No.1
BORING STRATUM CHART

SCALE	SHEET NO.	REV. NO.
1 : 100	CW-20	



JICA JAPAN INTERNATIONAL COOPERATION AGENCY

REPUBLIC OF MALDIVES
MINISTRY OF FOREIGN AFFAIRS
MINISTRY OF PLANNING AND NATIONAL DEVELOPMENT

NOTES:
1. All figures are approximate.
2. These data should be confirmed by topographic Survey and Bathymetric Survey before Construction works.

THE STUDY ON TSUNAMI RECOVERY, REHABILITATION AND DEVELOPMENT OF ISLANDS IN MALDIVES

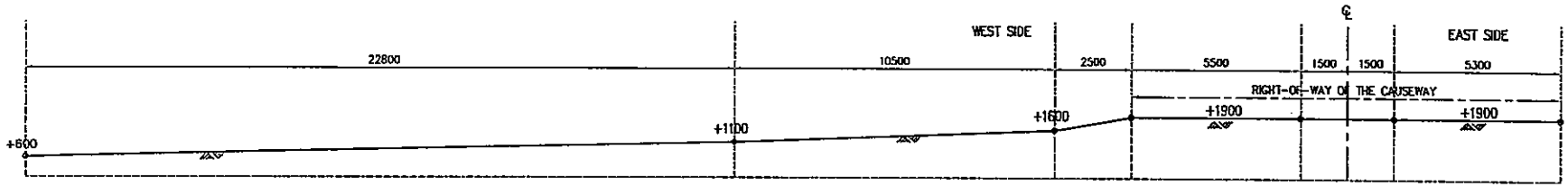
YACHIYO ENGINEERING CO.,LTD.
NIPPON KOEI CO.,LTD.

	PREPARED BY	CHECKED BY	APPROVED BY
NAME	O. Sase, T. Sato	S. Kubo	M. Komiya
SIGNATURE			
DATE	July 20, 2005	July 20, 2005	July 30, 2005

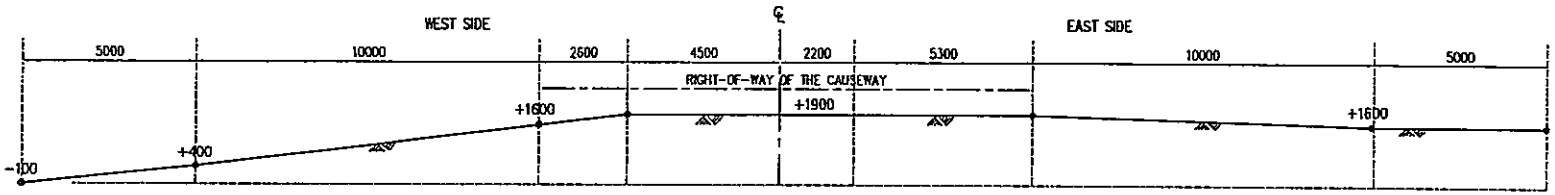
DRAWING TITLE
PRELIMINARY SURVEY DATA FOR REFERENCE INFORMATION
CAUSEWAY NO.1 (KADHOO-MAANDHOO)

SCALE	SHEET NO.	REV. NO.
1 : 1500	CW-REF-1	REV.02..JULY.13

Sec: 1



Sec: 2



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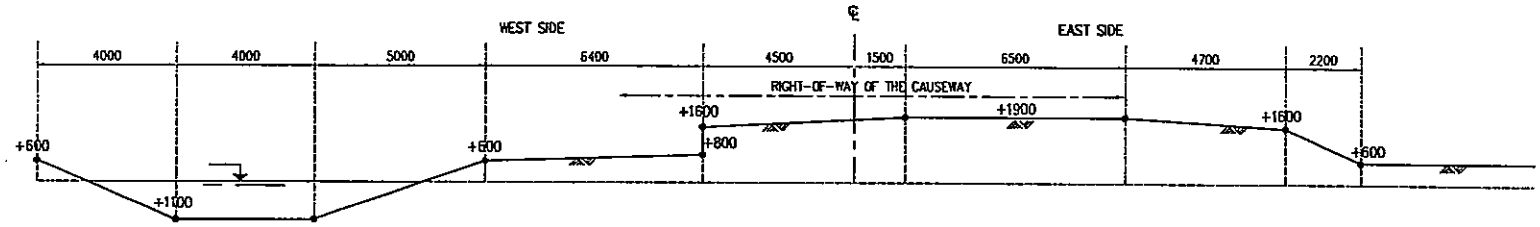

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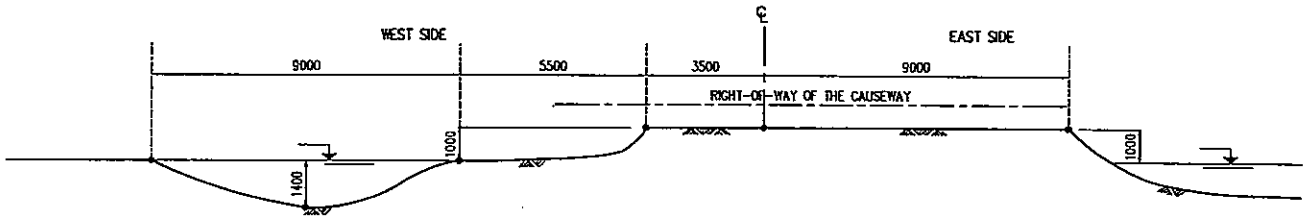

SCALE
0 1 2 3 4 5m

JICA JAPAN INTERNATIONAL COOPERATION AGENCY

REPUBLIC OF MALDIVES
MINISTRY OF FOREIGN AFFAIRS
MINISTRY OF PLANNING AND NATIONAL DEVELOPMENT

NOTES:
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3. These data should be confirmed by topographic Survey and Bathymetric Survey before Construction works.
4. Elevation is referred to the tide level shown in Tide Table.
5. Shape of west side is changing daily.

THE STUDY ON TSUNAMI RECOVERY, REHABILITATION AND DEVELOPMENT OF ISLANDS IN MALDIVES

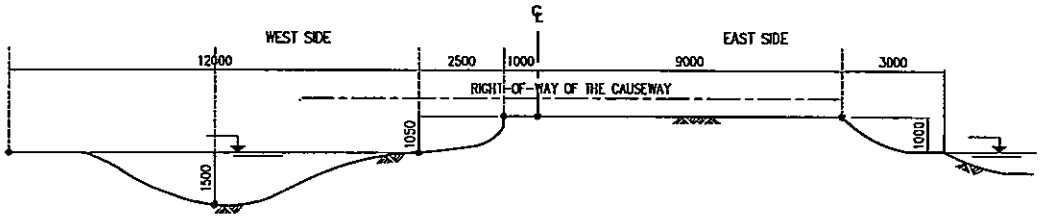
YEC YACHIYO ENGINEERING CO.,LTD.
NIPPON KOEI CO.,LTD.

	PREPARED BY	CHECKED BY	APPROVED BY
NAME	O. Sase, T. Sato	S. Kubo	M. Komiya
SIGNATURE			
DATE	July 20, 2005	July 20, 2005	July 30, 2005

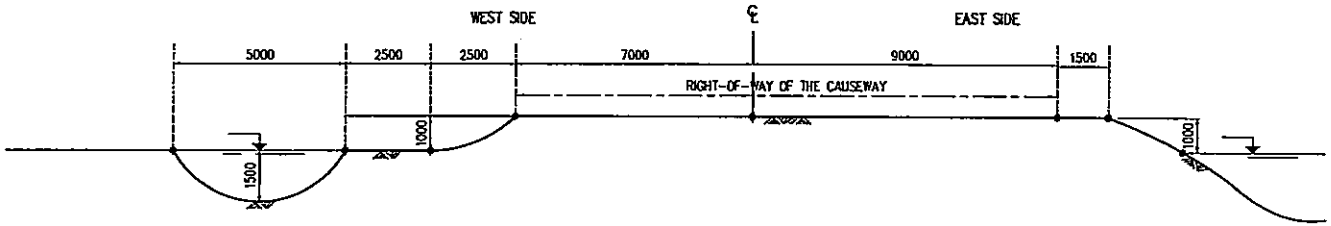
DRAWING TITLE
PRELIMINARY SURVEY DATA FOR REFERENCE INFORMATION
CAUSEWAY NO.1 / SECTION 1/4

SCALE	SHEET NO.	REV. NO.
1 : 150	CW-REF-2	REV.02..JULY.13

Sec: 5



Sec: 6



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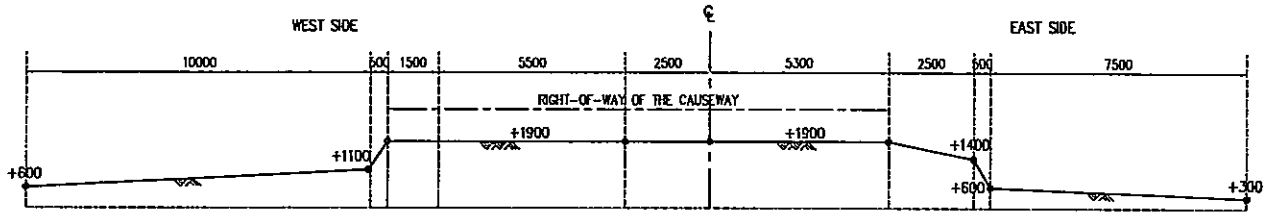

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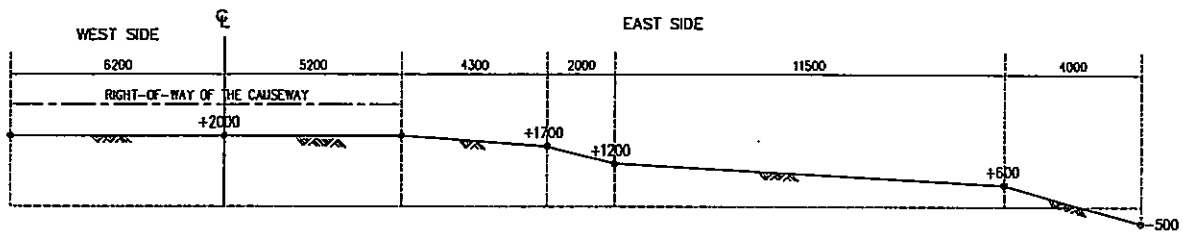

SCALE
0 1 2 3 4 5m

JICA JAPAN INTERNATIONAL COOPERATION AGENCY

REPUBLIC OF MALDIVES
MINISTRY OF FOREIGN AFFAIRS
MINISTRY OF PLANNING AND NATIONAL DEVELOPMENT

NOTES:
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4. Elevation is referred to the tide level shown in Tide Table.
5. Shape of west side is changing daily.

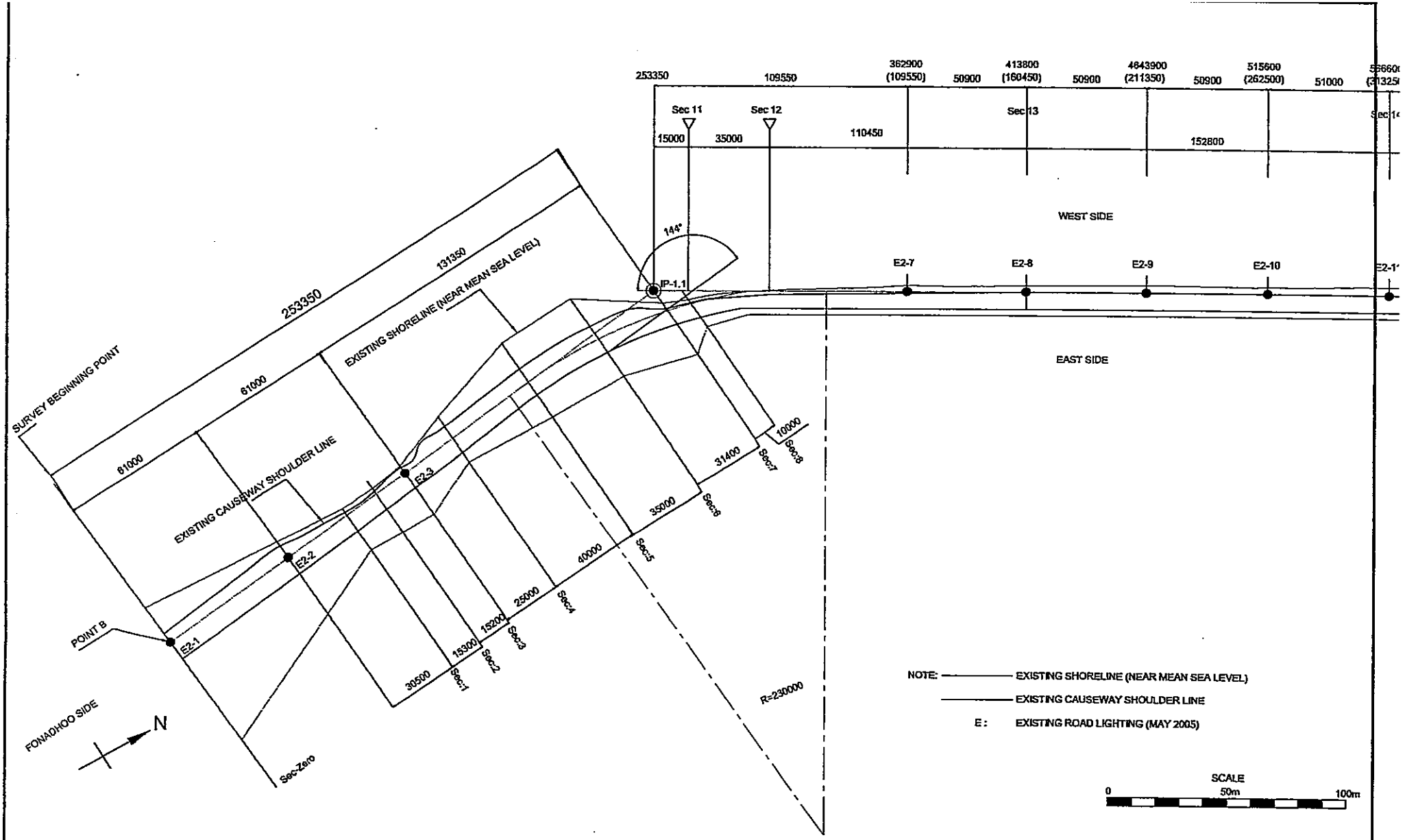
THE STUDY ON TSUNAMI RECOVERY, REHABILITATION AND DEVELOPMENT OF ISLANDS IN MALDIVES

YACHIYO ENGINEERING CO.,LTD.
NIPPON KOEI CO.,LTD.

	PREPARED BY	CHECKED BY	APPROVED BY
NAME	O. Sase, T. Sato	S. Kubo	M. Komiya
SIGNATURE			
DATE	July 20, 2005	July 20, 2005	July 30, 2005

DRAWING TITLE
PRELIMINARY SURVEY DATA FOR REFERENCE INFORMATION
CAUSEWAY NO.1 / SECTION 5/8

SCALE	SHEET NO.	REV. NO.
1 : 150	CW-REF-3	REV.02_JULY.13



JICA JAPAN INTERNATIONAL COOPERATION AGENCY

REPUBLIC OF MALDIVES
MINISTRY OF FOREIGN AFFAIRS
MINISTRY OF PLANNING AND NATIONAL DEVELOPMENT

NOTES:

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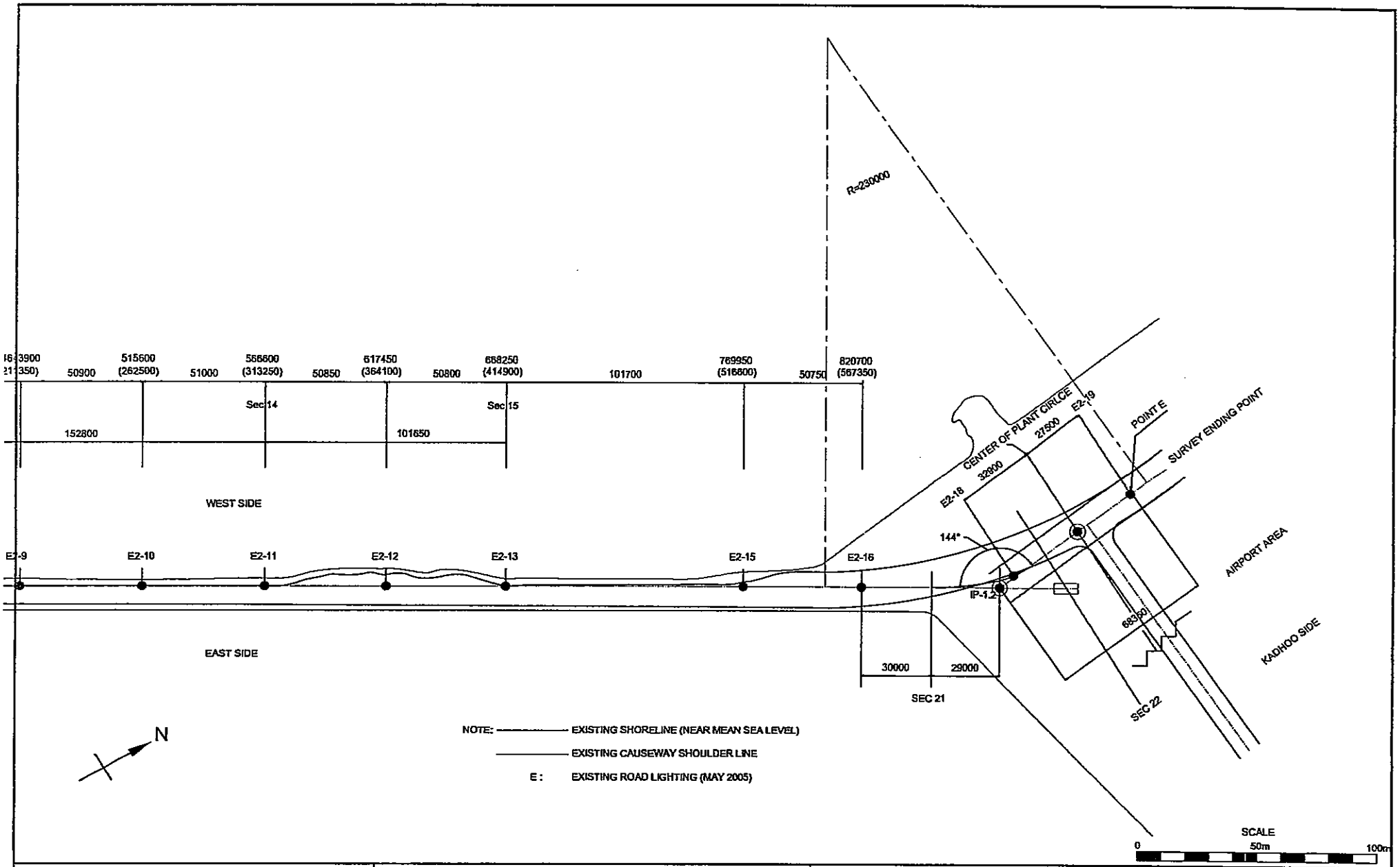
THE STUDY ON TSUNAMI RECOVERY, REHABILITATION AND DEVELOPMENT OF ISLANDS IN MALDIVES

YACHIYO ENGINEERING CO.,LTD.
NIPPON KOEI CO.,LTD.

	PREPARED BY	CHECKED BY	APPROVED BY
NAME	O. Sase, T. Sato	S. Kubo	M. Komiya
SIGNATURE			
DATE	July 20, 2005	July 20, 2005	July 30, 2005

DRAWING TITLE
PRELIMINARY SURVEY DATA FOR
REFERENCE INFORMATION
CAUSEWAY NO.2 (KADHOO-FONADHOO)
GENERAL PLANE NO.1 (EXISTING)

SCALE	SHEET NO.	REV. NO.
1 : 1500	CW-REF-4	REV.02..JULY.13



JICA JAPAN INTERNATIONAL COOPERATION AGENCY

REPUBLIC OF MALDIVES
MINISTRY OF FOREIGN AFFAIRS
MINISTRY OF PLANNING AND NATIONAL DEVELOPMENT

NOTES:
1. All figures are approximate.
2. These data should be confirmed by topographic Survey and Bathymetric Survey before Construction works.

THE STUDY ON TSUNAMI RECOVERY, REHABILITATION AND DEVELOPMENT OF ISLANDS IN MALDIVES

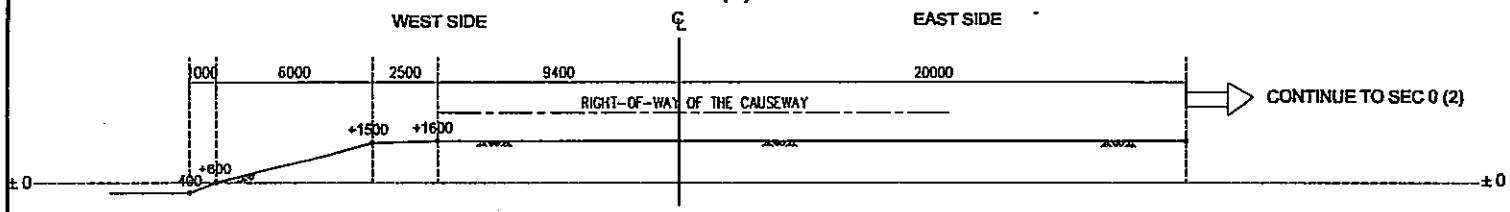
YACHIYO ENGINEERING CO.,LTD.
NIPPON KOEI CO.,LTD.

	PREPARED BY	CHECKED BY	APPROVED BY
NAME	O. Sase, T. Sato	S. Kubo	M. Komiya
SIGNATURE			
DATE	July 20, 2005	July 20, 2005	July 30, 2005

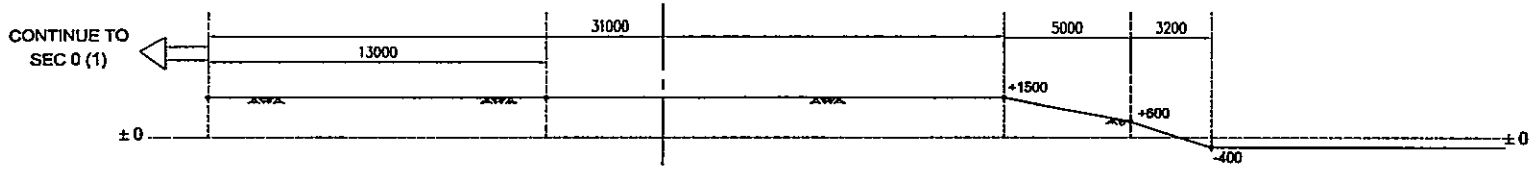
DRAWING TITLE
PRELIMINARY SURVEY DATA FOR REFERENCE INFORMATION
CAUSEWAY NO.2 (KADHOO-FONADHOO)
GENERAL PLANE NO.2 (EXISTING)

SCALE	SHEET NO.	REV. NO.
1 : 1500	CW-REF-5	REV.02_JULY.13

Sec 0 (1)



Sec 0 (2)



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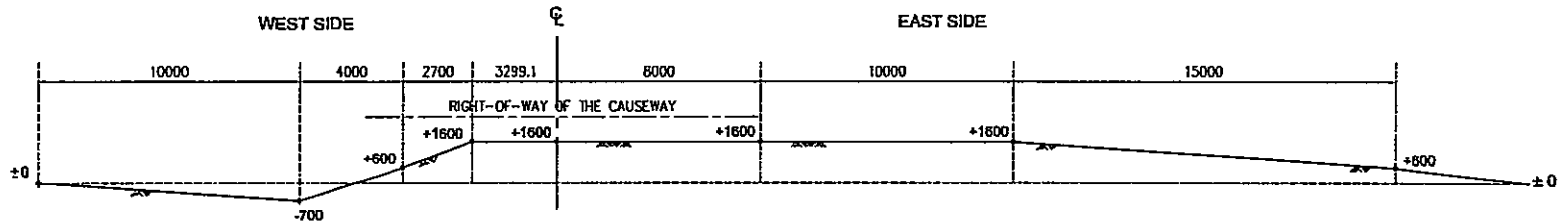

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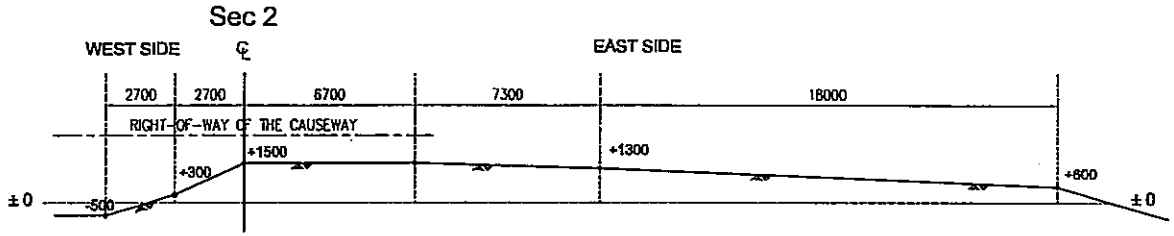
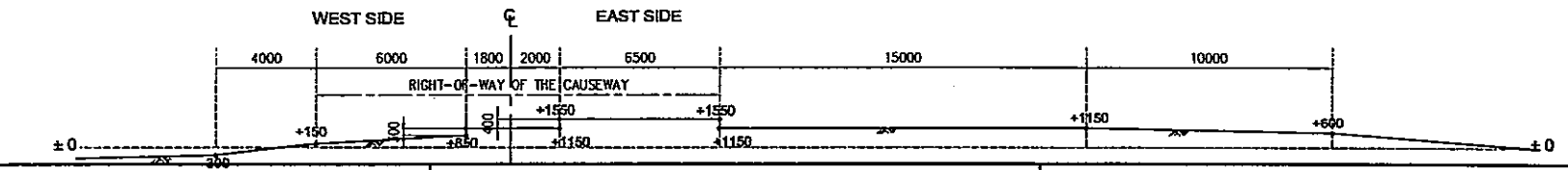


Sec3



SCALE
0 5m 10m

JICA JAPAN INTERNATIONAL COOPERATION AGENCY

REPUBLIC OF MALDIVES
MINISTRY OF FOREIGN AFFAIRS
MINISTRY OF PLANNING AND NATIONAL DEVELOPMENT

NOTES:
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5. Shape of west side is changing daily.
6. Emergency repair works was carried out at the end of May 2005 after survey.

THE STUDY ON TSUNAMI RECOVERY, REHABILITATION AND DEVELOPMENT OF ISLANDS IN MALDIVES

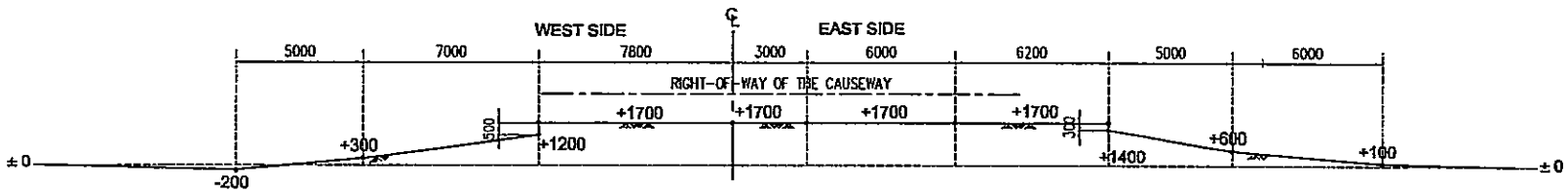
YACHIYO ENGINEERING CO.,LTD.
NIPPON KOEI CO.,LTD.

	PREPARED BY	CHECKED BY	APPROVED BY
NAME	O. Sasa, T. Sato	S. Kubo	M. Komiya
SIGNATURE			
DATE	July 20, 2005	July 20, 2005	July 30, 2005

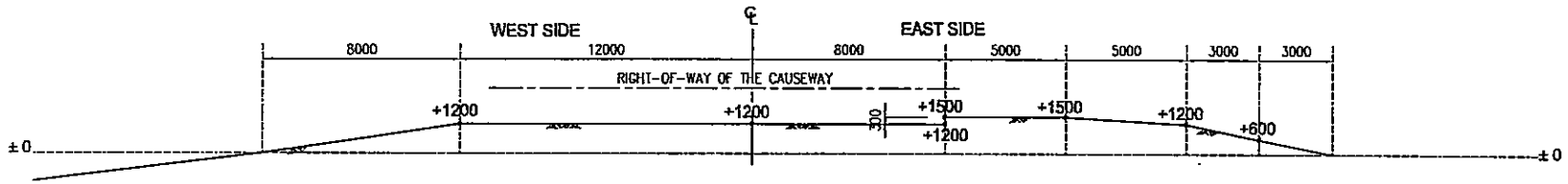
DRAWING TITLE
PRELIMINARY SURVEY DATA FOR
REFERENCE INFORMATION
CAUSEWAY NO.2 / SECTION 1/4

SCALE	SHEET NO.	REV. NO.
1 : 200	CW-REF-6	REV.02..JULY.13

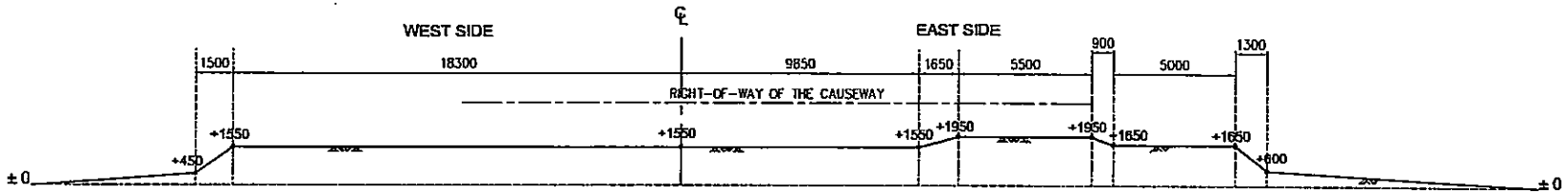
Sec 4



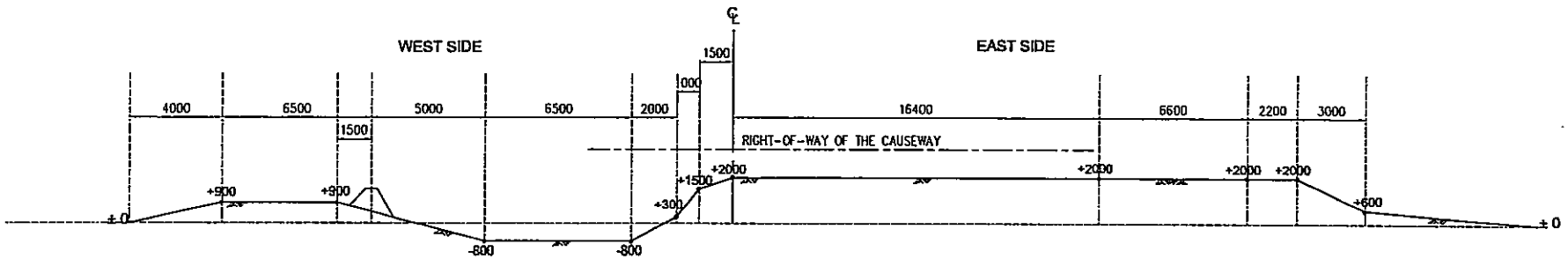
Sec 5



Sec 6



Sec 7



SCALE

0 5m 10m

JICA JAPAN INTERNATIONAL COOPERATION AGENCY

REPUBLIC OF MALDIVES
MINISTRY OF FOREIGN AFFAIRS
MINISTRY OF PLANNING AND NATIONAL DEVELOPMENT

NOTES:

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THE STUDY ON TSUNAMI RECOVERY, REHABILITATION AND DEVELOPMENT OF ISLANDS IN MALDIVES

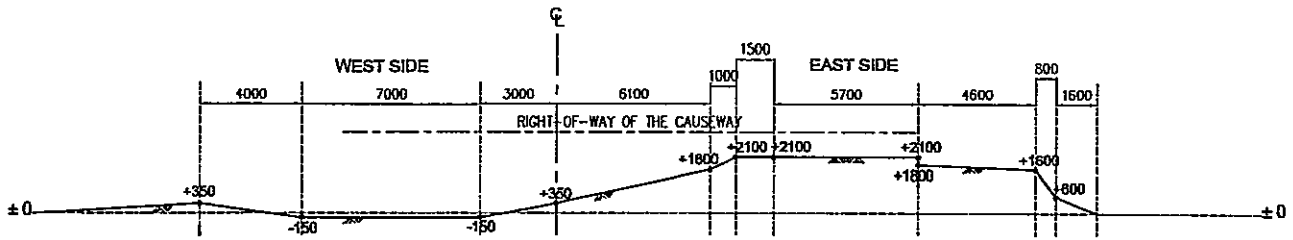
YEC YACHIYO ENGINEERING CO.,LTD.
NIPPON KOEI CO.,LTD.

	PREPARED BY	CHECKED BY	APPROVED BY
NAME	O. Sase, T. Sato	S. Kubo	M. Komiya
SIGNATURE			
DATE	July 20, 2005	July 20, 2005	July 30, 2005

DRAWING TITLE
PRELIMINARY SURVEY DATA FOR
REFERENCE INFORMATION
CAUSEWAY NO.2 / SECTION 2/4

SCALE	SHEET NO.	REV. NO.
1 : 200	CW-REF-7	REV.02_JULY.13

Sec 8



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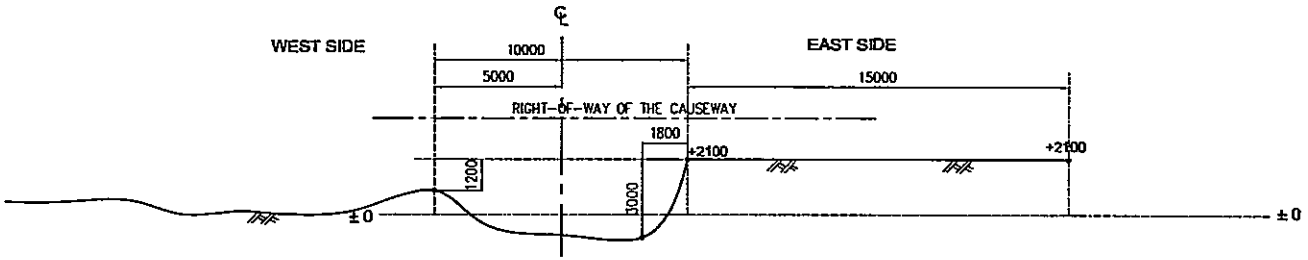
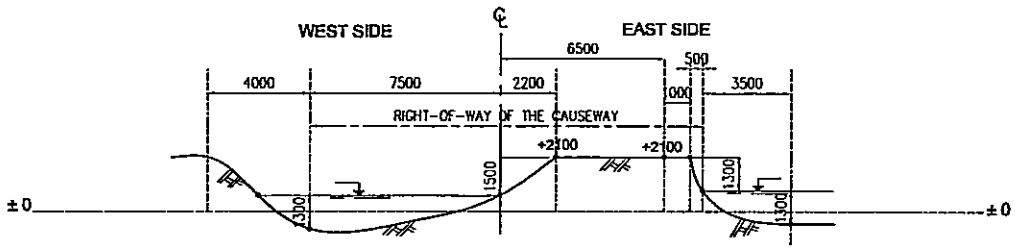
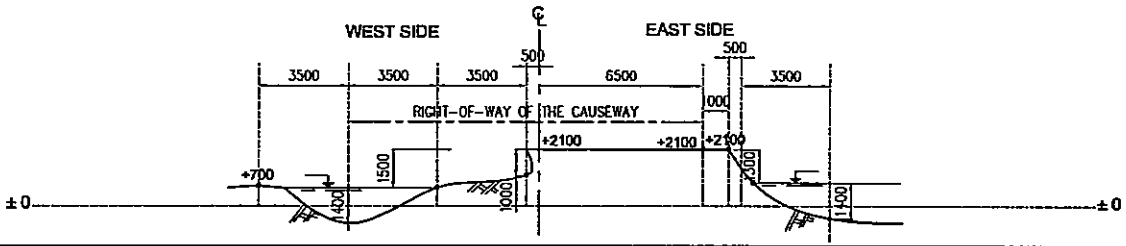


Sec 12



Sec 13



SCALE
0 5m 10m

JICA JAPAN INTERNATIONAL COOPERATION AGENCY

REPUBLIC OF MALDIVES
MINISTRY OF FOREIGN AFFAIRS
MINISTRY OF PLANNING AND NATIONAL DEVELOPMENT

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THE STUDY ON TSUNAMI RECOVERY, REHABILITATION AND DEVELOPMENT OF ISLANDS IN MALDIVES

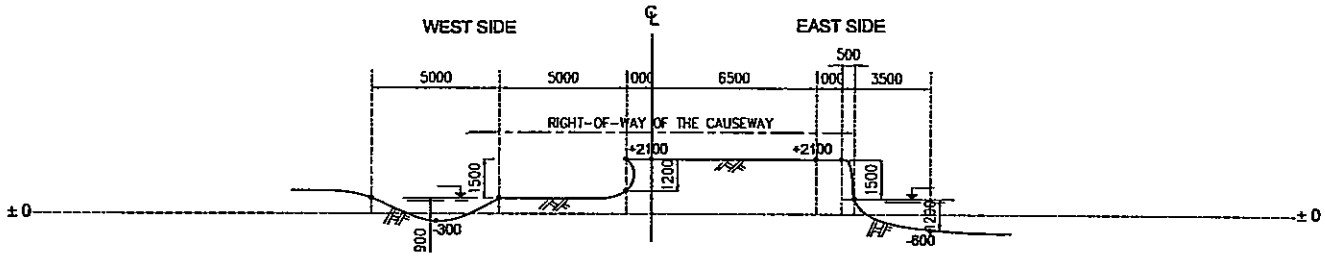
YEC YACHIYO ENGINEERING CO.,LTD.
NIPPON KOEI CO.,LTD.

	PREPARED BY	CHECKED BY	APPROVED BY
NAME	O. Sase, T. Sato	S. Kubo	M. Komiya
SIGNATURE			
DATE	July 20, 2005	July 20, 2005	July 30, 2005

DRAWING TITLE
PRELIMINARY SURVEY DATA FOR
REFERENCE INFORMATION
CAUSEWAY NO.2 / SECTION 3/4

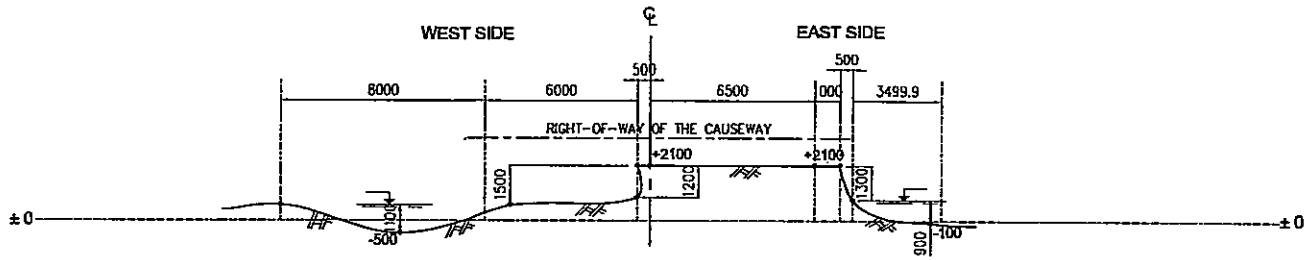
SCALE	SHEET NO.	REV. NO.
1 : 200	CW-REF-8	REV.02_JULY.13

Sec 14

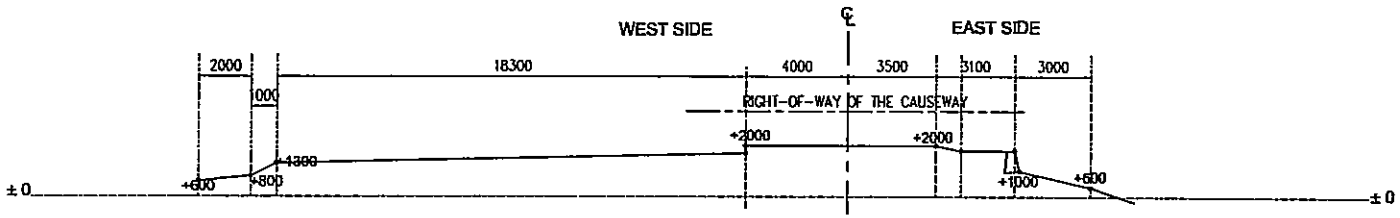


Sec 15

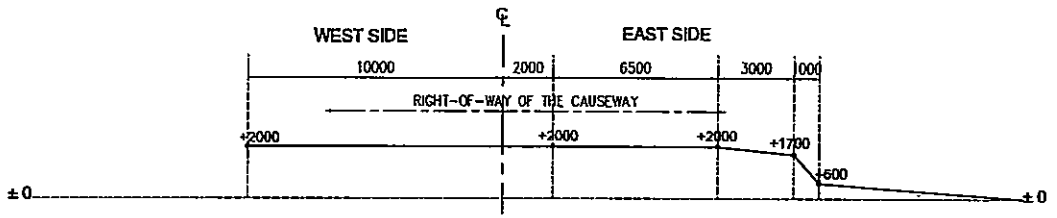
MAY.3 14:50



Sec 21



Sec 22



SCALE
0 5m 10m

JICA JAPAN INTERNATIONAL COOPERATION AGENCY

REPUBLIC OF MALDIVES
MINISTRY OF FOREIGN AFFAIRS
MINISTRY OF PLANNING AND NATIONAL DEVELOPMENT

NOTES:
1. All figures are approximate.
2. All elevations are based on Datum, LAT.
3. These data should be confirmed by topographic Survey and Bathymetric Survey before Construction works.
4. Elevation is referred to the tide level shown in Tide Table.
5. Shape of west side is changing daily.
6. Emergency repair works was carried out at the end of May 2005 after survey.

THE STUDY ON TSUNAMI RECOVERY, REHABILITATION AND DEVELOPMENT OF ISLANDS IN MALDIVES

YEC YACHIYO ENGINEERING CO.,LTD.
NIPPON KOEI CO.,LTD.

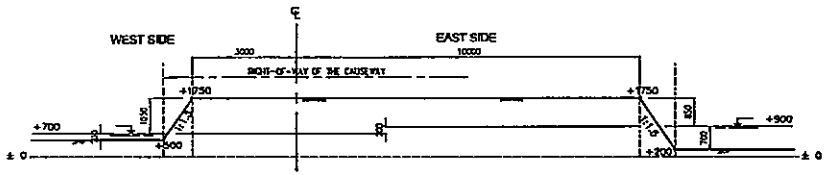
	PREPARED BY	CHECKED BY	APPROVED BY
NAME	O. Sase, T. Sato	S. Kubo	M. Komiya
SIGNATURE			
DATE	July 20, 2005	July 20, 2005	July 30, 2005

DRAWING TITLE
PRELIMINARY SURVEY DATA FOR REFERENCE INFORMATION
CAUSEWAY NO.2 / SECTION 4/4

SCALE	SHEET NO.	REV. NO.
1 : 200	CW-REF-9	REV.02_JULY.13

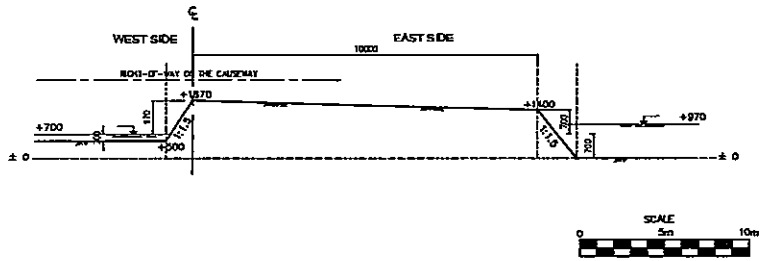
SEA LEVEL MEASUREMENT, NEAR SECTION 2: CAUSEWAY 1

MAY.19 14:20



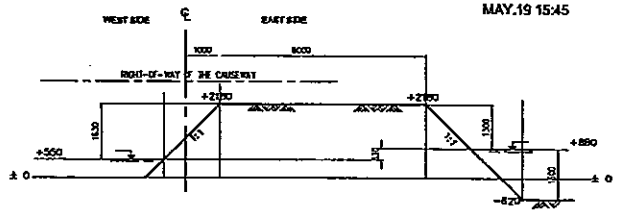
SEA LEVEL MEASUREMENT, NEAR SECTION 3:CAUSEWAY 1

MAY.19 14:25



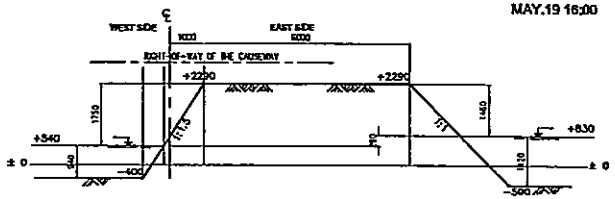
SEA LEVEL MEASUREMENT, NEAR SECTION 12: CAUSEWAY 2

MAY.19 15:45



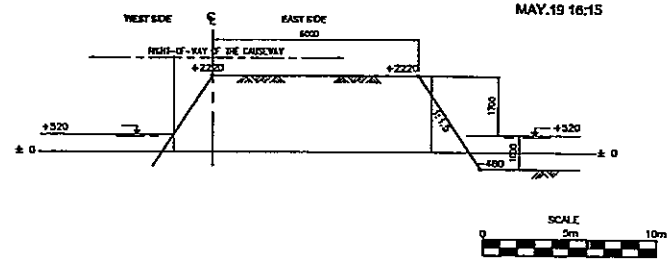
SEA LEVEL MEASUREMENT, NEAR LAMP POST 2E-10: CAUSEWAY 2

MAY.19 16:00



SEA LEVEL MEASUREMENT, NEAR LAMP POST 2E-11: CAUSEWAY 2

MAY.19 16:15



JICA JAPAN INTERNATIONAL COOPERATION AGENCY

REPUBLIC OF MALDIVES
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NOTES:

1. This drawing indicates the sea level difference between the West and East..
2. 0.3m difference in average was observed.
3. East sea level is always higher than West.
4. It is anticipated that speed at the passage may be 4m/s or more if the width of the passage is 15m.

THE STUDY ON TSUNAMI RECOVERY, REHABILITATION AND DEVELOPMENT OF ISLANDS IN MALDIVES

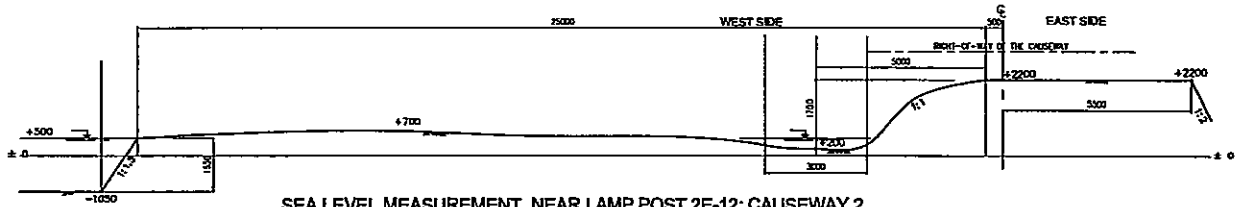
YACHIYO ENGINEERING CO.,LTD.
NIPPON KOEI CO.,LTD.

	PREPARED BY	CHECKED BY	APPROVED BY
NAME	O. Sase, Niushad	S. Kubo	M. Komiya
SIGNATURE			
DATE	July 20, 2005	July 20, 2005	July 30, 2005

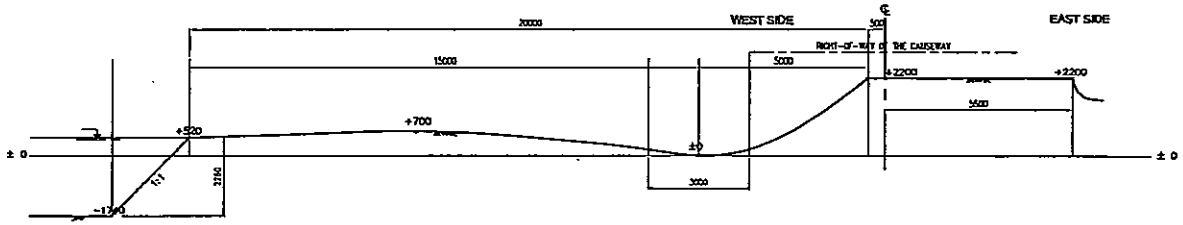
DRAWING TITLE
PRELIMINARY SURVEY DATA FOR REFERENCE INFORMATION
SEA LEVEL MEASUREMENT
CAUSEWAY NO.1 / CAUSEWAY NO.2 1/2

SCALE	SHEET NO.	REV. NO.
1 : 100	CW-REF-10	REV.02..JULY.13

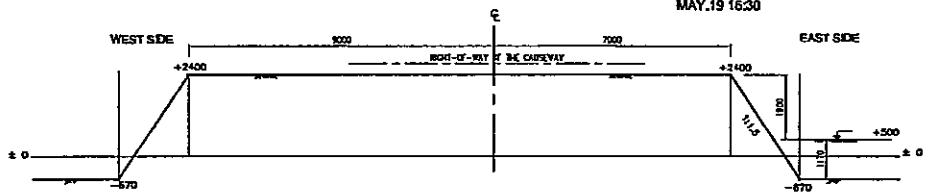
SEALEVEL MEASUREMENT, NEAR LAMP POST 2E-13: CAUSEWAY 2
MAY.19 16:30



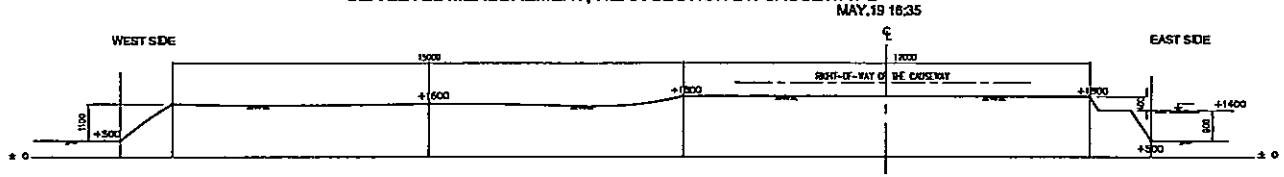
SEA LEVEL MEASUREMENT, NEAR LAMP POST 2E-12: CAUSEWAY 2
MAY.19 16:20



SEA LEVEL MEASUREMENT, NEAR LAMP POST 2E-15: CAUSEWAY 2
MAY.19 16:30



SEA LEVEL MEASUREMENT, NEAR SECTION 21: CAUSEWAY 2
MAY.19 16:35



SCALE
0 1 2 3 4 5m

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NOTES:
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NIPPON KOEI CO.,LTD.

	PREPARED BY	CHECKED BY	APPROVED BY
NAME	O. Sase, Nkushad	S. Kubo	M. Komiya
SIGNATURE			
DATE	July 20, 2005	July 20, 2005	July 30, 2005

DRAWING TITLE
PRELIMINARY SURVEY DATA FOR
REFERENCE INFORMATION
SEA LEVEL MEASUREMENT
CAUSEWAY NO.2 2/2

SCALE	SHEET NO.	REV. NO.
1 : 100	CW-REF-11	REV.02. JULY.13