Ministry of Infrastructure Development
Solomon Islands

BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR CONSTRUCTION
OF
MARKET AND JETTY IN AUKI
IN
SOLOMON ISLANDS

July 2007

JAPAN INTERNATIONAL COOPERATION AGENCY

FISHERIES ENGINEERING CO. ,LTD.

Preface

In response to a request from the Government of Solomon Islands, the Government of Japan decided to conduct a basic design study on the Project for Construciton of Market and Jetty in Auki and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Solomon Islands a study team from Janurary 29 to February 28, 2007.

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

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

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

July 2007

Masahumi Kuroki
Vice-President
Japan International Cooperation Agency

July 2007

Letter of Transmittal

We are pleased to submit to you the basic design study report on the Project for Construciton of Market and Jetty in Auki, Solomon Islands.

This study was conducted by Fisheries Engineering Co., Ltd., under a contract to JICA, during the period from January, 2007 to July, 2007. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Solomon Islands and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

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

Very truly yours,

Kuniaki Takahasi
Project manager,
Basic design study team on
The Project for Construction of Market and Jetty
in Auki, Solomon Islands
Fisheries Engineering Co., Ltd.

SUMMARY

Solomon Islands consists of six main islands and many small islands of various sizes, and has a total land area of 28,400km^2. With the annual rainfall exceeding 3,000mm, the sub-tropical climate and the volcanic soil, forests and timber resources are rich. The topography is comparatively mountainous, and only about 12% of the land is arable. However, as the exclusive economic zone waters amount to a huge 1.63 million square kilometers, marine fish resources, in particular tuna, are abundant. Malaita province is located north-east of the Guadalcanal island on which Honiara is situated, and consists of Malaita Island, Small Malaita Island and two atolls. Its land area is 4,225 km^2, of which 536 km^2 is arable. The gross national income (GNI) per capita of Solomon Islands is US$560 (World Bank, 2004). Compared with other Pacific island countries the domestic land resources of Solomon Islands are comparatively plenty, but development has been slow. Since export of gold has stopped since 2000, due to ethnic tensions, the main exports are limited to agricultural and fishery products, such as timber, tuna, copra, cocoa, etc. The gross domestic product (GDP) comprises 29.4% primary industries, 7.3% secondary industries, and 63.3% tertiary industries. According to the World Bank, the population is about 534,000 (World Bank, 2005 estimate), and only 23% of the population aged 14 or over are active in paid work. About 85% of the population in rural communities of Solomon Islands is engaged in subsistence production. The World Bank estimates that subsistence food production accounts for about 40% of the GDP of the Solomon Islands.

As a result of the ethnic tensions since March 1999, the main industries of the domestic economy, such as the mining industry, fisheries industry, and palm oil industry, suffered large reductions, and the GDP per person dropped by 35%. In addition to the above, during the conflict jetties and other transport infrastructure were not maintained properly, so marine transport which is so important to Solomon Islands was hindered. After the ethnic tensions have tamed, domestic production has shown a recovery as a result of an increase in timber exports, etc., but the GDP has not yet recovered to the level before the tensions.

The Government of Solomon Islands formulated the National Economic Recovery, Reform and Development Plan 2003-2006 (NERRDP) to restore the economy that had been destroyed by the ethnic tensions, and adopted as the main strategies for the national development plan the revitalization of the production sector, reconstruction of the infrastructure and recovery of the basic social services in order to accelerate social development. The Malaita Provincial Government took up the economic development of Malaita Province as the main objective in “the Strategic Plan of the People of Malaita Province 2007-2017” and plans to promote the construction of a market to facilitate the sale of rural produce and products. Stress is also placed on the rehabilitation of transport infrastructures, such as roads and jetties.

For the people of Malaita Province, the market at the provincial capital Auki is a very important facility that trades the surplus products of rural subsisitence households in Malaita Province and necessities of life transported from Honiara. However, the space in the market is small compared with the number of users, so at present many people are obliged to sit on the nearby roads selling their products. Also, since there is no roof, fish, vegetables, fruit, etc., that is displayed for sale is exposed to the direct sunlight, the freshness

of such products deteriorates. In addition, there is frequent rain in Auki, and during the rain the produce is exposed to the rain. There is no paving, so the produce is displayed on the muddy ground. And to prevent the fish drying, fish venders are splashing seawater, in which the Escherichia coli (E. coli) bacterium has been detected, on the fish. Although perishable produce is trading, the necessary equipment is not provided, which results in problems of loss of freshness, lowering of price, and health problems for the consumers.

The existing jetty is narrow, so on weekends when several ships from Honiara are arriving at the same time there is congestion with disembarkeing passengers and unloading cargos. It takes about 3 to 5 hours to disembark the passengers from the boats and to unload the cargos, which has an adverse effect on the convenience of distribution and safety of people and cargos. As 50 years have passed after construction of the existing jetty, parts of the concrete have spalled off, the reinforcements are exposed, and many parts of the reinforcement and steel members are corroding. In particular, deterioration of the superstructure is severe, and the danger of collapse of the concrete slabs is high. If the jetty were to collapse, transport with the other islands would be severed, including between Malaita Province and Honiara, and the economy of Malaita Province would be further adversely affected, so it is vital to re-build the jetty for Malaita Province.

Under such circumstances, the Solomon Islands Government has developed a Project for Construction of Auki Market and Renovation of Auki Jetty (hereinafter called “the Project”) and has formulated a Request to the Government of Japan in August 2005 for a grant-aid to realize this Project. In response to this request, the Government of Japan had decided to carry out a preliminary study, and from 14th August to 8th September 2006 a preliminary study team was dispatched by the Japan International Cooperation Agency (hereinafter called “JICA”). As the result of the preliminary study, it was found appropriate to plan a market at a new site because the existing market site is difficult to expand, and to utilize the existing jetty while constructing a new jetty, and the Government of Solomon Islands withdrew the request for construction of a meeting hall, a slipway, a small craft repair shop, and dismantling of the existing jetty and construction of a temporary jetty during construction of a new jetty.

Based on the result of the preliminary study, the Government of Japan decided to carry out a basic design study, and JICA dispatched the following study teams.

Basic design study	:	29th January to 28th February 2007
Explanation of Draft Basic design study report	:	5th June to 12th June 2007

Based on the survey, the objective of this project was determined as to improve transport of the people between Malaita and Honiara and distribution of goods of Auki and Malaita Province and, in order to bring economic vitality to Malaita Province, by constructing the Auki Market and the Auki jetty.

The details of the appropriate scope for grant-aid cooperation were determined as follows.

A. Building facility

Outline of the planned facility (building facility)

Facility name	Structure	Details of the facility	Scale (area)
1.Market facility	One story, RC structure Pile foundations * The access passage portion has partly direct foundations	- Market hall (fixed sales tables for agricultural produce, daily necessities, marine products: total 224 tables) - Access passage with roof (accommodating 100 lots of agricultural produce sales area)	Floor area: 1,710.6 ㎡
	One story, Concrete block construction Direct foundations	- Shops (10 retailer's booths, 3 canteens) - Rooms for Butchery and Chest freezers (one shop each)	
2. Administrative office	One story, Concrete block construction Direct foundations	Contains several rooms for management and operation of the market	Floor area: 136.5 ㎡
3.Other facilities	One story, Concrete block construction Direct foundations	- Public toilet (ladies and gents separate) - Temporary garbage shed - Guard's post	Floor area: 143.4 ㎡
	Height 10.8m RC structure Pile foundations	- Elevated water tank (elevated water tanks for city water and rain water, provided a pump room in the first floor)	
4.Parking lot	Concrete pavement	Parking lot, roads within the Market facility	Paved area: 572.0 ㎡
5. External grounds	Concrete flat slab pavement	Unloading area, pedestrian walkways, etc.	Paved area: 545.3 ㎡
Total area			Building floor area: 1,990.5 ㎡ Park lot and external grounds: 1,117.3 ㎡

B. Civil engineering facility

Outline of the planned facility (civil engineering facility)

Facility name	Structure	Details of the facility	Scale
1. Jetty	Substructure: steel pipe piles Superstructure: RC	Jetty: 1 No.	64.0m long × 12.0 m wide
		Access bridge: 1 No.	49.0m long × 8.0 m wide
		Ferry ramp: 1 No.	18.0m long × 8.0 m wide
		Ancillary facilities: Mooring posts, fenders, lighting	
2. Shore protection for the market site	Stepped gabion basket type	Shore protection combined with a small fishing vessel mooring facility will be constructed at the shore line of the market	Total length 105m

To implement the subject Project on the basis of grant-aid from the Government of Japan, a construction period, including the detailed design, of 24 months will be required. The project cost to be borne by the Solomon Islands Government, for the electrical and water installation cost to the site, is

estimated to be about SBD110,000 (about 1.8 million yen).

The Government of Solomon Islands is fully responsible for the proper operation and maintenance of the new market and jetty. The Ministry of Infrastructure Development (hereinafter called "MID"), at the initial stage, will take care of the operation and maintenance of the new market and jetty. At the same time, the Malaita Provincial Government is planning to establish a new organization as the registration is currently ongoing. As soon as the new organization is established, it will implement operation and management works under the supervision of MID, and once the new organization is capable of implementing more effective management, MID will hand over the responsibility to the Malaita Provincial Government. The direct costs of day-to-day maintenance and operation expenses of the facility are expected to be secured from the operation of the planned facility. Large-scale maintenance and repair costs are to be obtained from the budget of MID, so there should be no problem.

The implementation of this project is expected to have the following benefits in terms of solving the current problems in Malaita Province.

<Direct effects>

① The sales gross area per vender will be increased by a factor of 1.3 from the present 1.8 ㎡/person to 2.4 ㎡/person, so congestion within the market will be eased.

② As a roof be provided on the market place, venders who would not have come to market in rainy days will come to the market, so the number of venders in a year is expected to increase by 2,520 from the present 86,505 to 89,025.

③ As a result of enlarging the jetty, the time to disembark passengers from a vessel will be reduced by about 24% from the current average of 160 minutes per ship to 122 minutes per ship. The time for unloading cargos will be reduced by about 8% from the present 240 minutes per ship to an average of 222 minutes per ship.

<Indirect effects>

① The project will contribute to the stabilization of the local economy by improvement of transport and distribution of people and goods in Malaita Province.

② The project will eliminate difficulties due to parking vehicles for commercial activities in Auki shopping districts

③ Marine transport for an annual 89,000 passengers and 14,000 tons of freight between Malaita, for which the possibility of collapse and loss of the existing jetty is high, and Honiara and other islands will be secured.

Along with the above effects, providing the opportunity for rural people to trade their products in the Auki Market for earning cash will contribute to stabilization of the local economy of Malaita Province. These benefits would accrue to all of the 140,000 residents of Malaita Province. It is, therefore, appropriate and justified that this project be implemented on the basis of grant-aid cooperation.

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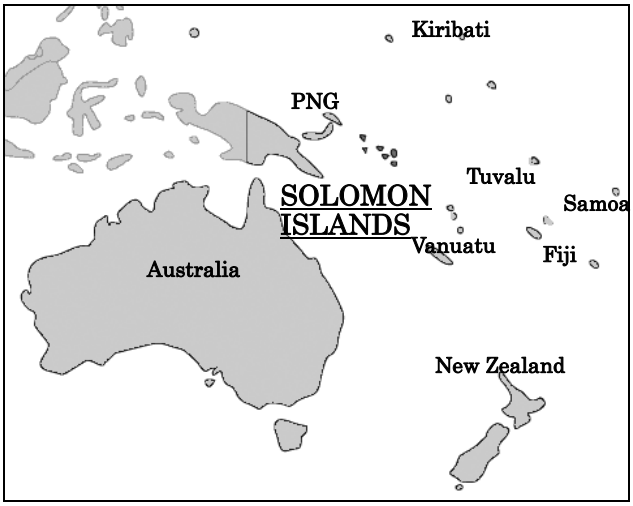
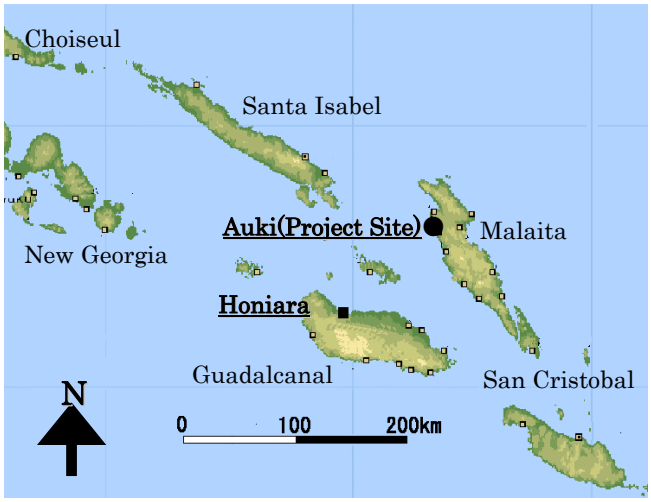
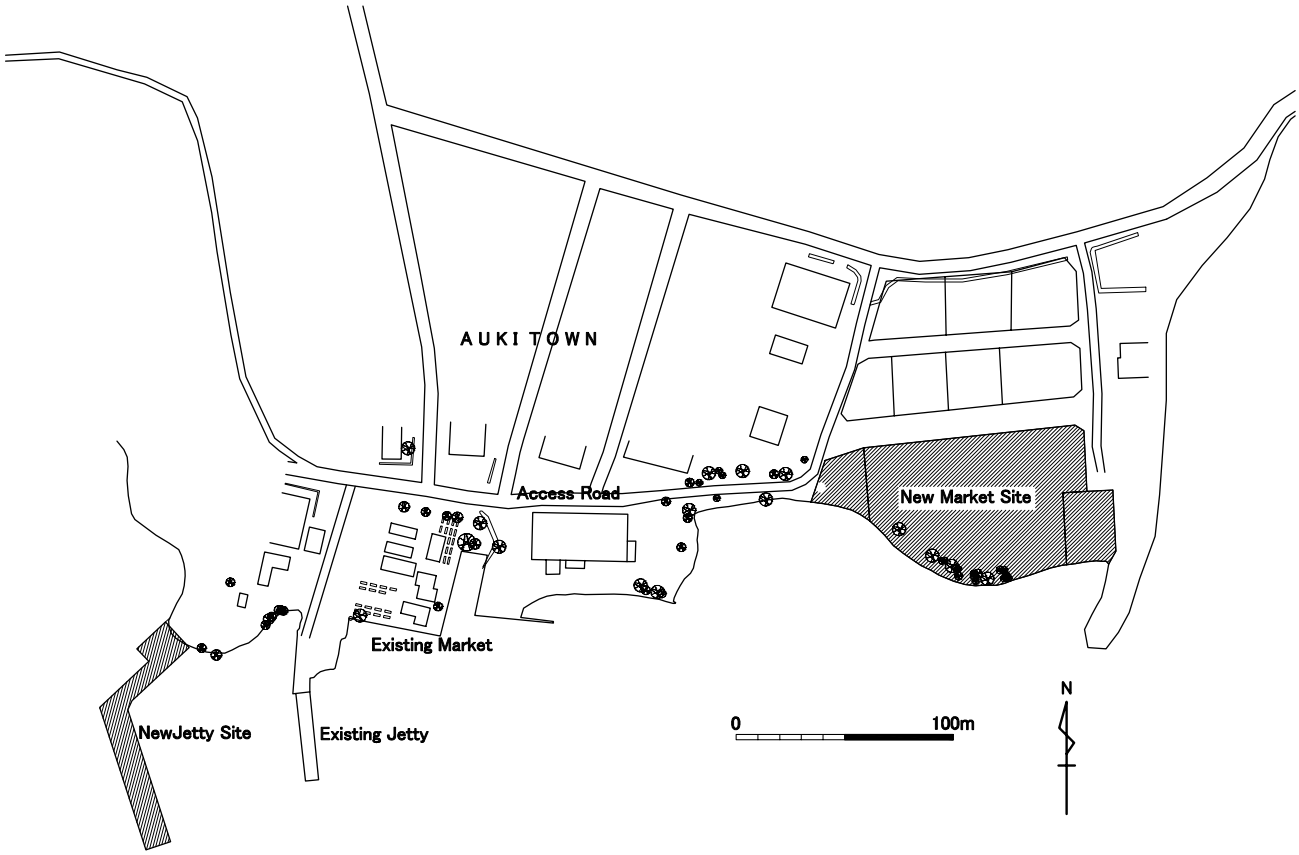


Map of Solomon Islands



Map of Auki City and Malaita Province



Site Map

Location Map


Perspective (MARKET)

Perspective (JETTY)

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Abbreviations

C.D.L.	Chart Datum Level
D.L.	Datum Level
EIA	Environmental Impact Assessment
EP	Emulsion Paint
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FRP	Fiber-Reinforced Plastic
G.L.	Ground level
GDP	Gross domestic product
GNI	Gross National Income
HIES	Household Income and Expenditure Survey
H.W.L.	High-Water Level
IEE	Initial Environmental Examination
IMF	International Monetary Fund
JICA	Japan International Cooperation Agency
JIS	Japanese Industrial Standards
L.W.L.	Low-Water Level
M.H.H.W.	Mean Higher High Water
M.H.L.W.	Mean Higher Low Water
M.H.W.L.	Mean High Water Level
M.L.H.W.	Mean Lower High Water
M.L.L.W.	Mean Lower Low Water
M.L.W.L.	Mean Low Water Level
M.S.L.	Mean sea level
M.W.L.	Mean Water Level
M/D	Minutes of Discussions
MID	Ministry of Infrastructure Development
MOU	Memorandum of Understanding
MPA	Minisutry of Development Planning and Aid Coordination
MSP	Management Service Provider
NERRDP	National Economic Recovery, Reform and Development Plan
NGO	Nongovernmental Organization
OFCF	Overseas Fishery Cooperation Foundation
PNG	Papua New Guinea
PVC	Polyvinyl chloride
RAMSI	Regional Assitant Mission to Solomon Islands
SBD	Solomon Islands Dollar
UNDP	UN Development Programme
USGS	US Geological Survey
WHO	World Health Organization

CHAPTER 1 BACKGROUND OF THE PROJECT

CHAPTER 1 BACKGROUND OF THE PROJECT

1-1 Background of the Request

In Solomon Islands, infrastructure facilities have been damaged by subversive activities during the "Ethnic Tensions" since 2000, in addition to the deterioration of facilities and equipment due to interruption of maintenance resulting from the stagnation of economic activities during the "Ethnic Tensions". In the national economic recovery, reform, and development program (NERRDP), the economic growth of Solomon Islands absolutely requires an efficient and effective system of physical distribution, and this development program is considered to be based on the development of a transport infrastructure for restoration of the foundation of human development.

In Malaita Province, 54.2% of households engage in subsisitence farming and fishing activities, demonstrating a belated shift to a money economy in the province, whereas the nationwide average ratio of subsisitence farming and fishing households in the Solomon Islands is 36.9%. The population in the province is 140,000 (2005 estimate), accounting for 26.3% of the total national population, and the population density is more than double that of the national average. Malaita Province ranks lowest in both the human development index and the human poverty index among all the provinces in the Solomon Islands. The social infrastructure facilities of Malaita Province are seriously inadequate, and the average income of the residents in Malaita Province is lower than that in other provinces in the Solomon Islands. The Malaita Provincial Government, therefore, states in the Strategic Plan of the people of Malaita Province (2007-2017) that it will promote the construction of a market to sell the province's products in order to enable acquisition of cash income from village-based production. In addition, the Government also places stress on the rehabilitation or construction of the roads and jetties.

For rural residents who live in a society relying on a subsisitence economy in Malaita Province, Auki Market is an important place to sell surplus products to earn cash income and to buy daily necessities. However, the market facilities are in such a poor condition that goods exposed to direct sunlight lose their freshness and their quality deteriorates, and many of the products are also exposed to rain, resulting in a harmful hygienic situation. In addition, Auki Jetty, the only entrance for everyday sundries and necessities such as rice and salt from Honiara, has also heavily deteriorated and been in a dangerous state due to the explosive fractures and spalling of its reinforced concrete.

Therefore, it is an urgent necessity to construct the Auki Market which will be a place for the rural residents in Malaita Province to earn cash income, and to rehabilitate the Auki Jetty which will support marine transport between Malaita Province and the other islands.

The Government of Solomon Islands has formulated the "Auki Market Construction and Jetty Rehabilitation Project" to improve the distribution in the Auki Market and transpotation of Auki Jetty, and requested the Japanese grant aid to implement the project.

Japan International Cooperation Agency (JICA) dispatched a study team for the preliminary study of the Auki Market Construction and Jetty Rehabilitation Project to the Solomon Islands for the period of

August 14 to September 8, 2006 in order to clarify the background of the request by the Government of Solomon Islands and to confirm the contents of the Auki Market and Jetty Rehabilitation Project. The Government of Solomon Islands notified the preliminary study team of a partial change in their request, and the request components and their priority order as shown in Table 1-1 were confirmed in the discussions between both parties.

Table 1-1 : Request components identified in the Minutes of Discussions of the Preliminary study

	Request component	Description	Quantity	Priority
1	Market House	Market 1,800m^2, administrative office, fish processing room and farmers' storage	1	A
2	Ice-making plant	2 tons per day, ice storage of 6 tons	1	B
3	Cold storage	5 tons at -20°C and 3 tons at +5°C	1	B
4	External Booths for general retailers	20 units	1	A
5	Outdoor lighting		1	A
6	Parking lot and yard pavement	1,600 m^2	1	A
7	General External works	Elevated water tank, rainwater collector, rainwater drainage and wastewater treatment system	1	A
8	Market Accessories devices	Fish boxes, scales, etc.	1	C
9	Berthing facilities for fishing boats (OBM) and canoe		1	A
10	Fishermen's gear lockers		1	B
11	Abiution block (Public toilet) and garbage dump area t	Separate buildings for men and women, each including 10 cells	1	A
12	Jetty for Inter-islands vessels	total length of 60 m and width of 12 m	1	A
13	Relating works	Revetment for the jetty	1	A

As the result of the preliminary study, it was decided to construct the market at a new site because the existing market site is difficult to expand, and to construct a new jetty utilizing the existing jetty. Thus, the Government of Solomon Islands withdrew the request for construction of a meeting hall, a slipway, a small craft repair shop, and dismantling of the existing jetty and construction of a temporary jetty.

The request components and their priority order as shown in Table 1-2 were confirmed through the field survey and discussions between both parties in the basic design study.

Table 1-2 : Request components and priority order identified in the Minutes of Discussions of the Basic Design Study

	Request component	Description	Quantity	Priority
1	Market house	Market 1,800m^2, administrative office, fish processing room and farmers' storage	1	A
2	Ice-making plant	2 tons per day, ice storage of 6 tons	1	B
3	Cold storage	5 tons at -20°C and 3 tons at +5°C	1	B
4	External Booths for general retailers	20 units	1	A
5	Outdoor lighting		1	B
6	Parking lot and yard pavement	1,600 m^2	1	A
7	General External works	Elevated water tank, rainwater collector, rainwater drainage and wastewater treatment system	1	A
8	Market Accessaries devices	Fish boxes, scales, etc.	1	C
9	Berthing facilities for fishing boats and canoe		1	A
10	Fishermen's gear lockers		1	B
11	Ablution Block (Public toilet) and garbage dump area	Separate buildings for men and women, each including 10 cells	1	A
12	Jetty for Inter-island Vessels	total length of 60 m and width of 12 m	1	A
13	Relating Works	Bank protection works for the jetty	1	A

A: Requires urgent construction, B: Important but needs examination, C: Necessary but relevance must be examined from technical and economical viewpoints

1-2 Natural Conditions of the Project Site

1-2-1 Natural Conditions

The topographic survey and the soil, climatic, oceanographic and water quality surveys were carried out in the field. Appendix 6-2-1 shows the map of survey points of natural conditions.

1-2-1-1 Topography

Appendix 6-2-2 shows the topographic map of the sites.

The topographic features of each site will be outlined below.

(1) Jetty site

- The water depth increases gradually from the base point of the existing jetty (-1m) toward its tip end (-6.5m), and the depth at about 40m off the tip is greater, about -11m.
- A stranded, abandoned vessel (steel ship of approx. 30m long by approx. 6m wide) exists at the spot with a depth of -3 to -4m at 38m from the northwestern side of the existing jetty.

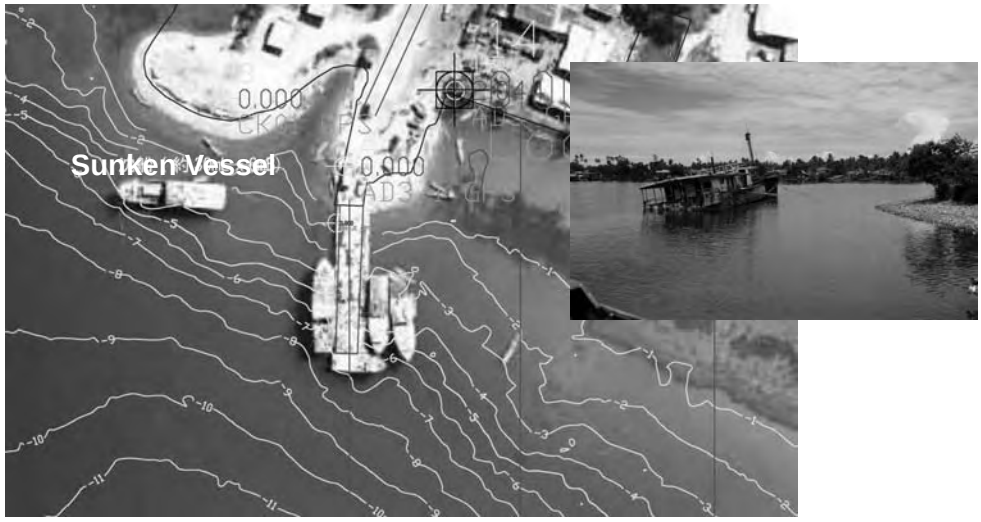

Figure 1-1 : Sunken vessel scene

(2) Market site

- The market site was a swampy ground in which mangroves grew about 30 years ago, but it was used as a dumping ground before it was covered with sand and gravel as reclaimed land.
- The site is low ground of elevation about +1.6 to +2.0m, but it is said to be a safe place which has not suffered from climbing waves due to cyclones or any other disaster.
- The front of the market site is shallow with a water depth of about ±0.0m to a distance of approximately 140m offshore, and a depth of -1.0m can be secured only at approximately 180m offshore from the shore line.
- The water depth at which FRP out-board motor boats can safely navigate even in the low tide is required to be at least 1.0m. However, the water depth in front of the existing market is +0.2 to +0.3m, so the boats can be used when the water level is higher than the mean sea level, except during tide ebbing in the spring .
- On the other hand, the level of the shore line in front of the new market site is higher than +0.5m, so the mooring facility cannot be used by FRP small out-board motor boats even if in the average water level in normal ebb tide.
- The route from the inside of bay to the front of the market in which the levels of +0.5m or lower are secured is shown at Figure 2-3, but the route may become unusable due to sand sediment from Kwaibara River in future. There are also some shallows in which sea grass is growing.
- The shore line of the market site has suffered from wave erosion due to surf for many years and the roots of trees at the waterside are exposed, some trees have fallen down or inclined. If those trees are left as they are, wave erosion may cause the existing trees to fall down.

1-2-1-2 Soil

The results of the soil survey are shown in Appendix 6-2-3.

The soil conditions at the sites will be outlined as follows:

(1) Jetty site

- The soil surveys were made at two points, the base point of the existing jetty: BH-J1 (1m deep) and the tip of the jetty: BH-J2 (6.5m deep).
- A layer which appears to be a reclaimed soil exists at the surface of the base point BH-J1, but there are soft silt-mixed sand and sand-mixed silt layers with N values of about 2 to 6 up to -24.5m from the current bottom ground surface, which are supported by a limestone layer at a depth of -24.5m.
- At the tip of the existing jetty BH-J2 (depth of -6.5m or more), there is silt-mixed sand and sand-mixed silt layers with N values of about 2 to 6 up to -25m from the current bottom ground similar to the base point BH-J1, which are supported by a limestone layer at the depth of -25m. As a result of core sampling from -25m to -30m, it was confirmed that there is another limestone layer under a thin sand layer (about 1m thick) lying between both limestone layers.

(2) Market site

- The soil surveys were made at two points, the site center (with a height of +1.3m) and the shore line (with a height of +1.0m).
- There existed reclaimed soil in the surface layers 1m deep at both points, and further than that, there was a soft silt and clay mixed sand layer with N values of about 2 to 6 down to -23m from the current ground surface, which is supported by a limestone layer at -23m.

1-2-1-3 Tide

The tidal current harmonic constants (main 4 tidal factors) in Auki are shown in Auki Harbour (No. 5692, lat. 8°46'S and lon. 160°42'E) in the British Tide Table.

Table 1-3 : Tidal current harmonic constants (main 4 factors)

ML	M_2		S_2		K_1		O_1	
From Zo (m)	Lag Km (degree)	Amplitude H.m (m)	Lag Ks (degree)	Amplitude H.s (m)	Lag k' (degree)	Amplitude H' (m)	Lag Ko (degree)	Amplitude Ho (m)
0.90	110	0.35	129	0.22	212	0.21	191	0.11

(Source:Admiralty Tide Tables Vol.4, Pacific Ocean, 2007)

The tidal type in Honiara (Guadalcanal Province), Tulaghi (Central Province) and Gizo (Western Province) has the feature of "once per day tidal type" in which the diurnal tide is high while the semi-diurnal tide is very low, but two high tides and two low tides per day are caused at Auki sites and at Bina Harbour in the central-western area of Malaita Province. There are very large differences between the successive two high or low tides, and eventually, there is a tidal type of one tide per day. Therefore, the tidal type is classified into "mixed tidal type".

Auki: Mixed tidal type: $0.25 \leqq 0.56 = (K1 + O1) / (M2 + S2) < 1.50$

Honiara: Once per day type: $1.50 \leqq 2.83 = (K1 + O1) / (M2 + S2)$

The tidal relations in Auki are as follows:

M.H.H.W.	＋1.4 m
M.L.H.W.	＋0.9 m
M.H.L.W.	＋0.6 m
M.L.L.W.	＋0.2 m
C.D.L.	±0.0 m

1-2-1-4 Hydrological regime

The 24-hour observation of tidal flow direction and velocity was carried out at one point each at the planned site of the new jetty (CT-1: at a depth of 10m, the direction and velocity record device installation depth = water depth -3m) and at the eastern side of the estuary of Kwaibara River (CT-2: at a depth of 3m, the direction and velocity record device installation depth = water depth -1m) on February 15 and 16, 2007 when the flood tide came. The results of observation are described below.

- The flows were weak, 10cm/sec maximum at both CT-1 and CT-2, as shown in the hydrological regime vector diagrams in Appendix 6-2-4.
- At CT-1 (the west side of the existing jetty), a weak SE flow of 8.6cm/sec was caused about 1.5 hours after the full tide. A very weak NW – NNW flow of 3cm/sec on average appeared at other time durations.
- On the other hand, the NW flow of 10cm/sec in the opposite direction from CT-1 was caused about 1.5 hours after the full tide at CT-2 (offshore of the new market site) and changed the W – SW direction gradually toward S in the river flow line. For other time durations, a very weak NW – NNW flow of about 1cm/sec on average was observed, and it is deemed to be a flow from the river.
- At the times of flood tide and ebbing tide for the same period, a float was flowed and tracked from the river center at the lower reach of Kwaibara River. As a result, it was observed that the float flowed at a velocity of about 0.22m/sec in the SSW direction from the river straight toward the artificial island at the bay center.

1-2-1-5 Waves

During the study period, the wave height off the Auki Bay at normal times was about 0.6 to 1.0m in the SW – WSW wave direction in a cycle of 3 to 4 sec. The wave height within the Bay was always calm, about 0.1 to 0.15m in the vicinity of the existing jetty at normal times during the same study period and the wave direction was from SSW.

According to the local fishermen, the offshore wave height is about 1.0 to 1.5m at normal times, but about 2m under the attack of a cyclone. However, the water within the Bay is always very calm and no wave height of more than 1.0m has been caused. From their statements, it can be presumed that the wave height ratio of the waves impacting against the jetty to the offshore waves in the vicinity of the bay inlet is about 0.2 or less at normal times and about 0.4 even in emergency times.

Close to the shore line within Auki Bay, there are houses with an elevated floor, which are supported by thin wooden piles and extended over the seawater. A shore-protecting embankment of dry masonry was built at the shore line on the southwestern side of the artificial island at the center of Auki Bay and the weight of each building stone seems to be about 20kg to 40kg. From this, it is assumed that no waves which the embankment cannot withstand have attacked the water area.

In marine construction projects that are being implemented by the EU, a design wave height of 4.0m is used on Malaita Island and on the northeastern side of San Cristobal Island which face the open sea. However, the design wave height at Su' u directly hit by waves on the Indispensable Strait side facing the southwest shaded from the open sea is 2.5m and the design height at the sites shaded by reefs and the bay bottom is 1.2m as in Auki Bay. Assuming that the waves with a height of 1.5m are formed in the open sea of Auki Bay as in Su' u, the wave height of the waves impacting the jetty is estimated to be 1.0m, provided that the wave height ratio of the waves in the vicinity of the jetty to the offshore waves is 0.4 as obtained in the wave observation in the field survey. This wave height is considered to be consistent with that obtained through the local hearing survey.

[Estimation of Design Waves]

There are no statistical records on the waves off and in Auki Bay. Therefore, the specifications of the waves used for the wave design are estimated from the wind velocities and fetch lengths of the cyclones which have passed the vicinity of Auki Bay.

The abnormal waves in the seawaters in the vicinity of Auki are caused by a tropical cyclones or tropical atmospheric depressions, and according to the records made available for the period of 1966 to 1993, it was the cyclone "Namu" and the tropical depression "Isa" that might have a large influence on the waves in Auki Bay.

In estimating the data of the waves appearing off Auki Bay due to both phenomena, the offshore waves caused by the cyclone "Namu" are considered to have a wave height of 5.0m in the SNW direction in cycles of 8 sec.

The waves caused by the tropical depression "Isa" are considered to have a wave height of 3.0m from the SW direction in the cycles of 6 sec, assuming that the waves travel from the front toward the bay inlet when "Isa" is the most dangerous before and after passing by the direct front of Auki Bay.

If the waves travel into the bay inlet, from which they pass through the narrow channel of 170m wide and scatter around in the Auki Bay, the wave height will decrease. Stevenson has proposed a wave height estimation method as given by the following formula:

$$h = H \cdot \left\{ \sqrt{\frac{b}{B}} - 0.027 \left(1 + \sqrt{\frac{b}{B}} \right) \cdot \sqrt[4]{D} \right\}$$

where, h: Wave height (m) at a distance D from the bay inlet

H: Wave height outside the bay (m) = 5m x 3/4 = 3.75m or 3m

b: Bay inlet width (m) = 170m

B: Length (m) of the arc with the radius D (m) centered at the bay inlet = 780m

D: Distance (m) from the bay inlet center to an arbitrary point of wave estimation = 617m

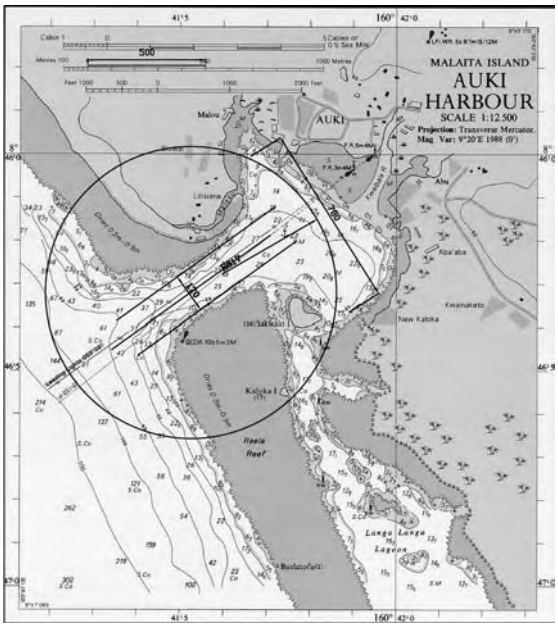

Figure 1-2 : Map showing the wave height estimation conditions in constriction and scattering of waves within Auki Bay

The height of the waves caused by the cyclone “Namu” off Auki Bay is estimated to be 5m in the NNW direction along the alignment of the strait. However, it is considered that the energy of the waves traveling from the inlet of the Bay is not so high because the water depth is low around Auki Bay and the bay inlet is narrow. Assuming that the incoming waves having 3/4 of the wave height of 5m, namely about 3.75m attack the inside of the bay, the height of the waves reaching the Auki Jetty is estimated to be 1.0m.

Similarly for the waves caused by the tropical depression “Isa”, which are the most dangerous because they travel from the front toward the bay inlet, the wave height in the vicinity of the jetty is estimated to be 0.8m if an incoming wave height of 3.0m is input.

The estimated wave height as estimated above can be represented by the ratio of the wave height in the vicinity of the jetty to the offshore wave height, which is 0.27. This value is approximately the same as the wave height ratio of 0.2 to 0.4 as observed in the field survey, and similar to the wave conditions as obtained in the hearing from the local residents.

In considering safety based on those data, it is concluded that an appropriate design wave height around the jetty is estimated to be 1.0m.

1-2-1-6 Bottom materials

From the mouth of the Kwaibara River to the front of the new market there is shallow water of depth less than 1m that extends for about 150 to 200m towards the center of the bay.

Sea grass is distributed in the shallow water at about 100m off the water's edge line, but not in density. The bottom materials consist of medium-sized grains of sand and a small quantity of gravel of 20mm diameter at the center of the river mouth. The sand materials reduce toward the front of the site, where silt and clay were observed.

1-2-1-7 Meteorology

(1) Rainfall and atmospheric temperature

Table 1-4 : Monthly average rainfall and maximum and minimum atmospheric temperature (1962 - 1990)

	Jan.	Feb.	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct.	Nov.	Dec.	Average
Monthly maximum temperature (ºC)	23.8	23.8	23.6	23.5	23.2	22.9	22.5	22.3	22.6	22.8	23.2	23.6	**23.2**
Monthly minimum temperature (ºC)	30.6	30.4	30.4	30.3	30.2	29.9	29.3	29.4	29.6	30.1	30.5	30.7	**30.1**
Rainfall (mm)	397	385	428	257	223	178	239	227	212	227	224	293	**3,290**
Rainfall days (days)	21	22	23	21	19	22	20	17	19	19	18	19	**20.0**

(Source: World Meteorological Organization)

(2) Winds

As shown in Figure 1-3, the wind direction from S is most frequent. However, it is also clear that the monthly maximum wind velocity is from NW, NNW and SSE as shown in Table 1-5.

Table 1-5 : Monthly maximum wind velocity and direction (1994-2006)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1994	N/14	NW/15	N/15	SE/12	E/18	S/16	SE/14	S/18	S/22	S/12	S/14	S/12
1995	S/10	NW/12	NNW/12	SSE/07	SE/16	S/13	S/18	ESE/16	E/12	S/14	S/15	S/18
1996	N/12	N/09	NNW/18	SE/08	NW/18	E/15	S/16	ENE/15	S/12	E/10	NNW/15	NNW/18
1997	NW/15	N/12	NW/16	S/16	S/14	S/30	SE/18	SSE/25	S/25	S/17	SSE/14	S/13
1998	NW/18	NW/18	NW/13	SSE/06	ESE/07	S/12	S/14	S/12	S/12	SE/09	E/09	W/15
1999	NE/10	NW/12	ENE/08	ENE/08	SSE/09	S/08	SE/13	S/15	S/18	SE/10	S/15	E/07
2000	NW/12	NE/07	NNW/08	NE/10	NNW/16	S/08	S/08	S/18	SSW/12	S/16		
2001	NE/15	N/18	NNW/10	SE/15			S/13	S/18	SSW/16	S/15	SSE/16	S/15
2002	NW/12	NNW/14	N/12	N/11	SSE/10	S/17	S/16	SSE/25	S/20	S/12	S/12	SSW/12
2003	NW/14	NW/09	NW/15	NW/17	SSE/06	N/08	S/13	S/12	S/18	SW/12	S/12	S/08
2004	W/12	NNW/12	W/10	N/16	S/09	S/15	S/15	SES/15	S/12	SE/12	S/12	S/08
2005	WSW/12	NNW/12	S/10	S/14	S/13	S/12	SSE/25	SSE/17	S/20	E/16	SE/09	W/06
2006	NNW/12	SW/13	NW/07	SE/09		S/12	S/15	SSE/20	NE/16	SSE/16	NW/12	SW/12

*Wind velocity unit is knot (1 knot =0.51m/sec)

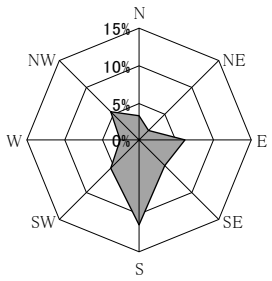

Figure 1-3 : Wind direction frequency

(3) Cyclones

The Solomon Islands are located near the place where cyclones originate and most of their strength is in the initial stage of development.

Of the cyclones in the surrounding areas of the Solomon Islands (1966 – 1988), the one which brought the largest disaster to the Solomon Islands including Malaita Island was the tropical cyclone "Namu" in May 1985.

The cyclone that approached closest to Auki was the tropical cyclone "Isa" which traversed from NNW to SSW through Indispensable Strait 13km off Auki Bay in April 1969.

This cyclone originated in the sea to the east of the Solomon Islands and passed over through the south of Malaita Island to the south of Guadalcanal Island and departed toward the southwestern direction. It crossed over Indispensable Strait (about 55km wide) located at 10km south-southeast of the sites in Auki. It was recorded that its average wind velocity was 46 to 50kt and the traveling speed was 12.3km/h.

1-2-1-8 Earthquake

The Solomon Islands often experience earthquakes of over M.4 because the Islands are located at the boundary of the Australian Plate and the Pacific Plate. The epicenter distribution in the world for the period from 1990 to 2000 and the positions of the boundaries of the subsurface plates in the areas surrounding the Solomon Islands are shown in Fig. 1-4 below.

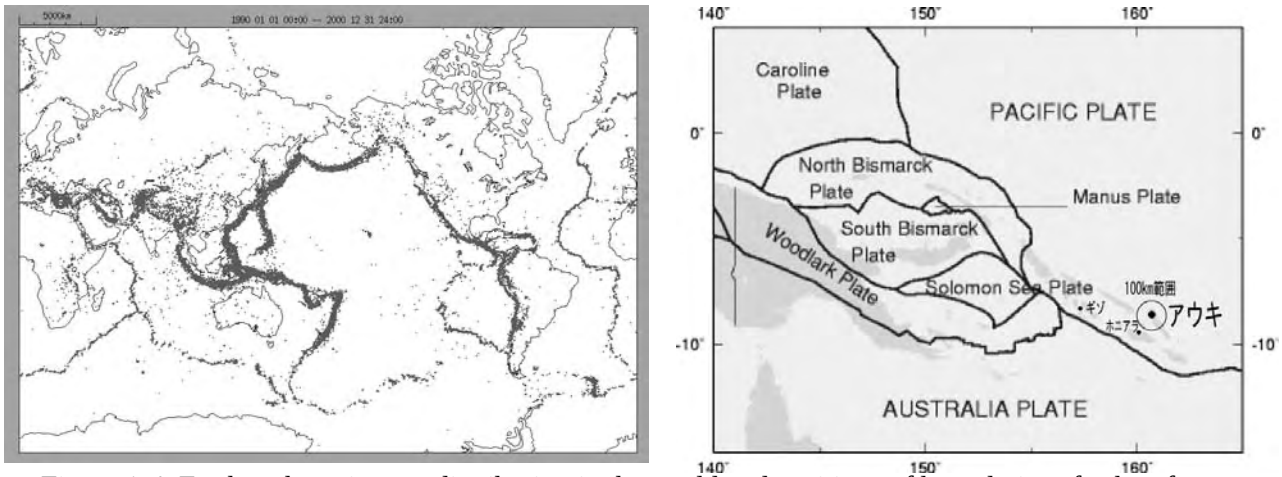

Figure 1-4：Earthquake epicenter distribution in the world and positions of boundaries of subsurface plates in the surrounding areas of the Solomon Islands
(Earthquakes with magnitude 4.0 or greater and at depths of 50km or more)
(Source: Meteorological Agency)

As shown in the diagram above right, most of the great earthquakes that have occurred in the surrounding areas of the Solomon Islands have been of the plate boundary type which originate at the boundary line between the Pacific Plate and the Australian Plate which runs from the northwest to the southeast at the south of Guadalcanal Island, or at the northwest of the Solomon Islands

(Western Province, New Georgia Island and the surrounding area of Choiseul Island) where several small subsurface plates collide with each other.

In our most recent memory is the big earthquake of M8.1 that occurred in the vicinity of the capital city of Gizo in Western Province in the early morning of April 2, 2007.

Malaita Island is located at a distance of 100km from the boundary line between the Pacific Plate and the Australian Plate and has experienced relatively few earthquakes compared with the rest of the Solomon Islands. According to the earthquake database (since 1973) by USGS (US Geological Survey), 42 earthquakes of M4 or more occurred within the area covered by a 100km radius circle centered at this project site "Auki". Of these, there was one earthquake of M6 or more (M6.3, originated at 31km to the east of Auki on July 31, 1973), 14 M5-class and 27 M4-class earthquakes. The earthquake nearest area to the project site was the one of M5.5 that occurred 8km to the north-northeast of the site on July 25, 1973.

The buildings in the Solomon Islands require earthquake-proof design considering a seismic force based on NZS4203:1984. The earthquake-proof design of public facilities must be compliant with the local category "A" under the above standard and calculated by the following formula:

$$V=Cd \cdot Wt$$

where Wt is the building weight and Cd is a base shear coefficient, which is given by the following equation:

$$Cd=C \cdot I \cdot S \cdot M \cdot R$$

(Coefficient determined by the subsurface type in the local area and the natural period of the building)

I:Importance factor of the building

S: Coefficient determined by the structural form of the building

M: Coefficient determined by the structure type of the building (RC building: M=1)

R: Risk factor determined by the building use

1-3 Environmental and Social Considerations

In the preliminary study before the basic design study, the JICA team carried out an Initial Environmental Examination (IEE) in collaboration with the Solomon Islands Government and reached the conclusion that the Project for Construction of Market and Jetty in Auki in the Solomon Islands does not require Environmental Impact Assessment (EIA) according to the environmental laws of the Solomon Islands. After the implementing agency, the Ministry of Infrastructure Development, confirmed with the Ministry of Forestry, Environment and Conservation, the director of the Department of Environmental Conservation of the said ministry issued a written approval for exemption from EIA.

In the basic design study after the preliminary study, Public Consultation Meetings were held at two locations in the rural area of Malaita Province to provide an explanation of the project to local residents and hear the opinions of those residents. The residents gave their approval to the project and made various proposals. Since, in the Solomon Islands, the complexity of land ownership/user rights often becomes an obstacle to project implementation, the Malaita Provincial Government held discussions with the interested parties who claim the customary land ownership/user rights to the project site. As a result, the interested parties gave their concurrence to the construction of the planned project facilities on the planned site and public use of Auki Market and Jetty. Finally, a Memorandum of Understanding (MOU) was created between all the interested parties and the Malaita Provincial Government.

According to the procedures defined in JICA Guidelines for Environmental and Social Considerations, no environmental issue likely to have a serious negative impact is involved in the implementation of this project which, however, was classified as Category B in the preliminary study because a few negative impact was assumed.

Thus, the following measures were taken in the basic design study to avoid and mitigate such environmental and social impacts:

(1) Mooring facilities in front of the market site

It is considered desirable to construct mooring facilities for boats and canoes for the benefit of market users. However, it is impossible for small craft to always use the mooring facilities because the seawater area in front of the planned market is a sandbank at the mouth of Kwaibara River where the water depth is shallow and a dry beach is made at the ebb tide. In addition, mangroves grow in the vicinity of the river mouth and the present conditions have to be conserved to the maximum. However, the area along the shore line suffers from some erosion due to climbing waves, causing trees to fall down. Therefore, it is planned to construct a stepped gabion basket type embankment to enable small craft to use it at the full tide.

(2) Installation of public lighting

Public lighting will be installed at 4 points at the jetty site and at 4 points at the market premises as it is necessary to provide public lighting equipment at the jetty and market sites especially for crime prevention and for the safety of users in the nighttime.

(3) Installation of toilets for gender consideration

The toilets for women and men will fully be separated by a partition taking noise and visibility into consideration. The quantity of toilet equipment has been determined in accordance with the proportion of men-women among the market users.

(4) Scenic considerations

The roof slope and framework system of the market building will follow the common roof

structure that is used in the Solomon Islands and colors that are common in this country will be adopted.

(5) Water supply and sewer treatment programs

This country is in a heavy rainfall region, but the city water drawn from the groundwater in mountains is constantly in short supply. Therefore, the cleaning water except drinking and cooking water shall be made available by collecting rainwater from the large roof of the market building into an underground tank. For miscellaneous wastewater, large scale processing will not be carried out within the market facility, so high concentration wastewater will not arise. However, the wastewater will be treated in a combined treatment tank, after removal of solid matter will be percolated into the underground.

(6) Rubbish collection and disposal plan

A volume of rubbish including coconut casks, banana leaves and vegetable garbage will arise in the market facilities. This rubbish will be collected daily by cleaning personnel of the market and temporarily kept in a temporary rubbish shed with doors which will be installed in the market facilities. The collected rubbish will be moved out of the market facilities by an outsourced rubbish collector several times per week and treated at a place of final disposal as designated by the Provincial Government.

CHAPTER 2 CONTENTS OF THE PROJECT

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2-1 Basic Concept of the Project

2-1-1 Basic Concept of the Project

The greatest issue facing Solomon Islands is to restore the economy in Malaita Province which had been stagfrated by the “Ethnic Tension”, and has been pressureed by rapidly increasing population, both causes life of rural people of Malaita Province unstable. To prevent re-migration of Malaitan residents to Honiara which is deemed a cause of the ethnic tensions, it is an urgent task to vitalize the economy by expanding the opportunities of the rural people of Malaita Province to earn cash, by improving the flow and the exchange of goods and people with Honiara.

The objective of this project is to improve transport of the people between Malaita and Honiara and distribution of goods of Auki and Malaita Province and, in order to bring economic vitality to Malaita Province, by constructing the Auki Market and the Auki jetty.

2-1-2 Examination of Request

The request items and their priority, as confirmed through discussions with the Government of Solomon Islands in the field study made in the Solomon Islands, are the facilities and equipment as shown in Table 1-2 in Section 1.1.

The relations between the objectives of the Project and the planned facilities are shown in Figure 2-1 below.

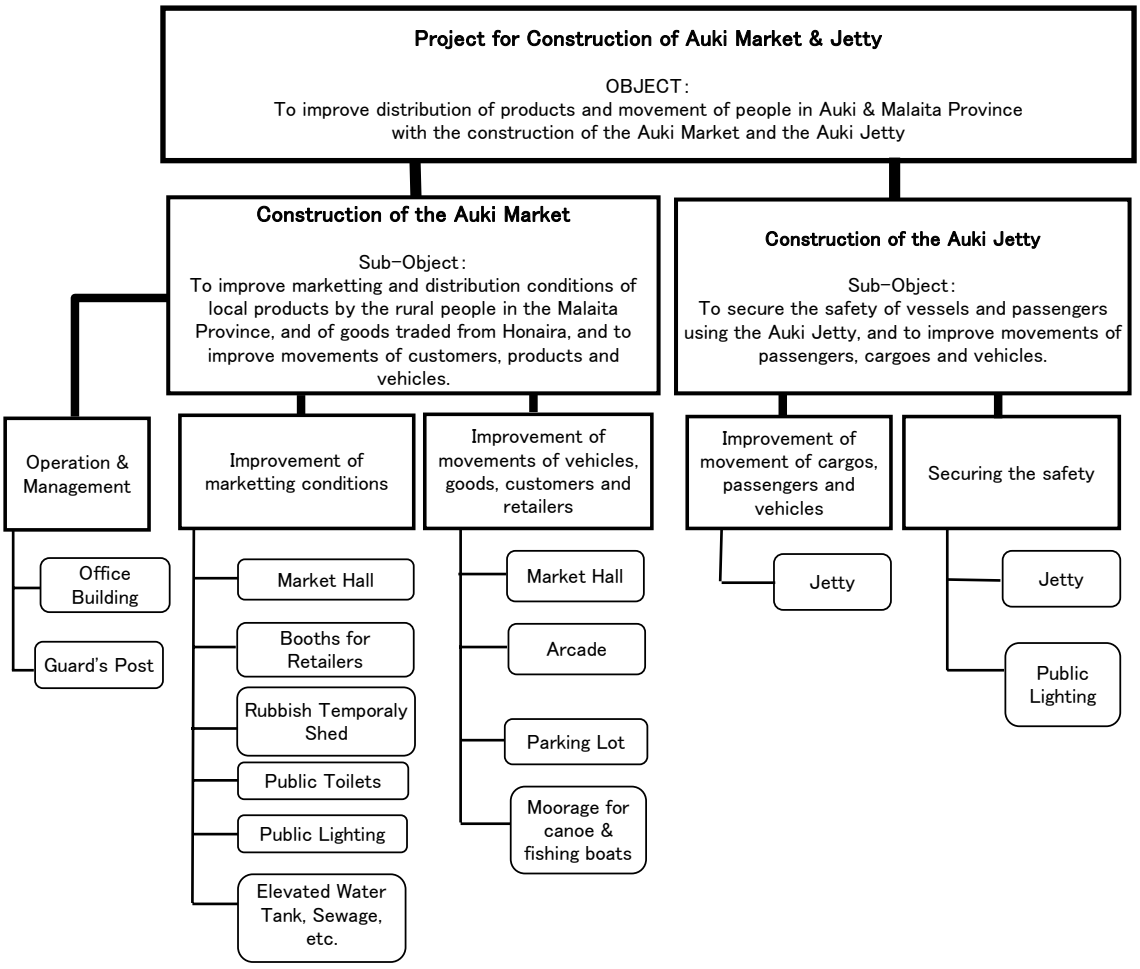


Figure 2-1 : Project objective and planned facilities

2-1-2-1 Market hall

At present, Auki Market, located at the corner of two roads on the north and west sides and facing Auki Bay to the south and a private building to the east, has no room for expansion. The roadside vendors' area, unpaved, has puddles and becomes muddy when it rains and many of the goods are exposed to rain. When it is sunny, perishables such as vegetables, fruit and seafood are exposed to direct sunlight and greatly lose their freshness, and other commodities also deteriorate in quality.

The existing facilities on the site include the fisheries center, cold storage, booths for general retailers, butchery, and market hall. All these facilities are superannuated and the market facilities are too small for the number of venders coming to the market and greatly need to be rebuilt in order to meet the functions of a market.

The fish processing room proposed in the request, which would be used only to remove the gills of bonito, tuna, etc. and wash the fish, needs to be constructed not as an independent room but only as a fish washing area to fulfill its purpose. Additionally, the lockable retailer's storage, which would be used to store unsold coconuts, root crops, etc. until the next morning, needs to be constructed not as independent storage but only as storage space for root crops, for example, in the

lower part of the sales table.

2-1-2-2 Ice-making plant

The shortage of ice appears to stem from the shortage of ice storage capacity, not the lack of ice machine performance. Since the existing ice machine, although superannuated, is running well and the shortage of ice for sale can be resolved by expanding the ice storage capacity, it is concluded that there is little need to construct a new ice-making plant.

2-1-2-3 Cold storage and chest freezer

Cold storage is said to be needed for storage of unsold vegetables and root crops. In the field study period, however, vegetables were brought to the market in the morning and were mostly sold out by late in the afternoon. It is true that root crops and coconuts often remained in the market until the early evening, but there is little need for cold storage for short-time storage of root crops. It is also doubtful whether inexpensive goods with unit prices from 1 to 3 SBD can be sold at a price with refrigeration costs added. There is, therefore, little need for cold storage.

A chest freezer is said to be needed for frozen storage of seafood and stock farm products forwarded to Honiara. At present, the Fisheries Center freezes these products. About four tons of products are frozen per month and these products are in frozen storage in a chest freezer together with ice for ice storage. Therefore, storage ice often runs short when there are a lot of goods in frozen storage, and frozen storage space often runs short when there is a lot of ice. Although there is a great need to enhance the frozen storage capacity, the Fisheries Center is currently managed by the fishermen's union and, after the completion of Auki Market, it is expected to be recommissioned by the market manager to the same union. Since the nature of the grant aid prohibits the supply of profit to any specific group, this project will not supply a chest freezer, but construct a freezing and ice selling room where chest freezers can be installed.

2-1-2-4 Booths for general retailers

In Auki Market, there is one butchery, 10 retailers' booths that sell daily necessities, sundries, canned goods, processed food, etc., and three canteens. These booths need to be relocated when the market is relocated.

2-1-2-5 Public lighting

At Auki Jetty, a passenger vessel comes into port late on Friday evening and leaves for Honiara on Saturday morning, so the jetty is crowded with passengers during this time. Auki Market stays open all through Friday night to sell goods to these passengers. Due to the lack of public lighting, however, retailers are dealing in the dark using flashlights, which is hindering sales activities. There is a great need for public lighting.

2-1-2-6 Parking lot

Many of the retailers come from remote villages on trucks loaded with products and pull up to unload them on the road in front of Auki Market. Customers' cars and taxis that have brought people to the market and are waiting for new passengers are also parked alongside the market, getting in the way of nearby traffic. There is a great need for a parking lot as a market facility.

2-1-2-7 Exterior works

An elevated water tank, rainwater drainage, wastewater treatment systems, etc. are requested. The water supply system in Auki has insufficient water capacity, so the water supply is restricted to certain hours outside the vicinity of the planned market site and the water pressure is as low as 0.03Mpa. An elevated water tank is needed to secure water for use in the market as well as water pressure. With the heavy rainfall in Auki, there is also a great need for a rainwater tank to make effective use of the water. No special wastewater treatment system is needed because the wastewater from the market is merely washing water. However, septic tanks for toilets are needed because there is no existing public sewerage system.

2-1-2-8 Market equipment

Market equipment such as fish boxes and scales to be used by the retailers in the market are requested. There is little need for scales because, in Auki Market, vegetables, fruits, root crops, etc. are sold by number or heap and fish by number, not by weight. At present, no fish boxes are used because fish are lined up on plastic sheets and sprinkled with seawater to prevent drying or a rise in temperature while being sold. In Honiara market as well, leaf fish are sold in cool boxes, but bonito and tuna are sold lined up on stands. The fish sold in Auki Market are mostly bonito, tuna, etc. and therefore there is little need for fish boxes.

2-1-2-9 Moorage for canoes & fishing boats

The sea area in front of the planned market site is an intertidal zone that runs dry at low water in the spring tides. This area is covered with sea grasses and is not suitable for navigation of outboards at low water. Extending the jetty for canoes and fishing boats up to a point appropriate for navigation of outboards will not only be excessively costly but also pointless, because then the distance would be almost as far as that between the point in front of the existing market which is currently used as a boat basin and the new market. However, there are many people who come from nearby fishing villages to the market on canoes. Mainly for the sake of canoes, therefore, the plan will be to construct small-scale moorage that can be used at high water as part of the bank protection works of the market site and, at low water, have the boats use the natural beach in front of the existing market.

2-1-2-10 Fishing gear lockers

Fishing boats that land fish for Auki Market go out fishing from the foreshore of the fishing villages, sell the fish at the market and go home to the villages. Their fishing methods are trolling or single-rod fishing and their fishing gear is not large enough to need to be stored in fishing gear lockers. Therefore, there is little need for fishing gear lockers.

2-1-2-11 Public toilets

In the interview survey of market users, public toilets were found to be the second most wanted facilities, next only to the market hall. There is a high need for public toilets because of environmental concerns as well as the lack of such facilities in the vicinity even though most users are in the market for more than four hours. The survey of jetty users also found that public toilets are strongly wanted by both men and women.

2-1-2-12 Temporary rubbish shed

At present, rubbish in Auki Market is collected and temporarily piled up on the front road by cleaners employed by the manager. A cleaning company contracted by the provincial government then picks up and transports the accumulated rubbish to a nearby temporary rubbish shed for disposal. There is a great need for an on-site temporary rubbish shed where collected rubbish from the market can be temporarily accumulated until it is picked up by the provincial government.

2-1-2-13 Jetty for ferries and incidental jetty facilities

The biggest problem for production activities and movement in Malaita Province is transportation. The jetty where daily necessities transported from Honiara and needed by both rural residents and Auki citizens are unloaded is important for improving the marketing conditions of Auki Market. The existing jetty is highly susceptible to collapse due to deterioration. There is a great need for construction of a new jetty.

Since vessels from Honiara come into the port late at night, the lack of public lighting poses a danger to the disembarkation of passengers and the loading and unloading of cargo. There is a great need for public lighting. Furthermore, while a vessel is approaching the jetty or is moored at it, many citizens in addition to the passengers and receivers of cargo gather on the jetty, getting in the way of disembarkation of passengers and cargo work and posing a danger.

In addition, some of the navigation aid facilities required for safe navigation, such as light beacons that indicate the fairways at the mouth of the bay, are broken, endangering ferries coming into the port at night. Repair of the light beacons, although required, shall not be included in this project, because the objective of the project is the improvement of Auki Jetty and the navigation aid facilities are outside the project scope.

Although the shipping operator has requested water supply facilities for ferries, Auki town has exceedingly small water tank capacity at present, so there would seem to be no surplus water that can be supplied to ferries.

There is little demand or need for refueling facilities.

2-2 Basic Design of the Requested Japanese Assistance

2-2-1 Design Policy

Based on the request by the Government of Solomon Islands for the Construction of the Auki Market and Jetty for the objective of the Project to improve the distribution of people and goods in Malaita Province, the design policy was established as follows:

2-2-1-1 Market Facilities

① As the existing site of the market facilities is narrow and land expropriation in the surrounding areas involves complicated problems with the rights to use the land, it is difficult to expand the existing market site. Therefore, the adjacent unused land possessed by the Malaita Provincial Government, for which there are no problems in acquiring the site, will be secured as a new market site.

② Market facilities which are protected against the direct sunlight, rain and mud which deteriorate the freshness and quality of the goods, and where the vendors can exhibit and sell goods and the consumers can select and buy the goods with safety and efficiency will be constructed.

③ The scale of planned selling booths in the planned facilities will basically be able to handle the current distribution volume in the existing Auki market and the daily average number of 224 fixed selling booths and an unfixed selling area for space expansion on weekends will be provided. It is also planned to construct the number of retailer's booth buildings equivalent to the number of existing stores.

④ The line of flow of people, goods and vehicles will be defined and a buffer space, parking lot, vehicle approach, and other facilities will be provided at crossover points to prevent congestion and interference. It is also planned to construct facilities in harmony with the surrounding environment.

⑤ Retailer's stores will be arranged facing the area with a roof considered not to expose goods and customers to sunlight, rain and winds.

⑥ A temporary rubbish shed will be provided with roof and walls to prevent refuse and smells from spreading to the exterior.

⑦ No independent storehouse will be provided for taking storage of crops and root vegetables at nighttime, but a store cabinet will be provided in part of each selling booth and administered by each vendor.

⑧ The market facilities will employ rigid materials and have a robust structure as they are used by many and unspecified persons, and will also be considered for ease of maintenance after completion and for low administration cost.

⑨ The facilities and equipment of the Auki market facilities will be of a grade adequate for the current conditions in Auki, by reference to the materials and equipment of the similar facilities in Honiara Market.

⑩ An ice maker, refrigerator, fishing tool locker and market furniture will be excluded from the Project because their level of necessity is low.

⑪ No structural design standard is established in the Solomon Islands. Therefore, the Japanese standards will apply to implement this grand aid cooperation project with efficiency and economy in comparing them with the standards adopted in the surrounding countries.

2-2-1-2 Jetty Facilities

① The plan for rehabilitation of the existing jetty will require works such as installation of a temporary jetty during the work execution period and disassembling the existing jetty and will be disadvantageous from the viewpoints of construction cost and work period. Therefore, the plan to construct a new jetty will be adopted.

② The jetty scale will be determined based on the largest ship (hull length of 54m and draft of 3.4m) among the liners using the jetty.

③ The position of the planned jetty will be so arranged that any problems with the rightful persons who have the customary right to use the land of the site will not be caused in the future.

④ The alignment of the jetty will be established so that the arrival and departure of ships at or from the jetty will be conducted easily and safely and that the sunken ship at the west side of the existing jetty will not obstruct the arrival of ships at the jetty and the work of dismantling the sunken ship to be done by the Solomon Islands side.

⑤ A ferry ramp will be provided at part of the jetty so that ferry-type ships and landing craft which have regularly used the Auki Jetty can use the ramp by lowering a flap.

⑥ The jetty width will be determined to be the minimum width required for controlling the works of loading and unloading cargo and disembarking passengers in accordance with applicable regulations and in order to relieve the congestion.

⑦ As there is soft ground from the sea bottom to a depth of -25m beneath the existing jetty, a piled structure that has no problems such as settlement due to consolidation will be selected and designed for safety against waves entering Auki Bay and influx silt sedimentation.

⑧ It is planned to install the minimum lighting equipment to secure the safety in using the jetty at nighttime.

⑨ Structural design standards are not established in the Solomon Islands. Therefore, the Japanese standards will apply to implement the grant aid cooperation project with efficiency and economy in comparing them with the standards adopted by the surrounding countries.

2-2-2 Basic Plan

2-2-2-1 Basic Plan of Market Facilities

(1) Setting of Market Facilities Scale

1) Planned Number of Stores

In this plan, fixed sales tables shall be installed in the market hall for the sale of agricultural produce, daily necessities and marine products in the same way as in Honiara Market and other existing markets. In addition, booths for general retailers shall be provided as a facility to accommodate the existing retailers' booths, butchery, etc.

① Determination of the scale of fixed selling booths and store buildings

The number of fixed selling booths will be determined as the average number of stores on weekdays (Monday to Thursday). The number of booths and canteens as well as butchery will be the same as that in the existing Auki market.

② Determination of the scale of unfixed farm products selling area

The current retailers' selling area consists of unroofed movable stores using simple tables or plastic sheets and permanent booths constructed inside the building. The number of movable stores varies depending on the day and increases especially at weekends, because the regular ferry arrives from Honiara on Friday night and leaves for Honiara at Saturday noon. Therefore, the movable agricultural produce selling area shall be planned particularly in view of the vendors who sell agricultural produce at weekends. The field study found that the day-by-day average number of stores selling agricultural produce on Monday through Thursday was 95. The average number of stores on Friday and Saturday was 195. Therefore, the planned selling area shall accommodate 100 stores, being the same as the difference in number, at peak time at weekends.

Based on the above, Auki Market shall have the following number of stores in the plan.

The Table 2-1 shows the current and planned numbers of stores in Auki Market and the current number of stores in Honiara Central Market.

Table 2-1 : Current number of stores in the existing markets

Classification		Auki Market current number (stores)	Planned number (booths)	Honiara Central Market average number (stores)
Fixed facilities	Sales tables	From 190 to 438 **224** (average Mon-Thu) 276 (average Mon-Sat)	224	420
	Booths for general retailers	14	14	17
Movable	Selling area	—	100	From 68 to 250 (average 182)

The types and numbers of selling booths and retailers' booths will be the same as in the existing market facilities as verified in the field study and as shown in Table 2-2.

Table 2-2 : Numbers of sales tables and booths for retailers in the plan

Classification	Store type	Number (stores)	Remarks
Sales tables	1) Sales tables for agricultural produce and daily necessities	208	Average at weekdays
	2) Sales tables for marine products	16	Average at weekdays
	Total	224	
Booths for retailers	①Retailers' booths	10	Same as at present
	②canteens	3	Same as at present
	③Butchery	1	Same as at present
	Total	14	

2) Scale of Sales Tables and Booths for General Retailers

① Agricultural produce sales tables

The scale (size and form) of fixed sales tables, intended as a replacement for the current wooden sales tables, shall be set according to the form and size of the latter.

Since the current wooden tables measure 1.27 meters (width) by 0.68 meters (depth) on average, the planned dimensions shall be set at 1.3 meters (width) by 0.7 meters (depth) accordingly. Incidentally, the sales tables used in Honiara Central Market measure 1.5 meters (width) by 0.7 meters (depth).

② Marine product sales tables

The marine product sales tables shall also be set according to the current sales palette dimensions.

Since the current sales palettes measures 2.39 meters (width) by 1.20 meters (depth) on average, the planned dimensions shall be set at 2.4 meters (width) by 1.2 meters (depth) accordingly.

③ Booths for general retailers

Since the retailers' booths, canteens and butchery are replacements for the existing facilities and the scale of the area currently poses no problem, the scale of the booths for general retailers shall be the same as at present.

Table 2-3 : Planned scale of booths for general retailers

Facility name	Planned scale (m^2)
Retailer's booth	9
Canteen	21
Butchery	40

④ Agricultural produce selling area (movable)

The size of one seller's segment in the selling area used at peak time at weekends shall be set according to the current size of one segment used for sales on plastic sheets.

Since the current size of one segment used for sales on plastic sheets measures 1.18 meters (width) by 0.75 meters (depth) on average, the planned dimensions shall be set at 1.2 meters (width) by 0.7 meters (depth) accordingly, the same depth as the sales tables.

3) Scale of Freezing and Ice-making Agent

At present, the freezing and ice-selling agent (Fisheries Center) provides a freezing service and sells ice. The monthly amount of ice for sale is around 4 tons and the ice that has been made is stored in chest freezers together with other frozen products.

In view of the procurement cost and current maintenance status, the appropriate plan shall be to continue the current system of using chest freezers generally traded and used in the Solomon Islands.

Six chest freezers with a capacity of 700 liters are currently in use. In this project, as many chest freezers of the same size as at present shall be used. A freezing and ice-selling agent with accommodation for six chest freezers shall be provided in the floor plan. If the freezing and ice-selling agent needs to be relocated or expanded in the future due to the replacement of ice-makers or increase in the freezing amount, the neighboring land reserved for future expansion shall be used for this purpose.

4) Scale of Farmers' Storage

Storage shall be provided to store the unsold stock of vegetables, fruit and root crops. In the plan, wooden doors shall be installed under the agricultural produce sales tables so that the space under the stands can be used as storage. (see Figure 2-2)

This storage method, clearly indicating who owns the crops stored under each sales table, has advantages in terms of management, because it allows each retailer to take his crops out at any time and does

(Fish market in Kaolack, Senegal)

Figure 2-2 : Example of storage under a sales table

not require any storage management personnel who would otherwise be needed if a warehouse was shared by retailers. Possible fee collection methods would be, for example, to set a higher rental fee for each sales table or to loan padlocks for a charge to retailers who need storage.

The number of farmers' storage spaces, which are required only for the unsold stock of "vegetable and fruit stores," shall be 25 as shown in the Table 2-4:

Table 2-4 : Required number of farmers' storage spaces

Item	Number	Remarks
① Number of stores in the market	95	See *1.
② Ratio of stores with unsold stock	27.3%	See *2.
Number of required storage spaces (①×②)	25	

*1 No storage is needed on Friday when the stores are open until late at night or on Saturday after which stores are closed (on Sunday). Therefore, the average number of "vegetable and fruit stores" on weekdays (Monday through Thursday) found in the field study was 95.

*2 The average ratio of "vegetable and fruit stores" open until around 6:00 p.m. with unsold stock on weekdays found in the field study is shown in the following table:

Monday	Tuesday	Wednesday	Thursday	Weekday average
32.9%	30.9%	12.2%	33.0%	27.3%

5) Scale of Administrative Office

An office shall be provided for administration and operation of Auki Market.

The details of the office scale shall be set according to the floor plan for each room in view of the furniture to be accommodated, based on the standard floor area of offices in Japan (5 to 15 m^2 per person: Illustrative Standard Data for Architectural Design) and the administrative office in Honiara Central Market. The meeting room is mainly intended for weekly meetings among the market personnel (50 days per year), monthly informal gatherings with each group of retailers who sell vegetables and root crops, marine products, and retail goods, processed foods, and daily necessities (3 times by 12 months = 36 days per year), and meetings with representatives of each of these selling areas (4 days per year). The room shall accommodate up to 10 operation management persons who attend weekly meetings excluding guards. The following table lists the required administrative office rooms, purposes of use, and numbers of occupants.

Table 2-5：Planned rooms in the administrative office

Room name	Purpose	Number of occupants
1. Market master's room	Room in which the market master works and receives guests	1
2. Accounting room	Room in which market accounting (fee collection and processing) is conducted	3
3. Staff room	Room for cleaners and guards	4
4. Meeting room	Room for meetings of market management personnel, etc.	Max. 10
5. Toilets	Only for use by market administrative office personnel	—
6. Utility room	Same as above	—
7. Storage	Storage of management equipment and cleaning tools for the market hall and office	—

6) Scale of Toilets

Public toilets for use by market users (such as retailers and customers) shall be provided. A fee shall be collected for use of this facility and appropriated for the cleaning and maintenance expenses of the facility. As in Honiara Central Market, personnel for management, cleaning and fee collection shall be permanently stationed in a room in this facility in order to maintain cleanliness.

The number of target users is determined to be the weekly average number of market users around noon (553 retailers and 442 simple users). Furthermore, the ratio of men to women among the retailers is 2 to 3 and the ratio of men to women among the customers is 1 to 1, according to the results of the field study.

Table 2-6：Weekly average number of users of the existing market around noon

(unit: person)

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Average
Retailers	380	440	480	492	650	876	553
Customers	170	158	214	309	710	1,087	441
Users in total	550	598	694	801	1,360	1,963	994

Source: Field count study by the consultant

The number of toilet facilities is determined according to the Figure for Calculating the Required Number of Sanitary Apparatuses provided in the Illustrative Standard Data for Architectural Design (Architectural Institute of Japan) as shown on the Table 2-7:

Table 2-7：Planned number of public toilet facilities

Toilet facilities		Required number of sanitary appliances	Number of target users
Men's toilets	Urinal	5	442 (553×0.4＋441×0.5)
	Toilet bowl	4	
	Hand wash basin	3	
Women's toilets	Toilet bowl	10	552 (553×0.6＋441×0.5)
	Hand wash basin	5	

Incidentally, the number of appliances in Honiara Central Market is shown in the Table 2-8, and since the Basic Design Report indicated the basis for these numbers as the "standard corresponding to a scale of 1,000 persons in the Illustrative Standard Data for Architectural Design" (wording in the BD report), they seem to have been calculated from the above calculation chart on the assumption that the number of male and female users will be 500 each. Due to the difference in the number of target users, therefore, the current Honiara Central Market must have "more appliances in the men's toilets" and "fewer appliances in the women's toilets" than in this project.

Table 2-8：Comparison of number of sanitary appliances in Honiara Central Market

Toilet facilities		Number of sanitary appliances	Comparison with this project
Men's toilets	Urinal	6	＋1
	Toilet bowl	4	±0
	Hand wash basin	3	±0
Women's toilets	Toilet bowl	8	－2
	Hand wash basin	4	－1

7) Scale of Parking Lot

A goods handling area shall be provided for haulage trucks and other carry-in vehicles as separate parking spaces from other vehicles.

On the assumption that the turnover rate is three times an hour (the planned value for Honiara Central Market) according to the results of the field study, the spaces to be secured for carry-in and other vehicles shall be four and eight, respectively.

Table 2-9：Planned number of vehicles to be parked

Vehicle type	Number of vehicles	Estimation
Carry-in vehicles and trucks	4	12.4÷3 turnovers
Other vehicles	8	25.7÷3 turnovers

*The average numbers of vehicles are based on the field survey

One space for the boarding and disembarkation of passengers, who will come and go in large number at one time, from a minibus shall be secured near the planned location of the market hall in order to avoid them walking through the parking lot to ensure safety.

8) Scale of Temporary Rubbish Shed

The accumulated waste is collected only three times a week (Monday, Wednesday and Friday) and transported to a dump site close to the market for disposal. In this project, therefore, a temporary rubbish shed that can store two days' worth of rubbish shall be provided in the market.

Since about two rubbish mounds measuring three meters square are generated during this time, a

roofed temporary shed about 20 m^2 in size shall be constructed.

9) Examination of Moorage for Canoes and Fishing Boats and Bank Protection

① Moorage for canoes and fishing boats

Moorage for canoes and fishing boats, which was requested in front of the market site in this project, is unavoidably severely restricted in that it can only be used at high tide and is not expected to satisfactorily fulfill its function as moorage.

② Bank protection

The shoreline of the market site has been carved away by incoming waves for so many years that the roots of the trees along the shoreline are exposed, with some trees already fallen or inclining. This wave-cut, if not prevented, may cause more of the trees that are still standing to fall or even erode the foundations of the land facilities of the market. Therefore, bank protection shall be established along the shoreline of the market (about 120 meters long) using gabions filled with boulders that can be collected locally. The bank protection shall be in a form where gabions are piled up in a staircase pattern to enable the use of canoes and fishing boats at high tide.

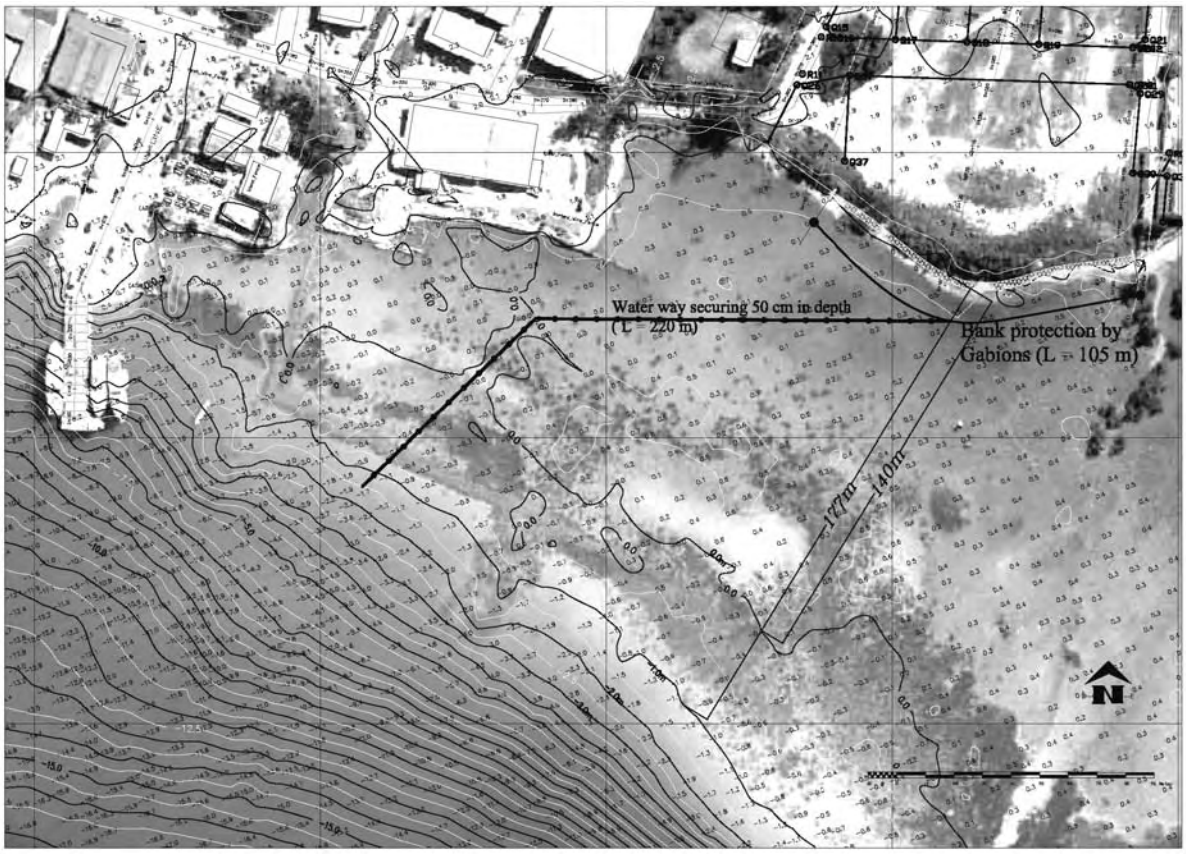
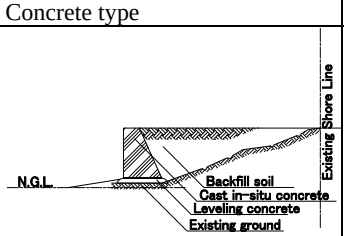
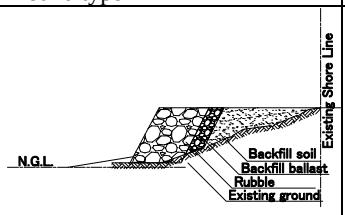
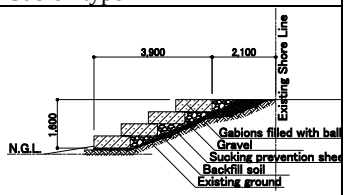


Figure 2-3：Topographic survey map (market site front)

A revetment type can be considered, but the mat gabion type which is applicable to soft ground and easy to maintain and repair because the materials are available in the Solomon Islands is recommended. The mat gabion has been adopted for revetments for bridges and bank protection in the vicinity of the existing jetty in the Solomon Islands, requiring no special techniques and machinery in the construction work.

While the types of bank protection listed in The Table 2-10 are possible, the gabion type is recommended in this project because the materials are locally available, maintenance and repair can be easily conducted locally, and gabions can be used on soft ground. Gabions have been adopted in the Solomon Islands as bank protection for bridges and around the existing jetty, and the construction of gabions requires no special skills or machines

Table 2-10：Comparison of bank protection types

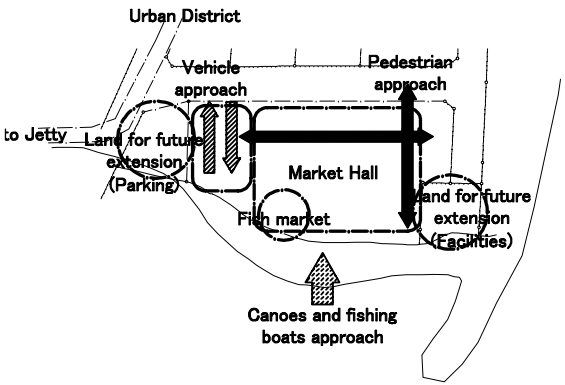
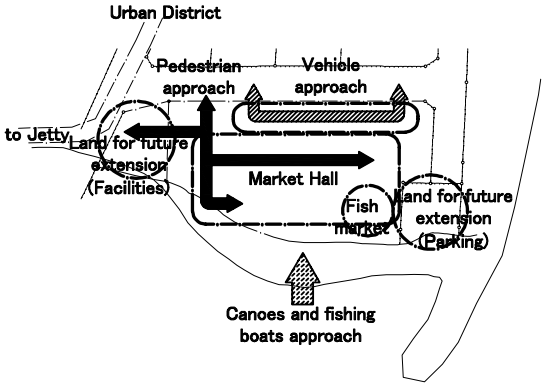
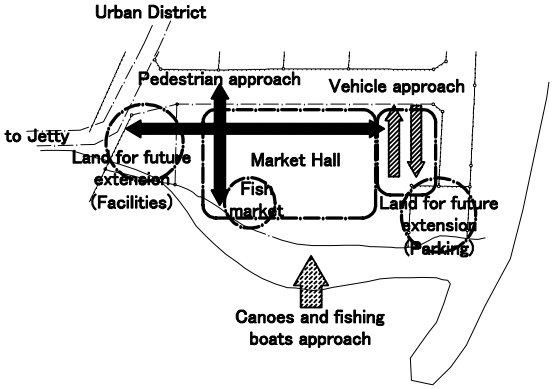
Item	Concrete type	Mound type	Gabion type
Schematic diagram			
Adaptation to local ground conditions	Uneven settlement may occur due to the soft ground.	This type adapts well to uneven settlement.	This type adapts well to uneven settlement.
Convenience	Stairs must be partially constructed or a slipway must be constructed.	Not compatible with the use of canoes and fishing boats.	If constructed in a staircase pattern, this type is compatible with the use of canoes and fishing boats.
Materials	Cement must be imported.	Building stones: Can be collected locally but large-diameter stones cannot be easily mined.	Building stones: Stones around 10 to 20cm in diameter can be collected from local river gravel.
Maintenance and repair	×	○	○
Cost	×	△	○
Overall evaluation	×	△	○

(2) Site Planning for market hall

The site planning for the market hall is examined on the next page.

As the pedestrian approach is closer to the urban district and jetty, unloading space can be secured, and the market hall space can be secured at a convenient location in the center, it was decided to further study the case of putting the market hall on the west. On the assumption of the above scale and site planning, the floor plan of each facility is examined.

Table 2-11：Examination of site planning for market hall

	1. Locating the market hall on the east	2. Locating the market hall on the south	3. Locating the market hall on the west
Zoning and lines of movement			
Characteristics	● The pedestrian approach is further from the urban district and jetty and is divided by the vehicle approach. ● Both unloading space and land for future extension can be secured. ● Market hall space can be secured at a highly convenient location in the center.	● The pedestrian approach is closer to the urban district and jetty and does not cross the line of movement of vehicles. ● The unloading space has a sufficiently wide tangent line for cargo handling. ● While the market hall has a long east-west line of movement, efficient width cannot be easily secured for the north-south line. ● The market hall is closer to the shoreline and therefore susceptible to the effects of wind and rain.	● The pedestrian approach is closer to the urban district and jetty and does not cross the line of movement of vehicles. ● Both unloading space and land for future extension can be secured. ● Market hall space can be secured at a highly convenient location in the center.
Evaluation	△	○	◎

(3) Floor Plan of Market Hall

1) Number and scale of sales tables

Sales tables vary in required area and character depending on whether agricultural or marine products are sold on them. Therefore, sales tables shall be planned area by area.

① Number and scale of agricultural produce sales tables

The number of tables selling agricultural produce shall be 208 according to the number of existing stores in the market from Monday through Thursday, not including the peak time at weekends. The scale of agricultural produce sales tables shall be 1.3 meters by 0.7 meters based on the existing wooden tables used in the market. Selling space and aisles shall be secured around agricultural produce sales tables.

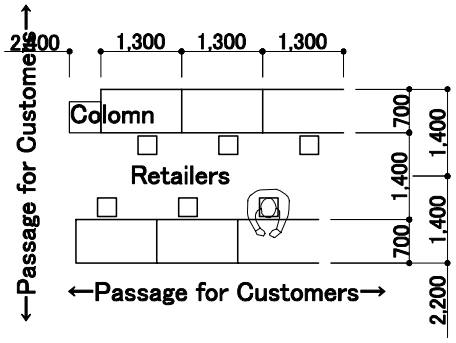


Figure 2-4：Sales table section

② Number and scale of marine product sales tables

The number of marine product sales tables shall be 16, and the scale shall be 1.2 meters by 2.5 meters based on the status quo of the existing market sales palettes. Retailers' space and aisles shall be secured around them.

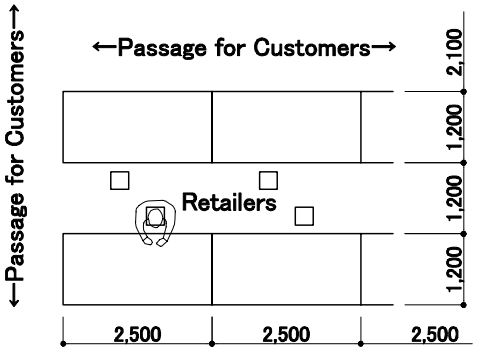


Figure 2-5：Fish market sales table section

	Area	(m^2)
Agricultural produce sales section	867	
Marine product sales section	159	
Total	1,026	m^2

According to the above examination, the total area of the market hall shall be 1,026 m^2.

③ Booths for general retailers

The existing retailers' booths and canteens shall be reconstructed with the following specifications according to their respective scale and number of stores. The retailer's booths shall consist of a counter and product shelves on four sides and accommodate one or two sales clerks. The canteens shall have a kitchen and eating space and an area of 18 m^2, a little less than the current average area, because users generally stay only for a short time and the most can be made of outdoor space facing the arcade. Three buildings, each consisting of four to five stores, shall be constructed.

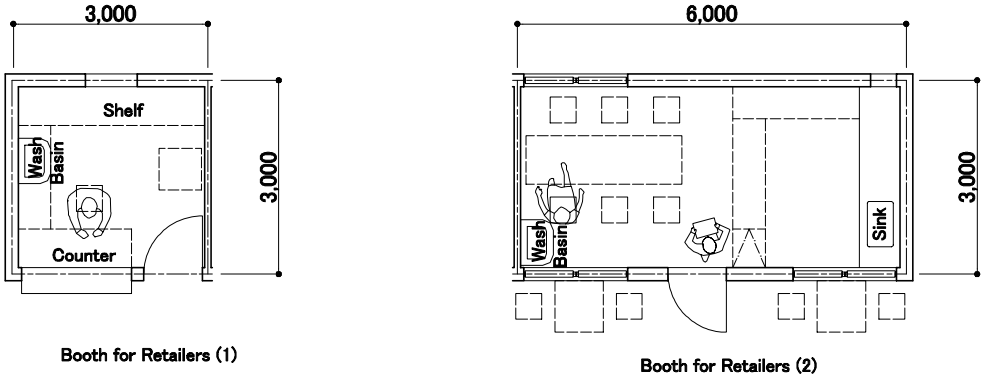


Figure 2-6：Booths for general retailers

④ Butchery

The room for the butchery shall be furnished. The equipment and furniture currently in use shall be rearranged to secure the necessary selling and work spaces. Therefore, the area of this building shall be 38.25 m^2 in total, as shown in the following figure:

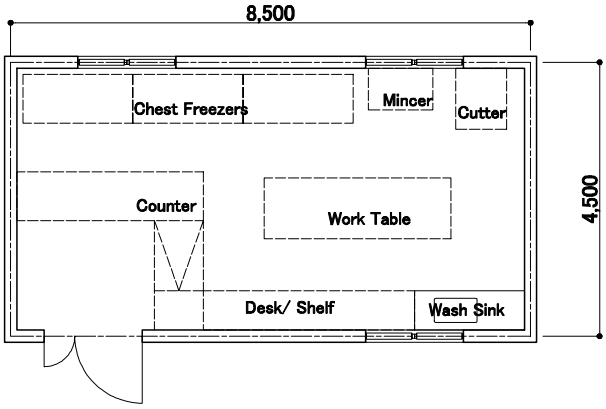


Figure 2-7：Butchery

⑤ Chest freezers room

The chest freezers room shall be able to accommodate the existing six chest freezers (frozen stockers). Since one 700-liter freezer needs a footprint of about 2 meters by 1 meter, the total area of this building including aisles and sale clerks' work space shall be 29.25 m^2.

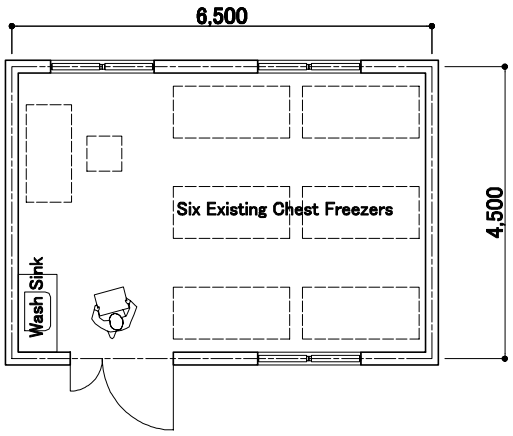


Figure 2-8 : Chest freezers room

⑥ Administrative office building

The administrative office building for the market, being small-scale, shall be a single-story structure for which site planning shall be made in view of the furniture, equipment and personnel to be accommodated in each of the necessary rooms.

⑦ Market master's room

The market master's room, the room where the market master works and receives guests, shall accommodate one market master and two or three guests. The room shall measure 19.6 m^2, including space for one desk and chair, one locker, two filing cabinets and one reception table and sofas for guests as well as space for movement of people.

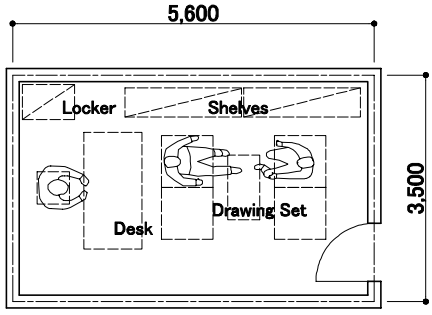


Figure 2-9 : Market master's room

⑧ Office

The office shall accommodate a total of three persons for accounting and paperwork. The room shall measure about 17 m^2, including space for three desks, three lockers and one filing cabinet as well as space for movement of people.

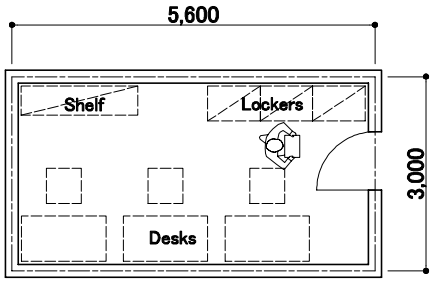


Figure 2-10 : Office

⑨ Staff room

The staff room, a room for cleaners and guards, shall accommodate four persons. The room shall measure about 18.45 m^2, including space for four desks, four lockers and one filing cabinet as well as space for movement of people.

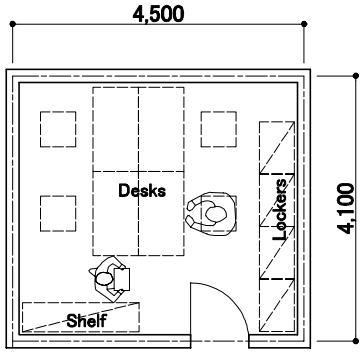


Figure 2-11 : Staff room

⑩ Meeting room

The meeting room, intended for meetings between market management personnel and informal gatherings for discussion with users, shall accommodate about 10 persons. The room shall measure about 31.5 m^2, including space for a long conference table, chairs for 10 persons and a whiteboard as well as space for movement of people.

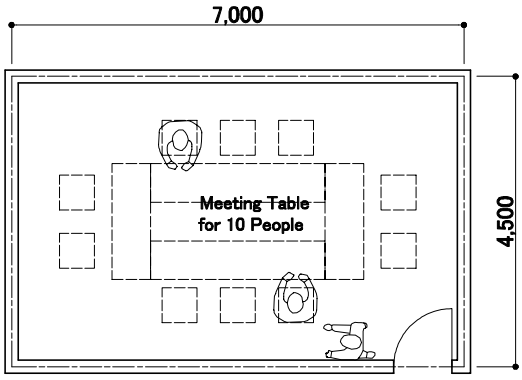


Figure 2-12 : Meeting room

⑪ Toilets / Utility room / Storage

The toilets shall be for about eight market employees. The facilities shall measure about 7.6 m^2 including space for urinals, toilet bowls and washbasins accommodated separately for men and women.

The utility room, with a kitchen sink (water heater and sink) and a cupboard, shall measure about 4 m^2 including space for movement of people.

The storage space, intended for storage of equipment and consumables as well as cleaning tools for the market hall and the administrative office building, shall measure 11.6m^2.

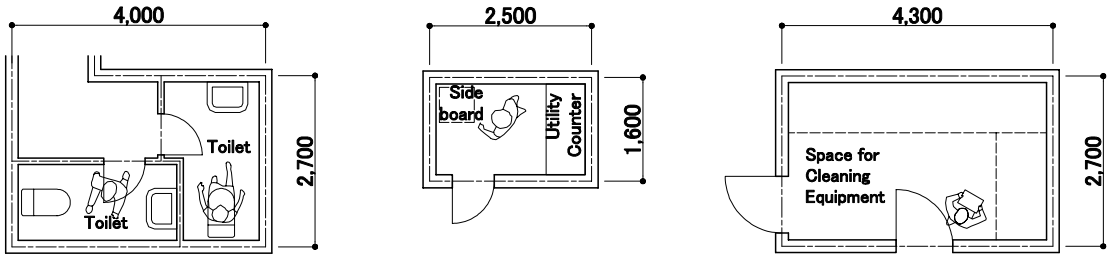


Figure 2-13： Toilets / Utility room / Storage

According to the above examination, the floor layout of the administrative office building shall be as shown in the:Figure 2-14.

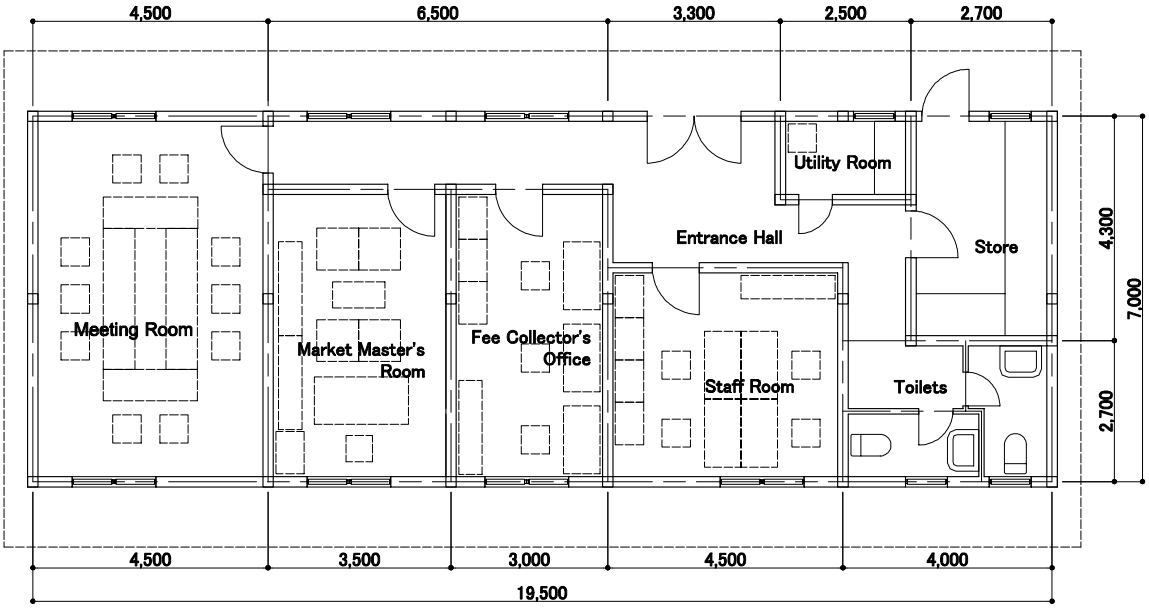


Figure 2-14：Administrative office building

2) Public toilets

The public toilets shall consist of separate facilities for men and women and be situated on the sea side for easy drainage. There shall be a box where the person in charge of maintenance who cleans the toilets and collects usage fees is permanently stationed and cleaning tools are stored. The entrances shall be clearly identified for men or women. The toilet booths, in view of the physical size and usage patterns of local residents, shall be designed with sufficient space and the specifications and structure shall ensure toughness and ease of cleaning.

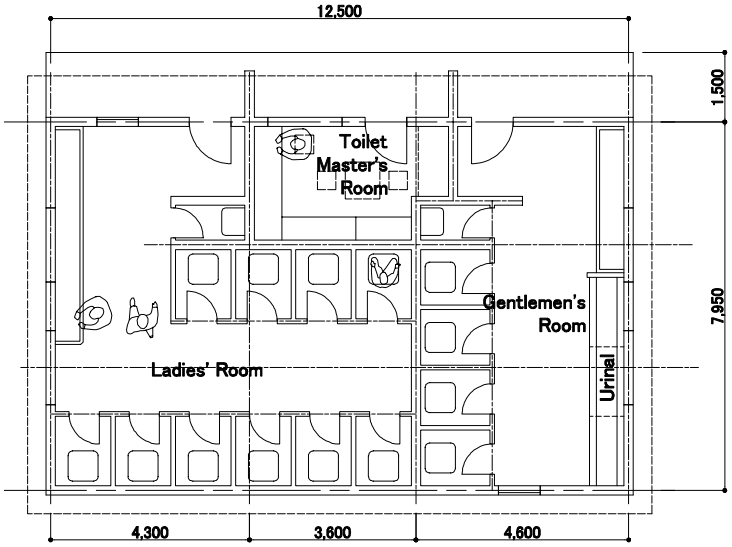


Figure 2-15：Public toilets

3) Parking lot and guard's post

There shall be an on-site parking lot for unloading by market users, boarding and disembarkation of passengers, and taxis waiting for customers. Furthermore, goods handling space for haulage trucks and other carry-in vehicles shall be provided next to the market hall.

The number of boarding and disembarkation spaces to be secured shall be four for carry-in vehicles, one for minibuses for boarding and disembarkation of passengers, and eight for other vehicles. Parking spaces for the vehicles of guests to the administrative office and maintenance personnel, who are expected to come rarely, shall be included in the above number. The parking lot shall be placed along the vehicle movement line on the east of the market hall. The premises road shall be a one-way, one-lane road, four meters in width, separated from the pedestrian movement line and provided with turnaround space to ensure smooth movement of vehicles and safety. There shall be a guard's post at the parking lot entrance, accommodating one guard who shall collect parking fees and control traffic.

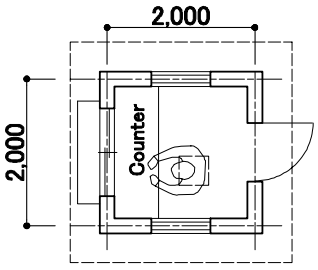


Figure 2-16：Guard's post

4) Temporary rubbish shed

The temporary rubbish shed, based on the status quo of the existing market, shall measure about

18 m^2 and be equipped with a roof. A distribution board room of 6 m^2 and a water faucet for cleaning shall be provided in an integrated manner.

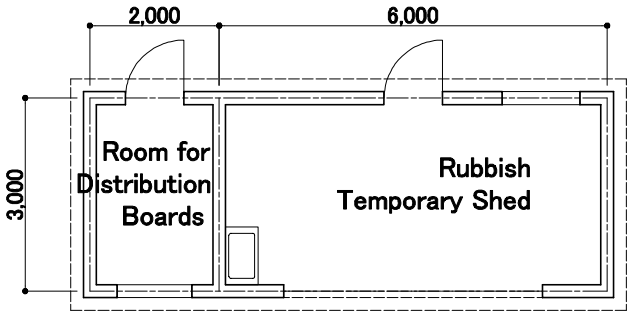


Figure 2-17: Temporary rubbish shed

Based on the results of examination of the total layout plan of the market and the detailed floor plan of individual facilities in Figure 2-4, the total zoning plan taking the following points into consideration is shown in Figure 2-18

<Notes on floor layout>

a.) The approaches of retailers and consumers (shoppers) shall be separated wherever possible.

Retailers tend to unload products from trucks and other vehicles and put them on sales tables as near to the entrance as possible. On the other hand, they also tend to go closer to the direction in which customers come. In the floor planning of the market hall, therefore, the goods entrance (goods handling space) and the shopper entrance shall be provided at opposite locations. This layout shall prevent the stores from being concentrated at one location and naturally spread them over the hall, consequently eliminating partial congestion.

b.) The marine product selling area (fish market) shall be provided close to the sea side and the existing jetty direction.

The fish market shall be provided close to the sea side and the existing jetty direction in consideration of marine products carried from canoes and fishing boats landed at the front sea shore of the planned site and transported by land from the existing jetty at low tide. Furthermore, the chest freezers room shall be provided close to the fish market to facilitate the movement of marine products intended for frozen storage.

c.) An outer passage way shall be provided to ease the congestion in the market and attain smooth connection between facilities.

A berm-type outer passage way (3 meters in width) shall be provided on the sea side out of the

market in parallel to the market hall to ease the congestion in the market and offer access to the public toilets and parking lot. Furthermore, this passage way shall be connected to a south-north passage way (sea to land) to be used to land marine products from fishing boats in consideration of ensuring smooth transportation.

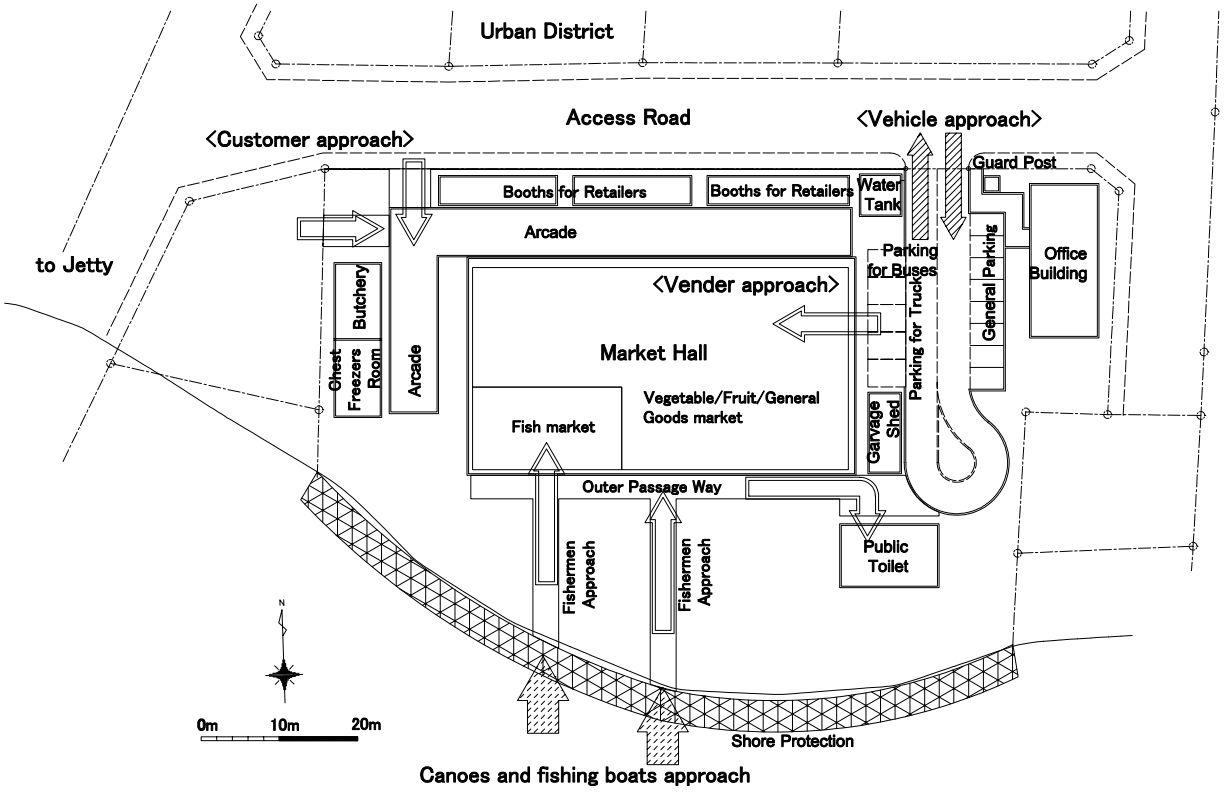


Figure 2-18：Zoning Plan of Market

The table of planned areas of the market facilities based on the above layout plan and the floor plan is shown below.

Table 2-12 : Planned area list

Facility			Area (m^2)	Nos.	Total Area (m^2)	Requested Area
A	Market Hall				1,499.1	1,800 m^2
	Market Hall	General: 208 lots For Fisheries: 16 lots	1,026.0	1	1,026.0	
	Arcade	including space for 100 lots	473.1	1	473.1	
B	Booths for Retailers	15 Booths in Total			211.5	20shops(*1)
	Booth(1)	10 Booths	9.0	10	90.0	
	Booth(2)	3 Booths	18.0	3	54.0	
	Butchery	1 Booth	38.25	1	38.25	
	Freezers Room	1 Booth	29.25	1	29.25	
C	Office Building	1 building	136.5	1	136.5	1 building(*1)
		Market Master's Room	19.6	1	19.6	
		Fee Collector's Office	16.8	1	16.8	
		Staff Room	18.45	1	18.45	
		Meeting Room	31.5	1	31.5	
		Toilets (Men, Women)	7.6	1	7.6	
		Utility Room,	4.0	1	4.0	
		Store	11.6	1	11.6	
		Corridor, etc.		-	26.95	
D	Parking & Exterior Works	Area of Pavement			1,117.3	1,600 m^2
	General Parking	8lots/ Concrete Pavement		-	100.8	
	Parking for Trucks	4lots/ Concrete Pavement		-	70.0	
	Parking for Buses	1lot/ Concrete Pavement		-	17.5	
	Road Pavement	W=4m/ Concrete Pavement		-	383.7	
	Pedestrian Way, etc.	Concrete Plate Pavement		-	545.3	
E	Others				143.4	(*1)
	Public Toilets	1unit (Men, Women)	99.4	1	99.4	2units(*1)
	Elevated Water Tanks	1unit (Rainwater, City water)	16.0	1	16.0	(*1)
	Rubbish Temporary Shed	1unit (including Room for Distribution Boards)	24.0	1	24.0	1units(*1)
	Guard's Post	1umit	4.0	1	4.0	

(*1): Area undefined in the request

(4) Section Planning

The ground elevation at the market site was decided at almost the same elevation as the current site of C.D.L.+2.0m, taking into consideration tidal level, waves and height of wave runup and to maintain consistency with the existing access roads.

Floor elevation of each facility will be decided depending on the requirements of its intended use, as no machinery or equipment is to be installed in any facility. Inundation of the facilities, even if it happens, will cause no harm to the lives of the people. The floor level of the vegetable market, which is to be located at the center, will be set at C.D.L.+2.6m, higher than the surrounding area, for ventilation and to ensure the minimum inclination required for water drainage. The fish market will be demarcated at a floor level of C.D.L.+2.3m, which is lower than that of the vegetable market, taking into consideration access from the coast area and water drainage. The floor levels of other facilities including the arcades and shop building will also be at C.D.L.+2.3m to facilitate access from the nearby roads. The floor level of the office building which is required for storage of data and office equipment will be set at C.D.L.+2.6m

The market hall, the largest in scale of the facilities included in the plan, will be a single-storied building with a roof structure articulated into three parts to suppress oppressiveness and with an economic roof height. Taking into consideration the climate at Auki with high temperatures and precipitation, the four sides of the hall will be left open and a monitor roof will be installed to facilitate ventilation and natural lighting, while long eaves and arcades for market users will be planned around the hall for protection against direct sunlight, wind and rain.

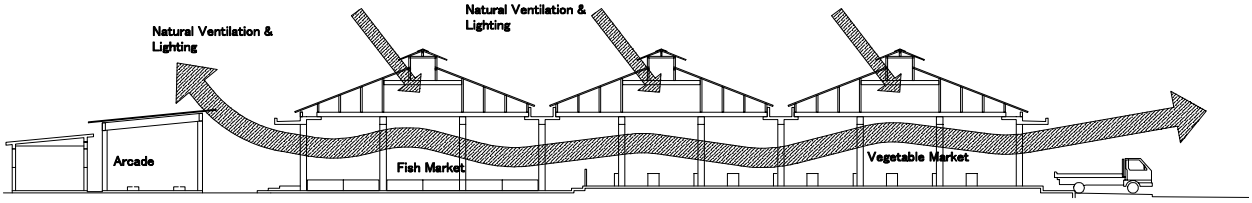


Figure 2-19：Section planning of the market hall

Following the example of similar facilities in the Solomon Islands, the standard eaves height of 5m (eaves height) and 3m will be adopted for the market hall and general habitable rooms, respectively, in order to ensure the ceiling height required for sufficient ventilation and heat alleviation.

(5) Structure Planning

1) Structural standards

① The Solomon Islands do not have a specific reference standard for structural design. In many cases, the standards of donor countries have been customarily adopted. However, adoption of such standards is not mandatory and the organizations responsible for planning are entrusted with the selection of a standard.

② Although there is little fundamental difference between Japanese structural standards and the standards of Australia and New Zealand, they differ in details because of differences in the reference industrial standards. As this plan is to be implemented as a project under the grant aid of Japan, a Japanese contractor will implement the work. Therefore, for efficient and economic work implementation, implementation with Japanese standards is recommended. In addition, as it is advantageous from the viewpoint of facility management to maintain consistency of the design specifications and standards with the existing facilities, such as Honiara Central Market which was also constructed with MID as the responsible agency, Japanese standards are to be used in the plan.

③ Seismic force and wind load

Seismic force and wind load will be calculated in accordance with the relevant Japanese standards.

2) Foundations

An evaluation of the bearing capacity of the soil by boring shows that a soft silt/clay layer mixed with sand with an N value of 2 to 8 exists from the current ground surface to -25m – 26m and that a limestone bearing layer exists at -26m. Therefore, an H-shaped steel pile foundation will be adopted for the three large-scale structures with heavy loads, the market hall, the areas of the arcades at which water-storage tanks are to be installed and the water supply building. Spread foundation will be adopted for other small-scale regular-shaped buildings.

3) Superstructure

In this plan, the optimal structures will be decided with attention paid to the following:

- To adopt as many local materials and construction methods as possible
- To select structures which conform to the functional requirements of each building as the plan consists of multiple facilities with distinctive functions
- To make the form compatible with local styles, climate and environment and the structures highly durable as the facilities are located in the center of Auki City and will serve as a major public building both in scale and in function
- To make the structures sufficiently suitable to the natural conditions including salt-damage prevention measures as the facilities will be constructed in the coastal area
- To conform to the conditions for procurement of construction materials
- Ease of maintenance and management

Reinforced concrete construction is considered to be a suitable structure as it can be implemented with locally available construction materials and methods. For the market hall, though it has relatively large story height and spans, as it is a single-storied building, of the local construction materials and methods similarly available, a wooden truss structure will be suitable for the roof structure because of its advantage in reducing the construction period, frame materials and supports. Therefore, a mixed structure of these two will be adopted. Despite its advantage in reducing the duration of work at the site, a steel structure will not be adopted in this plan because of the long period required for procurement and the need for transport and the availability of construction machinery.

4) Conditions for structural materials

The following design will apply to the structural materials.

- Structural concrete Design standard strength 21N／mm^2
- Reinforcing bars Deformed bars Tensile strength 295A (JIS G3122) equivalent

(6) Facility Planning

1) Electric facilities

As electric facilities, lighting and receptacles will be included in the design. Natural lighting will be the main source of lighting and only those light fixtures minimally required for the facilities will be included in the design. Lighting equipment and conduit materials which can be easily maintained and managed locally will be selected. They should meet the specifications which take salt damage prevention into consideration. Power will be supplied from the existing power grid (1.1 kV high voltage line and low voltage line) along the road situated north of the planned site. The Solomon Islands side shall be responsible for connection from the branching point on the trunk line to the site of the meter, installation of which will also be the responsibility of the Solomon Islands side. Connection from the meter to the premises will be implemented in this plan. Power will be distributed at local specifications (three-phase four-line 415/240V 50 Hz). Sub-meters will be installed at the retailers (10), canteens (3), butchery (1), and chest freezer room (1) to measure power consumption separately at each facility. Fluorescent lights will be used for indoor lighting. Illuminance standards have been determined in accordance with the actual conditions of the facilities as given in the Table 2-13. As the market hall will be open till late at night at weekends, light fixtures will be installed on the building for night-time lighting. However, the illuminance of the night-time lighting will be kept at the minimum acceptable for market operation.

Table 2-13 : Design indoor illuminance

Offices/general areas	Approximately 250 Lux
Toilets/warehouses	Approximately 150 Lux
Market hall	Approximately 50 Lux

Public lighting is to be installed at the parking lot and near the entrance to the market for all-night operation at weekends. The design will include receptacles for single-phase (220V/50Hz) electricity for general purpose rooms.

It is possible to connect telephone lines from the aerial lines installed along the road situated west of the planned site. Following locally adopted general specifications, exposed wiring will be used instead of conduit wiring.

2) Water supply facilities

To reduce maintenance and management costs, the plan intends to meet demand for general water other than that for drinking at the market with rainwater as far as possible. As it rains throughout the year in the Solomon Islands, rainwater storage tanks are installed in ordinary households and the stored rainwater is used as domestic water.

The Table 2-14 shows the facilities supplied with (service water and rainwater separately.

Table 2-14：Facilities supplied with service water and rainwater

Facilities using service water	Facilities using rainwater
・ Management office	・ Toilets (for flushing and hand-washing)
・ Water taps at retailers (including canteens), butchery and chest freezer room	・ Water taps for washing agricultural and fishery products
	・ Water taps for cleaning inside the market

Service water will be provided by connecting water supply pipes to the 50mm-diameter water supply pipe installed near the periphery of the planned site. As the pressure of the service water is low at approximately 0.03MPa, water received in a water-receiving tank will be pumped up to an elevated tank and distributed to each facility using gravity flow. In similar fashion, rainwater harvested from the roof of the market hall will be stored in an underground rainwater tank installed in part of the arcade, pumped up to an elevated tank and distributed to each rainwater distribution point. As is the case with electric power, sub-meters will be installed at each clean-water-using booth to measure water consumption separately. The expected daily consumption is 5.1 m^3 and 17.0m^3 for service water and rainwater, respectively as shown on the Table 2-15.

Table 2-15：Planned required water volume (city water and rainwater)

A	Service water consumption									
1)	Office		80 ※1	ℓ / person	×	13	persons	=	1,040.0	ℓ
2)	Cold storage/ice plant	(Sales of potable water)	2 ※2	ℓ / person	×	110.6 (One in five purchases potable water. *2) 553 people: average number of venders per week	persons	=	221.2	ℓ
3)	Butcher's shop	(For business)	80 ※1	ℓ / shop	×	1	shops	=	80.0	ℓ
4)	Retailers	(For hand-washing)	80 ※1	ℓ / shop	×	10	shops	=	800.0	ℓ
5)	Canteens	(For cooking)	990 55ℓ / m^2×18 m^2=990ℓ 55ℓ / m^2 : Size of coffee shop in Reference 3	ℓ / shop	×	3	shops	=	2,970.0	ℓ
							Total		**5111.2**	**ℓ**
							∴		**5.1**	m^3/day

B	Rainwater consumption									
1)	Market hall(for washing floor of fish market)		8	ℓ / m^2	×	199.5	m^2	=	1,596.0	ℓ
			※4			※Floor area of Fish market				
2)	Toilets	Vendors (male)	13	ℓ / person	×	331.8	person	=	4,313.4	ℓ
			※5			※553×0.4×(6h/24h)×6 times/day				
		Vendors (female)	13	ℓ / person	×	414.75	person	=	5,391.8	ℓ
			※5			※553×0.6×(6h/24h)×5times/day				
		Customers	13	ℓ / person	×	202.13	person	=	2,627.6	ℓ
			※5			※441×(2h/24h)×5.5times/day				
3)	Agricultural produce market (for washing agricultural produce)		10	ℓ / unit	×	95	stalls	=	950.0	ℓ
			※1							
4)	Fish market(for washing fishery products)		2,162	kg	×	1	ℓ /kg	=	2,162.0	ℓ
			※6			※7				
							Total		**17,040.8**	**ℓ**
							∴		**17.0**	m^3/day

Source ※1： With reference to a similar facility, Honiara Central Market

※2： From the results of the field study (interview and questionnaire studies)

※3： Source: “Heating, Air-Conditioning and Sanitary Engineering Handbook” 13th Edition, The Society of Heating, Air-Conditioning and Sanitary Engineers of Japan

※4：8L per m2 (8mm) for washing floor. Reference value from a similar project

※5：12 – 20 L; source: “Heating, Air-Conditioning and Sanitary Engineering Handbook” 13th Edition, The Society of Heating, Air-Conditioning and Sanitary Engineers of Japan

※6： Average weight of daily fish handling

※7： Source: FAO Fisheries Circular No.905 FIIU/C905

The capacities of the water-receiving and elevated tanks are designed as shown in the Table 2-16.

Table 2-16：Capacities of water-receiving and elevated tanks

Service water	Water-receiving tank 3.0 ㎥ (60% of daily consumption※1) 5.1×0.6＝3.1 ㎥≒3.0 ㎥	Elevated tank1.0 ㎥ (17 % of daily consumption※2) 5.1×0.17＝0.87 ㎥ rounded up to the minimum unit of 1.0 ㎥
Rainwater	Rainwater-storage tank 90m^3 (Consumption for five days※3) 17.0×5＝85.0≒90 ㎥	Elevated tank 3.0m^3 (17 % of daily consumption※2) 17.0×0.17＝2.89≒3.0 ㎥

※1： From “Heating, Air-Conditioning and Sanitary Engineering Handbook” 13th Edition

※2： For efficient pump operation and the duration of power failures, capacity for two-hour operation during operating hours is required. As 2 hours / 12 hours (of operating hours) = 17%, the required capacity is set at 17% of daily consumption.

※3： As interviews at the site revealed that three to seven days of drought were experienced at the site, consumption for five days will be ensured.

In consideration of possible exhaustion of rainwater, piping for the elevated tank will be equipped with a bypass for service water.

3) Drainage facilities

In this plan, rainwater from the roof, water used for washing the floor and general domestic wastewater will be discharged through underground pipes within the premises and gutters into the sea. Solid matter will be removed from the washing water using baskets in the drainage pit as a means of primary treatment. Treatment methods in accordance with WHO standards used at Honiara Central Market and other facilities in the country will be adopted for the treatment of sewage from toilets and miscellaneous wastewater from the office building. As shown in the diagram below, sewage will be treated in septic tanks (anaerobic treatment) and disposed of through evaporation and soil penetration. Accordingly, multi-chamber septic tanks and penetration pipes will be installed. Mechanical aeration or application of chemicals will not be included in the plan.

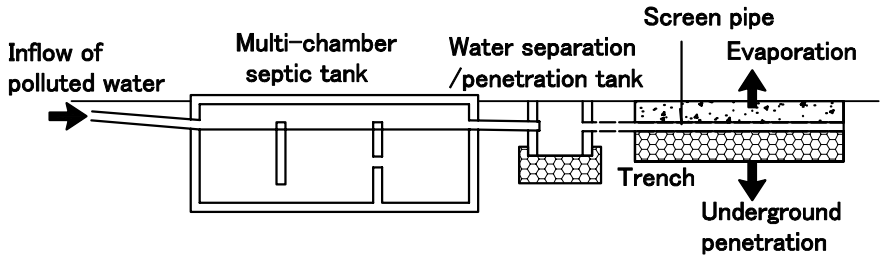


Figure 2-20 : Schematic diagram of toilet wastewater treatment

The planned sizes (in terms of number of users) of septic tanks are shown in the Table 2-17.

Table 2-17 : Sizes of septic tanks

	Estimation equation	Size of septic tank (n)
Public toilet for men	n=16×C=16×9=144	Tank for 144 people
Public toilet for women	n=16×C=16×10=160	Tank for 160 people
Office	n=A×0.06=137×0.06=8.2≒10	Tank for 10 people

C: Total number of toilet fixtures, A: floor area of the building

※ Estimation in accordance with JIS A3302.

4) Air-conditioning and ventilation facility work

The design will not include air-conditioning equipment as natural ventilation is taken into. Ceiling fans will be installed at places continuously occupied by users including rooms in the office building and booths. Ventilation fans will be installed as ventilation equipment in the pump room, toilets and utility room in the office building, in which odor, humidity and heat may be generated.

(7) Construction Material Planning

Interior and exterior finish will be designed using locally procurable materials, taking the natural

conditions at the site into consideration.

- The finish should be executed and repaired using general construction methods at the site.
- The burden of maintenance and management should be minimized.
- It should not be susceptible to the effects of salt damage.
- It should be suitable for a climate of high temperature and humidity.

Finish planning of each facility is shown in the Table 2-18 and Table 2-19.

1) External Finish Schedule

Table 2-18 : External Finish Schedule of each facility

Facility	Roof	Eaves/Ceiling	Wall/Beam/Column	Skirting
(1)-Market Hall	Sloped Roof Profiled Colored Zincaluminium Steel Sheet (H=85) Wooden Frames: OP Flat Slab (Pent Roof) Waterproof Cement Mortar S.T. Concrete	Eaves/Ceiling E.P. Cement Mortar S.T.	Multi-Layered Mastic Coating Cement Mortar Brush-Finish	Cement Mortar S.T. H=300
(2)-Arcade	Sloped Roof Profiled Colored Zincaluminium Steel Sheet (H=85) Wooden Frames: OP		Beam, Column Multi-Layered Mastic Coating Cement Mortar Brush-Finish	Cement Mortar S.T. H=300
(3)-Booths for Retailers	Sloped Roof Slab Waterproof Cement Mortar S.T. Concrete	Eaves/Ceiling E.P. Cement Mortar S.T.	Wall Multi-Layered Mastic Coating Cement Mortar Brush-Finish	Cement Mortar S.T. H=300
(4)-Butchery & Freezers Room	Sloped Roof Slab Waterproof Cement Mortar S.T. Concrete	Eaves/Ceiling E.P. Cement Mortar S.T.	Wall Multi-Layered Mastic Coating Cement Mortar Brush-Finish	Cement Mortar S.T. H=300
(5)-Office Building	Sloped Roof Slab Profiled Colored Zincaluminium Steel Sheet (H=85) Wooden Frames: OP	Eaves Ceiling, Fascia Board E.P. Cement Board	Beam, Column Multi-Layered Mastic Coating Cement Mortar Brush-Finish	Cement Mortar S.T. H=600
(6)-Public Toilet	Sloped Roof Slab Waterproof Cement Mortar S.T. Concrete	Eaves Ceiling, Fascia Board E.P. Cement Mortar S.T.	Wall Multi-Layered Mastic Coating Cement Mortar Brush-Finish	Cement Mortar S.T. H=300
(7)-Elevated Water Tanks	Flat Slab Waterproof Cement Mortar S.T. Concrete	Eaves Ceiling, Fascia Board E.P. Cement Mortar S.T.	Beam, Column Multi-Layered Mastic Coating Cement Mortar Brush-Finish	Cement Mortar S.T. H=300
(8)-Rubbish Temporary Shed	Sloped Roof Slab Waterproof Cement Mortar S.T. Concrete	Eaves Ceiling, Fascia Board E.P. Cement Mortar S.T.	Wall Multi-Layered Mastic Coating Cement Mortar Brush-Finish	Cement Mortar S.T. H=600
(9)-Guard's Post	Sloped Roof Slab Waterproof Cement Mortar S.T. Concrete	Eaves Ceiling, Fascia Board E.P. Cement Mortar S.T.	Wall Multi-Layered Mastic Coating Cement Mortar Brush-Finish	Cement Mortar S.T. H=600

S.T. : Steel Towel
O.P. Oil Paint
E.P. : Synthetic Resin Emulsion Paint
W.F. : Wood Float

2) Internal Finish Schedule

Table 2-19 : Internal Finish Schedule of each facility

Room	Floor	Skriting	Wall/Beam/Column	Ceiling	Remarks
(1)-Market Hall					
Vegetable & Food Market **Fish Market**	Cement Mortar S.T.+Hardener Finish Concrete	Cement Mortar S.T. H=300	Multi-Layered Mastic Coating Cement Mortar Brush-Finish	Wooden Frames:OP	Table x 208 (Top:50x50Vitreous Tile) Table x 16 (Top:50x50Vitreous Tile)
(2)-Arcade					
Arcade	Cement Mortar S.T.+Hardener Finish Concrete	Cement Mortar S.T. H=300	Multi-Layered Mastic Coating Cement Mortar Brush-Finish	Wooden Frames:OP	**manhole :x 6** w/ Underground Water Tanks
(3)-Booths for Retailers					
Booth(1) **Booth(2)**	150 x 150 Vitreous Tile	Vitreous Tile H=150	E.P. Cement Mortar S.T.	E.P. Cement Mortar S.T.	Counter, Sink (SS), Work Table
(4)-Butchery & Freezers Room					
Butchery **Freezers Room**	150 x 150Vitreous Tile	Vitreous Tile H=150	E.P. Cement Mortar S.T.	E.P. Cement Mortar S.T.	Sink (SS) 1,800x600x800
(5)-Office Building					
Market Master's Room, **Fee Collector's Office** **Staff Room, Meeting Room**	150 x 150Vitreous Tile	Vitreous Tile H=150	E.P. Cement Mortar S.T.	E.P. Wooden Boarding	
Store	Cement Mortar S.T.	Cement Mortar S.T. H=150	Ditto	E.P. Cement Board	
Utility Room, Toilets	150 x 150Vitreous Tile	Vitreous Tile H=150	Ditto	Ditto	Wooden Shelves 1)4,100x600x1,500mm 2)1,900x600x1,500mm Sink(SS) 1,200x600x800mm
Corridor	Ditto	Ditto	Multi-Layered Mastic Coating Cement Mortar W.F.	Ditto	
(6)-Public Toilet					
Toilets **Toilet Master's Room**	150 x 150Vitreous Tile	Vitreous Tile H=150	150 x 150Vitreous Tile (H<2,000) E.P. (H>2,000)	Direct Ceiling, E.P.	Built-in Basin (Vitreous Tile)
(7)-Elevated Water Tanks					
Pump Room	Cement Mortar S.T.	Cement Mortar S.T. H=300	E.P. Cement Mortar S.T.	Direct Ceiling, E.P.	Manhole 500mm dia. x 1 Base Concrete x 4 for Pumps
(8)-Rubbish Temporary Shed					
Rubbish Temporary Shed **Room for Distributin Boards**	Cement Mortar S.T.	Cement Mortar S.T. H=300	Multi-Layered Mastic Coating Cement Mortar Brush-Finish	Direct Ceiling, E.P.	Wash Basin
(9)-Guard's Post					
Guard's Post	150 x 150Vitreous Tile	Vitreous Tile H=150	E.P. Cement Mortar S.T.	Direct Ceiling, E.P.	Wooden Counter 1,800x600x50mm

W.F. : Wood Float
E.P. : Synthetic Resin Emulsion Paint
S.T. : Steel Towel
O.P. Oil Paint
SS Stainless Steel
*Above:Finish, Below:Backing material

2-2-2-2 Basic Plan of Jetty

(1) Overall Plan

The existing jetty is old and heavily damaged after almost 50 years of service after its construction; in particular, it is considered to be necessary to urgently repair or rebuild the pavement concrete of the superstructure because the reinforcing bars are exposed or spalling of concrete due to corrosion has occurred in the concrete slabs. The substructure may not be in danger of imminent collapse, but many more serviceable years are not expectable taking account of almost 50 years of use after its construction. Therefore, it is appropriate to construct a new jetty.

If the new jetty is built at the same site of the existing jetty, the existing Auki Jetty which is the only port facility in North Malaita will not function during the construction work period at all because it has to be dismantled, bringing a great difficulty to the residents in Malaita Island. Thus, a new straight-pile type jetty will be built to the west of the existing jetty.

The layout and alignment of the new jetty will be determined through examination of the most economical jetty position based on the current sea bottom terrain. The cargo handling berth at the new jetty will have a length of 64m which enables the TOMOKO with the longest hull (53.4m long) of the liners currently in service to moor safely with mooring ropes at its bow and stern. An access of approximately 49m is also required to secure the necessary water depth.

Among the vessels using Auki Jetty, M/V Renbel, LC Swift, Tina-I, etc. are small car-ferry-type vessels and landing vessels equipped with flaps at their bows which enable vehicles to be rolled on and off the vessels. Such types of vessel comprise approximately 10% of registered vessels in the

Solomon Islands. For these vessels with flaps, as the elevation of the top of a jetty of conventional structure is too high, a slope is required on the jetty in order to lower the flaps onto the top of the jetty. The study confirmed that, as the jetty was used without a slope, the flaps damage the edge of the jetty and the surface of the slabs which had not been reinforced for car ferries. Therefore, a ferry ramp is planned as part of the jetty so that these small car-ferry-type vessels will be able to lower and use their flaps.

The jetty structure will be of steel tube pile type which is least affected by sedimentation in the vicinity of the jetty after its construction and of straight pile type taking the procurement of construction machinery into consideration.

There are no technical standards for the design of port structures such as jetties in the Solomon Islands and such structures have been designed in accordance with the standards in New Zealand and Australia, which are not mandatory, but the standards are selected at the discretion of the responsible person of the planning organization.

Comparing the standards in Japan with that in New Zealand and Australia, the design results in accordance with the respective standards are not different if the design conditions such as external forces and durable years (50 years under each standard) are identical. As this Project will be implemented under Japanese grant aid cooperation, it will be advantageous to design the jetty under the Japanese standards, taking into consideration that the Japanese engineers concerned with this Project should be familiar with the applicable standards and that the steel materials should be easily procured and processed. Therefore, the jetty facilities shall be designed under the following standards in this Project:

① “Technical Standards and Commentaries for Port and Harbour Facilities in Japan, 1999, the Japan Port and Harbor Association
② “Port and Harbor Structure Design Samples, April 1999, Coastal Development Institute of Technology”
③ “Corrosion Prevention of Port and Harbor Steel Structures: Improvement Manual (Revised Edition) , April 1997, Coastal Development Institute of Technology”
④ “Standard for Estimation of Contracted Port Civil Engineering Work, Revised Version 2006, the Japan Port and Harbour Association”
⑤ “PC Jetty Technical Manual, October 2003, Coastal Development Institute of Technology”
⑥ “Jacket Method Technical Manual, January 2000, Coastal Development Institute of Technology”
⑦ “Specifications for Highway Bridges, Vol. IV Substructures, March 2002, the Japan Road Association”
⑧ “Standard Specification for Concrete Structures 2002, Vol. Structural Performance Examination, Japan Society of Civil Engineers”
⑨ “Steel Pipe Pile – Design and Construction – Japan Association for Steel Pipe Piles”

(2) Facility design

1) Site/ Floor plan

① Site plan

On the ownership of and the right to use the land and water areas to the east and on the west of the existing jetty, it has been confirmed between the Provincial Government and the persons having the customary right to use the land that there is no problem in using the land for this Project.

For the jetty site, the optimum site plan will be selected by comprehensive comparison and examination of the land and water area expropriation, the positional relations with the existing planimetric features and neighboring facilities, the sedimentation and erosion foreseen from the current sea bottom terrain and the jetty to be constructed, the required length of the access jetty section, the difficulty of ship maneuvering and the cost of construction work.

Figure 2-22 shows the comparative site plans and Table 2-20 shows the list of comparative examinations.

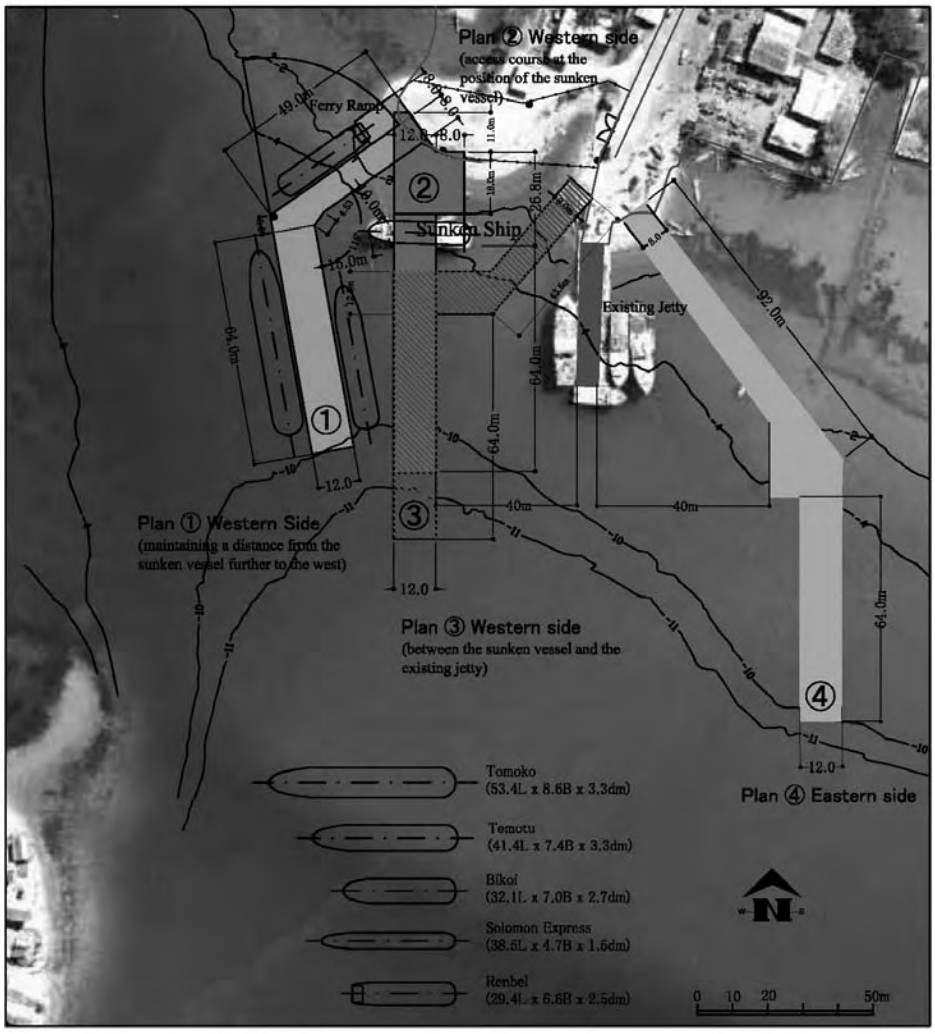


Figure 2-21 : Site plans for the jetty (draft)

The issues given particular consideration during the site planning are as follows.

a.) Removal of the sunken vessel

There is a sunken vessel in the shoreline area, approximately 38 m west of the existing jetty at a water depth of three to four meters. There is a document confirming that the Solomon Islands side is responsible for its removal.

In the event that the planned jetty is to be constructed without removing the sunken vessel, any risk to barges during construction and vessels docking at the jetty after completion of its construction should be eliminated. If the sunken vessel is to be removed in the future, barges will have to be operated near the sunken vessel and the jetty. In order to protect the newly constructed jetty from such risks, a distance of at least 15 m will be required as a safe distance between the sunken vessel and the jetty, assuming the use of 300t-class crane barges (approximately 25mL x 12mB) for the jetty construction or the removal of the sunken vessel. Assuming M/V Temotu class vessels (41.4L x 7.4B x 3.3dm) will use the eastern berth, this figure is twice the width of the vessel.

b.) Location of the head of the jetty and pile diameters

In the case of Site Plan 1, the water depth at the head of the planned jetty is -10m, while, in the case of Site Plan 2, it is -11m. Because of the large water depth and soft submarine stratum for the embedment, the structure of the jetty becomes weaker as the length of the piles protruding from the sea-bed increases with the increase in water depth. In the case of Site Plan 1, piles with a diameter of 600mm and a thickness of 12mm can be used, while, in the case of Site Plan 2, piles with a larger diameter of 700mm will be required and the length of the piles will also increase by 1m.

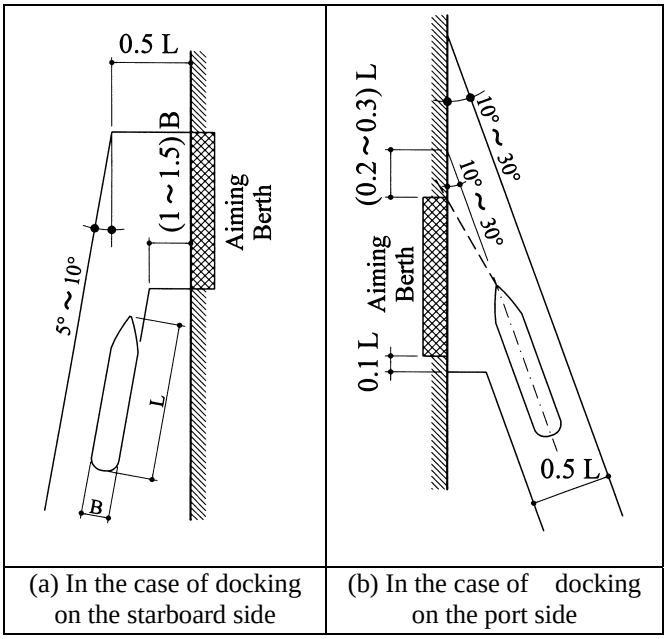
Assuming that the unit costs of the jetty construction per unit area are the same if the jetties are constructed on the same site, at the same water depth and with the same structure, the construction cost ratios of the planned jetties are compared. Assuming an execution area of 1.0 in Site Plan 1, that in Site Plan 2 is also 1.0. However, as the diameter and length of the piles increase as mentioned above, Site Plan 1 is the more economic site plan.

In general, the straighter the jetty is, the more convenient it is for cargo handling and vessel manoeuvring. However, under the specific circumstances mentioned above, the results of the comparative examination of the site plans for the planned jetty have led us to conclude that it is appropriate to adopt Site Plan 1, “maintaining a distance from the sunken vessel further to the west.”

c.) Setting of the normal lines of the jetty and the vessels’ courses in the case of Site Plan 1

When a vessel approaches the jetty, it must be manoeuvred at very low speed, causing it to show very poor response to manoeuvring. In order to make manoeuvring of the vessel as easy as possible, the normal lines of the jetty and course will be set in such a way that the vessel can

approach the jetty at as gentle an angle as possible.



(a) In the case of docking on the starboard side

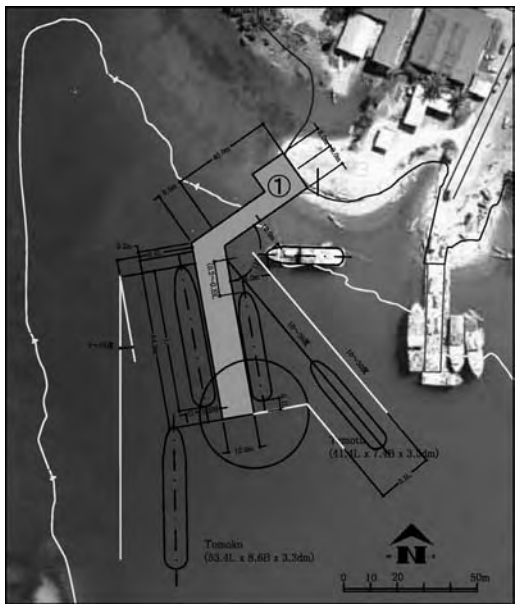
(b) In the case of docking on the port side

Figure 2-22：Standard approach angle of vessels docking at the jetty

In the planned site, as it is difficult to secure a turning basin large enough to allow vessels to turn in front of the mooring wharf, mooring head-in (mooring with the bow facing away from the harbor entrance) will be adopted.

In this case, under conditions of no wind or tidal flow as is the case at this site, the approach angle differs depending on whether the vessel docks at the jetty on the starboard side, as shown in Figure (a), or on the port side, as shown in Figure 2-22. This difference is caused by the characteristics of the rudder and the direction of propeller rotation when the vessel is moving astern. When approaching the jetty to dock on the starboard side, as the bow of the vessel inclines to the right, the approach angle is smaller than if it docks at the jetty on the port side as shown in Figure (b) and the vessel approaches the jetty at an approach angle of 5 to 10 degrees to the normal line of the jetty. In either case, half the length of the vessel is considered to be the standard width of the approach course.

In short, in the case of Plan 1, the vessel will be able to approach the jetty smoothly, while maintaining a distance from the shoreline to the west, by turning the periphery of the jetty toward the center of the port, or to the east, by 10 degrees, instead of making the normal line of the new jetty parallel to that of the existing jetty (or stretching due south), as shown in Figure 2-23 below, which shows the relative positions of the jetty and approach course.



Meanwhile, in order to prevent vessels docking at the eastern berth from colliding with the curved part of the jetty or the sunken vessel due to inertia on the approach, a space of 0.2 to 0.3 times the vessel's length is required in front of the berth. Furthermore, in case there is an obstacle, such as the sunken vessel, on the starboard side ahead of the vessel as is the case here, the vessel has to dock at the jetty with room to take measures against deviation from the normal line of the approach course.

Figure 2-23：Approach angle of vessels to the planned jetty

d.) Establishment of a safe distance between the jetty and the sunken vessel

Figure 2-24shows the track of a vessel leaving the wharf.

At first, by operating the engine at slow speed ahead without releasing the mooring rope at the bow, the stern leaves the jetty and, then, by returning the rudder to the straight position and operating the engine astern, the vessel leaves the jetty. After sailing astern while gradually turning the stern due east, the bow is directed toward the harbor entrance and the vessel leaves the harbor. Therefore, vessels docked at the eastern berth of the jetty will pass near the sunken vessel that is located ahead of the berth.

As mentioned above, a safe distance will be required for vessels using the eastern berth to avoid collision with the sunken vessel when entering or leaving the harbor. Assuming that M/V Temotu class vessels (41.4Lx7.4Bx3.3dm) use the eastern berth, approximately twice the width of the vessel (= approximately 15m) is considered the necessary distance to ensure safety, as can be seen in the figure.

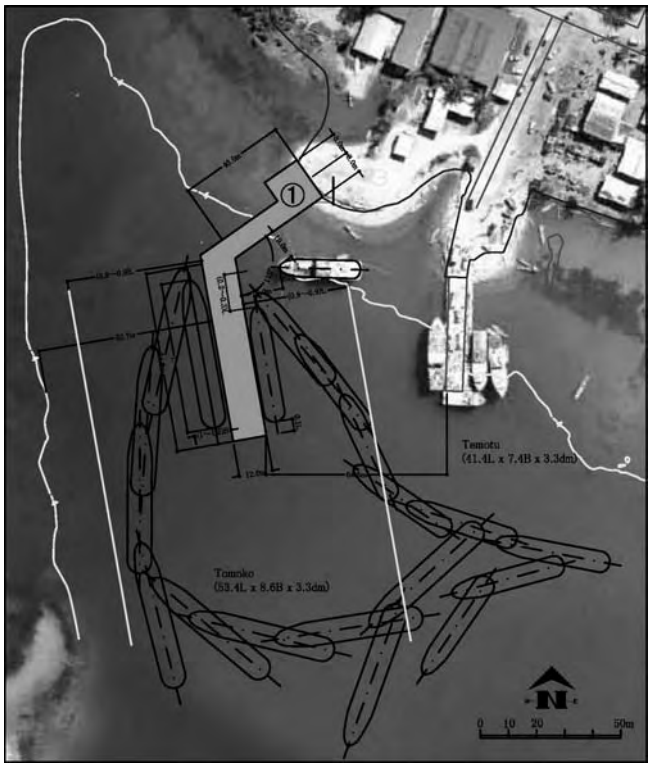


Figure 2-24：Track of vessels leaving the harbor from the planned jetty

Table 2-20：Comparative examination of alternative site plans for the planned Auki Jetty

	1). Western side (maintaining a distance from the sunken vessel further to the west)	2). Western side (access course at the position of the sunken vessel)	3). Western side (between the sunken vessel and the existing jetty)	4). Eastern side
Expropriation of land and water areas	Matters related to rights and interests concerning the sea areas are less complicated than Plan 4 (proposal for the eastern side).	Same as left	Same as left	As part of the planned site is situated on land once partially reclaimed by a private entrepreneur and owned by an individual, there is a fear that the problem could be rekindled during the project implementation.
Relationship with existing features and nearby facilities	・Although there is a sunken vessel (30L x 6mB) 30m northwest of the existing jetty at a water depth of 3 – 4 m, it is possible to construct the jetty further to the west of the sunken vessel. However, negotiations between the government of the Solomon Islands and the owner of the sunken vessel on ownership of the vessel and the cost of its disposal are essential for the work. ・Although the proposed site is infrequently used as a moorage for small boats, such use will not cause any problem if the moorage for small boats are consolidated at a site east of the jetty. ・The ground site can be used as an access road, parking space and a yard.	・As there is a sunken vessel (30Lx 6mB) 30m northwest of the existing jetty at a water depth of 3 – 4 m, execution by proxy by the government of the Solomon Islands shall be required for its disposal. ・For other issues, same as left.	・Although there is a sunken vessel (30L x 6mB) 30m northwest of the existing jetty at a water depth of 3 – 4 m, it is possible to construct the jetty to the east of the sunken vessel. ・For other issues, same as left.	The traffic lanes of vessels using the planned jetty and the wharf for small vessels will overlap. Depending on the exact site of the jetty, it may completely block access to the moorage for small boats.
Possibility of sedimentation and erosion expected from the current submarine topography and jetty construction	・This is the best plan for ensuring water depth at the berth of the jetty. ・Under existing conditions, sufficient water depth is ensured and this plan is least likely to be affected by sedimentation.	Same as left (but inferior to Plan ①)	Same as left (but inferior to Plan ②)	・Unfavorable (As a shoal protrudes from the land on the eastern side, large-scale dredging is required to ensure sufficient water depth. Alternatively, the jetty has to be elongated to a site where sufficient water depth can be ensured.) ・Risk of sedimentation is high

	1). Western side (maintaining a distance from the sunken vessel further to the west)	2). Western side (access course at the position of the sunken vessel)	3). Western side (between the sunken vessel and the existing jetty)	4). Eastern side
Length of the access jetty	Short	Short	Long	Longest
Safety for manoeuvring vessels	・Safe (As the distance from the planned jetty to the existing jetty and the 4m isobath near the shoreline on the western side is approximately 64m and 62m, respectively, there will be no problem.) ・ A distance of 14m, twice the width of the vessels, and a distance of approximately 10m is ensured between the sunken vessel and the loading/unloading and access jetties, respectively.	・Safe (Ensures a distance of approximately 40m between the planned and existing jetties)	As the seaward head of the planned jetty protrudes significantly further seaward than at present, there is danger of congestion of vessels, as the course for small vessels from villages on the western side of Auki Bay overlaps with the course for vessels using the planned jetty.	As the seaward edge of the planned jetty protrudes significantly further seaward than at present, there is danger of congestion of vessels, as the course for small boats from nearby villages in the bay overlaps with the course for vessels using the planned jetty.
Indicative cost & quantity of jetty construction	Set at 1.0	1.0++ *Although the execution area is the same as in ①, as the water depth increases, the pile length will also increase. As the increase in pile length increases the pile diameter, both quantity and construction cost will be more than ①.	1.3	1.4
Overall evaluation	A	B	C	D

② Floor Plan

a.) Berth Length

The specifications of the above-mentioned vessels currently in use for regular services and their operating schedules are to be used in determining the required berth length. Our field study revealed that nine vessels are currently in regular service at Auki. In addition, three vessels were in use for chartered service during the study period.

The minimum required length of the berth of the planned jetty is decided by the length of the part of the jetty occupied by the passenger boat used for regular service, the longest of the vessels using the jetty (M/V Tomoko, with a length of 53.4mL), when it is moored to the jetty with a mooring rope at the bow and stern.

The required length of a berth for a vessel is decided by taking the length of the mooring rope at the bow and stern of the ship, among other things, into consideration. In general, a length of 15 to 30 m and a length of 15 to 20 m added to the length of the vessel are considered to be the standard required length of berths for large tankers transporting hazardous materials and large vessels for general use, respectively. For small commercial vessels, which are the concern of this plan, a shorter berth length of 1.2 times the length of the vessel is considered to be the standard required berth length.

In accordance with the standard mentioned above, the berth length required for M/V Tomoko is:

Length of vessel 53.4mL × 1.2＝64.08 ≒ 64m.

The standard mooring method is to tie mooring ropes to mooring posts on the jetty at an angle of 30˚ to 45˚ from the bow and stern of the vessel. As shown in the figure below, the required length of the jetty is 64m when the mooring ropes at the bow and stern of Tomoko are stretched to the mooring posts on the jetty at an angle of 45˚. This figure coincides with the required berth length calculated above.

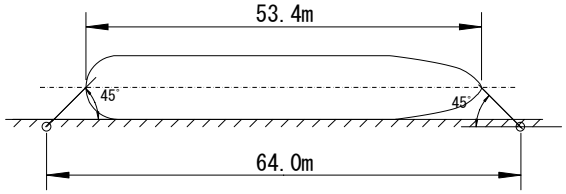


Figure 2-25：Required berth length

b.) Width of Jetty

<Current usage>

The following figure shows usage of the jetty at the busiest hours from late Friday night to Saturday morning. At present, in terms of usage, the width of the jetty is shared by 1) space for

unloading hand-carried luggage, 2) a passageway and waiting space for passengers and 3) a zone for vehicle traffic. However, in reality, the space for 1) and 2) and the space for 2) and 3) overlap each other. Vehicles come onto the jetty and a large number of people move randomly using their own traffic lines on the narrow jetty in the congestion. This condition creates the risk of people and luggage falling off the jetty. Such congestion starts one hour before the arrival of a passenger boat and lasts for two to three hours. The number of people and vehicles on the jetty starts decreasing gradually at two in the morning. However, traffic of people and vehicles on the jetty continues until four in the morning.

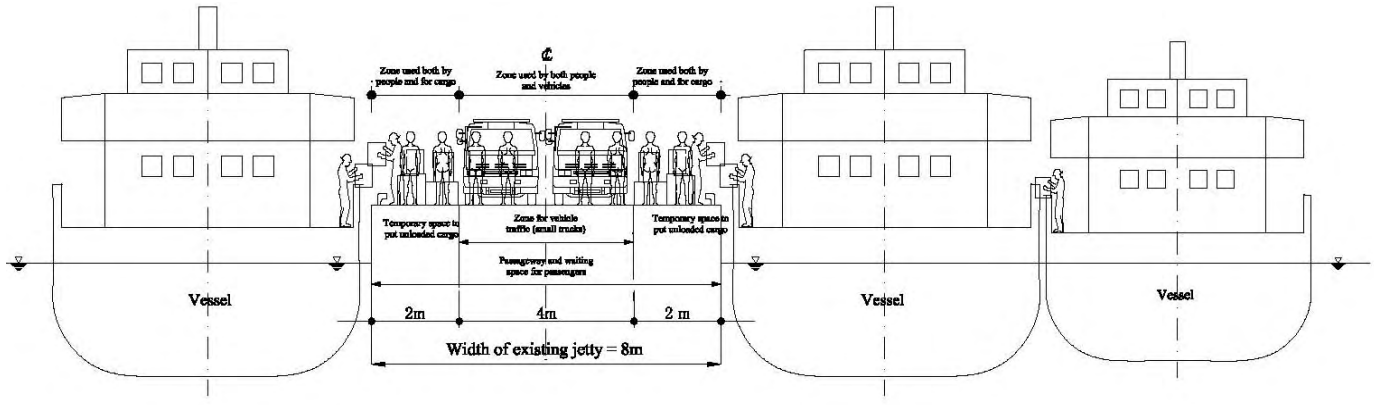


Figure 2-26 : Usage of the jetty at the busiest hours

< Required jetty width >

The jetty width required to accommodate a passageway for passengers, zone for vehicle traffic and margins between vehicles and people and between vehicles, which are the fundamental minimum requirements for safety on the jetty, is decided on the basis of the current usage shown in the Figure 2-26 above and the occupation width of each usage, as shown in the table below.

Instead of the width of 8.0m of the existing jetty, a required width of 7.0m per side, or 14m for both sides, is considered necessary.

Table 2-21 : Required width on the basis of current usage of the jetty

Usage	Occupation width	Current usage
1) Space for unloading hand-carried luggage	Approximately 2.0m per side	Hand-carried luggage includes a large number of items of large volume, such as mattresses for beds, cardboard boxes full of household goods, eskies (cooling boxes) and second-hand freezers to transport perishable foods, sacks of rice and flour and boxes containing tins. Some even contain hazardous materials such as fuel oil.
2) Passageway and waiting space for passengers	Approximately 3.0m per side	Includes people waiting for their relatives and friends arriving at the jetty. ※Width of pedestrian passageway = at least 2.0m. If congested, 3.0m or 4.0m depending on the volume of traffic. (From "Road Structure Ordinance," Ministry of Land, Infrastructure and Transport of Japan)
3) Cargo-handling vehicles	Approximately 3.0m per side	The majority are taxis, pick-up trucks and small trucks (with 2-ton capacity). ※Minimum of 3.0m adopted from 1.2.2 'Carriageways and Lanes" in "Technical Standards and Commentaries for Port and Harbour Facilities in Japan" (Ministry of Land, Infrastructure and Transport of Japan) 9th edition
Total	8.0m per side 16m=8.0m x 2 for the jetty	

At present, MID or Malaita Provincial Government imposes no restrictions or regulations on use of the jetty. In particular, during the busiest hours between late Friday night and Saturday morning when regular passenger service vessels anchor at the port, unrestricted entry of people and vehicles coming to greet their relatives and friends on the jetty further aggravates the congestion. If the width of the jetty is increased to cope with the unrestricted entry of people and vehicles as is the case at the moment, the extra space thus created will become dead space at times of ordinary traffic. In order to eliminate congestion at the busiest hours, to guarantee the safety of users, to ensure efficient cargo handling and movement of passengers and to avoid creating dead space at times of ordinary traffic, regulations such as entry restrictions are essential.

On the other hand, local vessel operators and the provincial government are fully aware of the congestion and dangers increased by the entry of neighborhood residents who have no business but greeting their acquaintance on the jetty and forced entry of vehicles at busy hours. Many of them requested implementation of entry restrictions at the entrance by fences or other means. Based on this awareness of the situation at the site, it will be possible to reduce the width of the jetty by controlling the entry of people and vehicles by installing fences and gates to restrict entry to areas

near the jetty.

Therefore, the required width of the jetty is established as follows:

- At present, the space for unloading hand-carried luggage occupies a width of approximately 2.0m. As it is considered possible to reduce the amount of hand-carried luggage temporarily placed on the jetty by increasing the efficiency of cargo transport from the jetty through expansion of the jetty, it will be halved to 1.0m. (This width includes the space required for installation of additional facilities at the sides of the jetty such as car stops (width of 0.25m) and mooring posts (0.75m).)

- As the passageway and waiting space for passengers can be regarded in the same way as the sidewalk of an ordinary road, the minimum sidewalk width of 2.0m specified in Article 11 (Sidewalk) of the "Road Structure Ordinance (Ministry of Land, Infrastructure and Transport of Japan)" will be adopted.

- The space for cargo-handling vehicle traffic can be regarded in the same way as a harbor road. Item 1.2.2 'Carriageways and Lanes" in "Technical Standards and Commentaries for Port and Harbour Facilities in Japan" (supervised by the Port and Harbor Bureau, Ministry of Land, Infrastructure and Transport of Japan) 9th edition, specified the width of such roads at 3.25m or 3.5m, in principle. However, as the road concerned falls under the case of small design traffic volume and difficult topographic conditions, it will be reduced to 3.0m by adopting the minimum width specifically stipulated for such cases in the standards.

As a result, it is considered possible to reduce the width of the planned cargo-handling jetty to 6m per side or 12m in total as shown in the following table.

Table 2-22：Occupation width of the planned jetty

Usage	Planned occupation width	Remarks
1) Space for unloading hand-carried luggage	1.0m per side	At present, this space occupies a width of approximately 2.0m. As an increase in the efficiency of cargo transport from the jetty is expected with the expansion of the jetty, the amount of temporarily left hand-carried luggage will be reduced.
2) Passageway and waiting space for passengers	2.0m per side	In accordance with Item 3 (Sidewalk), Article 11 (Sidewalk), Road Structure Ordinance, Ministry of Land, Infrastructure and Transport of Japan, a minimum sidewalk width of 2.0m will be adopted. Although, this space occupies a width of approximately 3.0m at present, as a reduction in the number of people waiting and alleviation of congestion are expected by restrictions on entry to the jetty, a reduction in width of 1.0m to 2.0m is expected to create no problem.
3) Space for cargo-handling vehicles	3.0m per side	The minimum figure of 3.0m provided in Item 1.2.2 ‘Carriageways and Lanes” in “Technical Standards and Commentaries for Port and Harbour Facilities in Japan” (Ministry of Land, Infrastructure and Transport of Japan) 9th edition, will be adopted.
Total	6.0m per side 12.0m ＝6.0m×2 in total	

Small trucks (with a load capacity of 2 tons) are widely used in the area. As they require a width of 11.7m to make a 180˚ turn, a jetty width of 12m is barely sufficient for them to turn. However, in reality, with additional facilities (such as mooring posts and car stops) installed on the jetty, there will not be sufficient room for the trucks to make the turn without making contact with these facilities. However, as they can make the turn safely with room to spare with a width of 10.1m using a switchback, a jetty width of 12m is considered appropriate.

Meanwhile, for the part of the access jetty on which no cargo handling takes place, a width of 8m is sufficient to ensure safe traffic of pedestrians and vehicles in both directions.

Table 2-23：Occupation width of the planned jetty (at the access part)

Usage	Planned occupation width	Remarks
1) Space for unloading hand-carried luggage	0.0m	No cargo handling takes place.
2) Passageway for passengers	2.0m	
3) Space for cargo-handling vehicles	6.0m (3.0m per site)	Space for two lanes will be ensured for possible two-way traffic.
Total	8.0m in total	

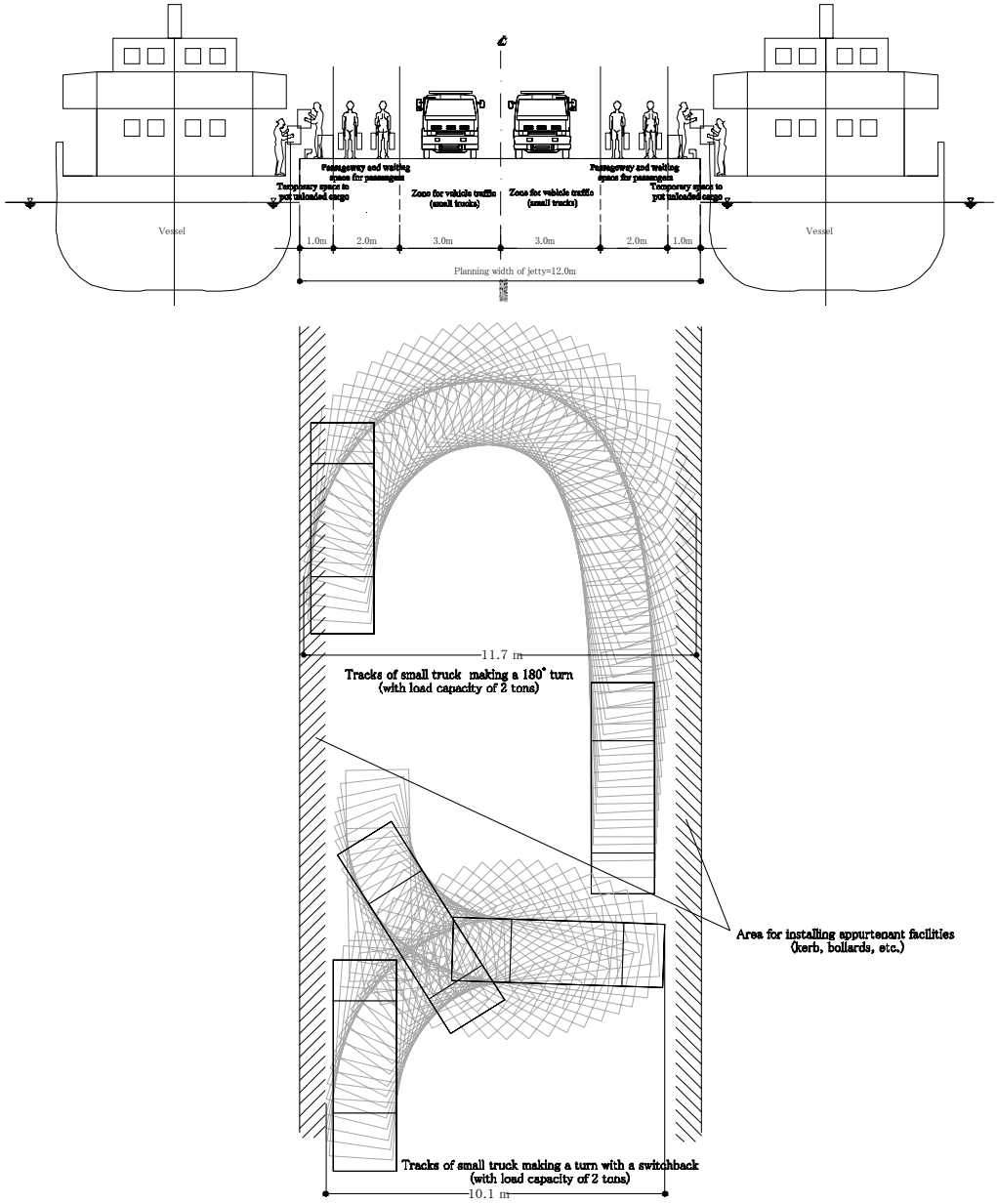


Figure 2-27：Planned width composition and tracks of small trucks (with load capacity of 2 tons) for turning

2) Structure / Section Planning

① Structural Type

In general, the basic structural types of mooring facilities can be classified into four, 1) gravity, 2) sheet-pile, 3) pile and 4) pontoon types as shown in the Table 2-24. In this section, a) environmental conditions, b) usage conditions and c) execution conditions for each type are comparatively examined, taking the characteristics of each respective type into consideration, and the structural type for this plan is determined based on comprehensive judgment, taking the period

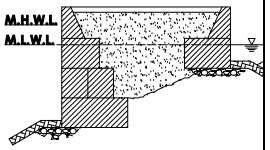
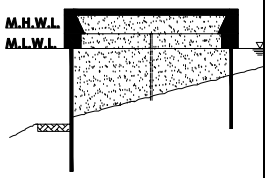
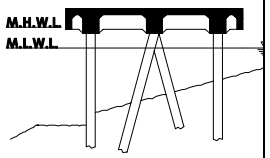
and cost of construction into consideration.

In general, the pontoon type is applicable to places with “large tidal range” and large water depths. While it has the advantage of relative ease of construction and transport, it has the disadvantages of low resistance to impulsive and traction forces from vessels and small load capacity. It is inferior to the other three fixed types in basic convenience in regard to mooring of vessels, cargo handling and operation of transport vehicles. The maintenance and management costs after completion of construction are also high. For these reasons, this type was excluded from the comparative examination.

The site conditions of the plan site, the sea bed topography and the results of the soil study favor the pile-type jetty for the following reasons.

- As a soft stratum of sand mixed with silt or silt mixed with sand with the N value of 2 to 6” occupies the layer from the current sea-bed to -24.5m, consolidation settlement is likely to occur with heavy structures such as gravity- and sheet-pile-type structures.
- A pile-type jetty is suitable for sites where the ground is too soft to sustain a gravity- or sheet-pile-type structure.
- As there exists a solid limestone layer at a depth of -24.5m from the current seabed in the planned site, constructing a pile-type jetty with this layer as the supporting layer is considered to be the safest and best method.

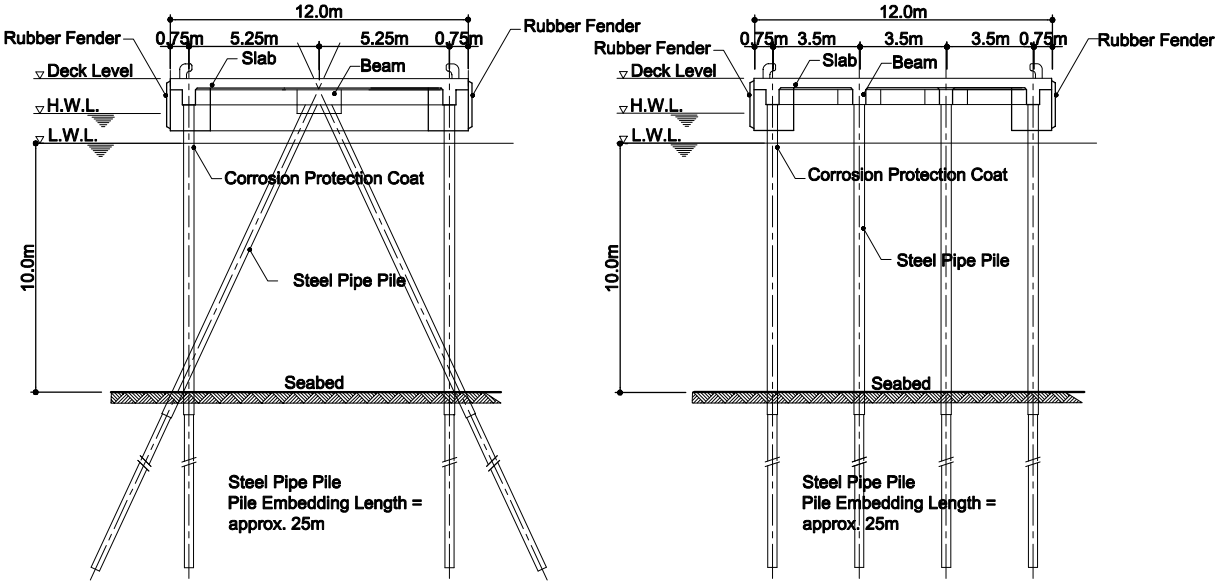
Table 2-24: Comparative examination of each structural type

Item examined	Schematic diagram	a) Natural conditions			b) Usage conditions			c)Execution conditions		
		(1) Correspondence to the existing ground	(2) Correspondence to the water depth at the front	(3) Safety against impulsive force from vessels	(1) Ease of cargo handling	(2) Calmness in the hinterland	(3) Main construction materials	(1) Main construction machinery to be procured abroad	(2) Main temporary work	(3) Main construction contents and technology
①Gravity type		In general, it is applicable to a hard sand gravel layer. However, the depth of the rubble-mound has to be decided depending on the conditions of the sand layer.	It is not appropriate for a site with a large water depth.	It is the strongest against impulsive force from vessels.	Good for all types	It improves calmness in the hinterland as it acts as a wave absorbing dyke.	Large-sized rubble is required for the foundation work below the concrete blocks.	Large heavy equipment is required for installation of the concrete blocks.	A yard to prepare the concrete blocks is required near the planned site.	Skilled technicians are required for a large amount of the underwater work when constructing the rubble foundation and installing the concrete blocks. As it is executed on ground, of the three types, the concrete work is relatively easy.
② Sheet-pile type		It is appropriate for a sand layer. However, the existence of cobblestone may require consideration of the use of another method such as water-jet at the sheet piling.		It is relatively strong against impulsive force from vessels and it has large absorbing energy.			Procurement of sheet piles is required.	Procurement of cranes, vibrohammers and generators for sheet piling is required.	Simple scaffolds are required.	The work is the simplest of the three.
③Pile type		Considerations similar to those for the sheet-pile type are necessary for this type.	It is applicable to a site with a large water depth.	Although it is strong against impulsive force from vessels, it is likely to become unstable if the force causes destruction.		Less improvement in calmness than with the other two types can be expected.	Steel pipe piles and materials for a temporary stage are required.	Procurement of a pile driving barge is required.	A large-scale temporary stage is required for the concrete work for the beams and slabs.	There is a large amount of pile driving and concrete work in the sea. Skilled workers are required. This was the method used for the existing jetty.

② Pile-type Jetty Structure Section

There are two section types of pile jetty, the raker pile type and vertical-pile type. The raker pile type is often adopted as a structural type against horizontal external forces such as docking force and traction force.

While raker piles are suitable in cases where horizontal displacement is small and horizontal external force is great in relation to horizontal force (seismic force and impulsive and traction forces from vessels), a specialized pile driving barge or a specialized pile driver to drive piles aslant is absolutely essential for execution of raker piles. As the planned site is located in a small island country in Oceania, it is difficult to procure heavy machineries for marine civil engineering within the country or in neighboring countries in a short time. Therefore, adoption of the raker pile type is not favored. Thus, the vertical-pile type is suitable for this plan.



Raker pile-type Vertical-pile-type

Figure 2-28：Section of raker pile-type and vertical-pile-type jetties

Based on the geotechnical survey result, piles are designed as bearing piles with their foundation enbedded to the solid limestone layer at a depth of 23~25m under the existing seabed, until which the soft stratum of sand mixed with silt and silt mixed with sand with the N value of 2 to 6 are existing. The total length of piles is accordingly 31m to 39m corresponding to the water depth.

The suitable material of piles shall be of steel pipe piles, as precast concrete piles are difficult to procure in Solomon Islands, they have to be imported from abroad and transport from Honiara to Auki, and there are risks of damage of concrete during marine transport, and the length of piles are limited to deck size of liner.

Examining the horizontal load as shown in the clause (3), the diameter, thickness, and layout of

the piles are determined to be 4 rows x ϕ 700mm x T=12mm for the main landing jetty, 3 rows x ϕ 700mm x T=12mm for the access jetty.

a.) Berth Depth

The required berth depth shall be decided by the vessel with the deepest draft among the vessels currently in regular service.

In general, the standard berth depth for large and small vessels is obtained by adding a margin of 0.5 to 1.5m and 0.5 to 1m, respectively, to the load draft. The soil characteristics of the seabed at the berth, waves and current are also taken into consideration in deciding the berth depth. The vessel with the deepest draft of those under consideration in this plan is a cargo-passenger vessel, M/V Belama, with a draft of 3.4m. Because of the muddy bottom sediment, small wave height and little current, the required berth depth is set at 4m in the plan.

b.) Crown Height of Jetty

The types of vessel using the jetty, sea level and waves are taken into consideration in deciding the crown height. As no tendency toward an increase in the size of the vessels is observed in the Solomon Islands, the specifications of the existing vessels shall be used in the decision-making. Putting abnormal high tides and waves aside for special consideration, the figures shown in the following table are considered to be the standard crown height in terms of H.W.L. in accordance with intended use and tidal range.

As the planned jetty is located at a site with a tidal range of 1.2m and is intended for mooring of small vessels, the standard crown height is obtained by adding 1.0 to 1.5m to the high water level (H.W.L.) (C.D.L. +1.4m).

Table 2-25：Crown height of mooring jetty

	Tidal range of 3m or more	Tidal range of less than 3m
Mooring jetty for large vessels (water depth of 4.5m or more)	0.5～1.5 m	1.0～2.0 m
Mooring jetty for small vessels (water depth of less than 4.5m)	0.3～1.0 m	1.0～1.5 m

※From “Technical Standards and Commentaries for Port and Harbour Facilities in Japan”, edited by the Japan Port and Harbor Association

The crown height of the existing jetty is lower than the standard at C.D.L. +2.519m, or H.W.L. +0.9m. The sea level at the site reaches C.D.L. +1.8m at the time of highest high water. High water lasting for a long time at synodic periods caused by tidal mixing at the site increases the risk of cyclones hitting the site at the time of spring high tides.

To alleviate the risk, this plan sets the crown height at C.D.L. +2.8m (H.W.L. +1.4m), 0.3m higher than the crown height of the existing jetty.

Crown height of jetty	＋2.8 m
M.H.H.W.	＋1.4 m
Crown height of ramp for landing vessels	＋1.0 m
M.L.H.W.	＋0.9 m
M.H.L.W.	＋0.6 m
M.L.L.W.	＋0.2 m
C.D.L.	± 0.0 m

③ Design Conditions of Jetty

a.) Reference standard

"Technical Standards and Commentaries for Port and Harbour Facilities in Japan (1999 and 1989 editions)," Japan Port and Harbor Association

b.) Planning conditions and usage conditions

(1) Planning conditions

1) Planned water depth D.L. -4.00m (at mooring jetty)
2) Design water depth D.L. -4.50m (at mooring jetty)
3) Planned crown height
   ① Mooring jetty: D.L.+2.80m
   ② Access jetty: D.L.+2.80m
   ③ Revetment: D.L.+2.50m
4) Total length
   ① Mooring jetty： 64.00m
   ② Access jetty： 40.00m
5) Apron width
   ① Mooring jetty： 12.00m
   ② Access jetty： 8.00m

(2) Usage conditions

1) Vessels using the jetty

As M/V Tomoko, a 500GT-class passenger boat, is the largest vessel to use the jetty, 500GT-class vessels will be considered.

Table 2-26：Particulars of Vessels to be considered

Vessel type	Length (m)	Width (m)	Draft (m)	Gross tonnage (GT)
Passenger boat	53.4	8.6	3.3	500

Full-load displacement (DT)

log (DT) =0.341+0.891log (GT) =0.341+0.891log (500) =2.74

DT =550 t

b.)Docking speed

As the vessels under consideration are small passenger boats with a displacement tonnage of 1000 tons or less, a docking speed of 25cm/s will be assumed. Fender reaction will be considered as extraordinary loading.

④ Working lifetime and anti-corrosion measures

a.)Working lifetime 50 years

b.)Anti-corrosion measures

Coating and extra thickness added to the piles

c.)Coating

Heavy duty coating will be applied to the underwater and intertidal zone from 1.00m below the seabed to the lower edge of the beams.

Meanwhile, a corrosion allowance will be considered for the underground part 1.0m below the seabed.

d.)Corrosion rate

The following generally adopted figures on Table 2-27 specified in the technical standards for ports and harbors will be adopted.

Table 2-27：Standard figures for the corrosion rate of steel materials

Corrosion environment	Corrosion rate (mm/year)	Amount of corrosion (mm)	Anti-corrosion measures
At or above H.W.L.	0.3	15.0	Heavy duty coating
Between H.W.L. and L.W.L.-1m	0.2	10.0	ditto
Between L.W.L.-1m and seabed	0.2	7.50	ditto
In muddy sediment on seabed	0.03	1.50	1.50

"Technical Standards and Commentaries for Port and Harbour Facilities in Japan (1999 edition)," Japan Port and Harbor Association

3) Natural conditions

① Sea level

High water level	H.W.L.	D.L. +1.40m
Mean sea level	M.S.L.	D.L. +0.79m
Low water level	L.W.L.	D.L. +0.20m

② Level of existing seabed

a) Mooring jetty

At head D.L.-10.00m

In middle D.L, -8.50m

b) Access jetty

At head D.L. -7.00m

In middle D.L. -4.00m

c) At revetment D.L.0m (Seabed inclination of 1:3)

③ Soil conditions

a) Revetment (BH-J1)

Ground depth	Sohil name	Mean N value	Unit weight (kN/m^3)	Internal friction angle(˚)	Cohesion (kN/m^2)
Existing ground					
-4.00m	Sandy soil	7	18	19	―
-25.00m	Cohesive soil	5	15	―	70
-25m~	Base rock	>50	18	40	―

b) Mooring and access jetties (BH-J2)

Ground depth	Soil name	Mean N value	Unit weight (kN/m^3)	Internal friction angle(˚)	Cohesion (kN/m^2)
Existing ground					
-25.00m	Cohesive soil	3	14.9	―	36.0
-23m~	Base rock	>50	18	40	―

④ Design seismic intensity

As the Solomon Islands are located on the boundary between the Australia Plate and the Pacific Plate, they occasionally experience earthquakes of M4 or above.

The design seismic intensity for the jetty in this plan will be calculated using the equation

shown next on the basis of the regional seismic intensity of the above-mentioned standards and applying the earthquake-resistance design standards of Japan, “Technical Standards with Commentaries for Port and Harbour Facilities in Japan, 1999, the Japan Port and Harbor Association.

Seismic intensity kh = (regional seismic intensity) x (soil-type coefficient) x (importance coefficient)

<Regional seismic intensity>

Regional seismic intensity will be set in accordance with NZS4203.

In accordance with NZS, the Solomon Islands are located in ZONE A. As shown in Fig.3 on P.45, regional seismic intensity depends on the natural period of the structure. In this case, C = 0.15 is adopted to be on the safe side.

<Soil-type coefficient>

Because of third-class soft soil with a thickness of more than 5m, the soil-type coefficient is set at 1.2.

<Importance coefficient>

As a structure that is difficult to restore after suffering seismic damage, the importance coefficient is set at 1.2.

Therefore, the design seismic intensity becomes

Intensity kh = 0.15×1.2×1.2 = 0.22.

4) Load conditions

① Unit weight of concrete

Concrete without reinforcement	$\gamma c = 22.6 kN/m^3$
Concrete with reinforcement	$\gamma c = 24.0 kN/m^3$

② Vertical load

At normal times	$w = 20\ kN/m^2$
At time of earthquake	$w' = 10\ kN/m^2$

③ Moving load

Vehicle load T-25

④ Tractive force of vessels

As the vessels under consideration in the plan are of 500GT-class, the tractive force of a vessel of 250kN will be adopted in accordance with Table 2-27 provided in the technical standards for ports and harbors.

Table 2-28：Tractive force of vessels (Attachment table no.12 of Notice No.79)

Gross tonnage of vessel	Tractive force on vertical piles	Tractive force on raker piles
Over 200 and 500 or less	150	150
Over 500 and 1,000 or less	250	250
Over 1,000 and 2,000 or less	350	250
Over 2,000 and 3,000 or less	350	350
Over 3,000 and 5,000 or less	500	350
Over 5,000 and 10,000 or less	700	500
Over 10,000 and 20,000 or less	1,000	700
Over 20,000 and 50,000 or less	1,500	1,000
Over 50,000 and 100,000 or less	2,000	1,000

"Technical Standards and Commentaries for Port and Harbour Facilities in Japan (1999 edition)," Japan Port and Harbor Association

(3) Additional Facilities

Plans for a pile-type jetty require the following additional facilities.

1) Mooring posts 1 set

Using "Technical Standards and Commentaries for Port and Harbour Facilities in Japan" (supervised by the Ports and Harbors Bureau, Ministry of Land, Infrastructure and Transport of Japan) as a reference, the size, location and number appropriate for the vessels under consideration at the site will be decided.

2) Fenders 1 set

Using "Technical Standards and Commentaries for Port and Harbour Facilities in Japan" (supervised by the Ports and Harbors Bureau, Ministry of Land, Infrastructure and Transport of Japan) as a reference, the size, location and number appropriate for the vessels under consideration at the site will be decided.

3) Car stops 1 set

As vehicles including trucks with a load capacity of approximately two tons enter the jetty and make turns on the jetty, car stops will be installed at the edge of the jetty to prevent them from falling off the jetty.

4) Lighting equipment (for passenger boats entering the port during the night)

4 locations

As passenger boats enter the port from late Friday night to dawn on Saturday every week, equipment for nighttime lighting is required on the jetty. As the minimum illuminance to ensure safe operation on the jetty at nighttime, approximately 10 lx of illuminance at the places expected to be used most by people and vehicles is set as the target.