

6.3.3 Equipment and Maintenance

(1) Objectives of the Plan

Current transport system by switching from collection vehicles to large dump trucks found effective and fits the geographical condition of capital region: final disposal site is isolated from the residential areas where the solid waste is generated everyday. In this system, efficient reloading of waste is the key process to keep the waste stream free from stagnation in residential area. Therefore the plan should have a component to keep and improve the facility for reloading waste, namely a transfer station.

There is a transfer station in Male' City operating to reload waste once stored there to dump trucks bound for Thifafushi island, however, the status of the facility in occupying the present site is unstable. The present transfer station is located amid the area designated as residential area by the authorized land use plan and is expected to somewhere else as soon as possible. To avoid the conflict with the super-ordinate plan, MCPW made a decision to relocate the facility to the other site which is administrated by MCPW, existing depot of Public Works Section.

In this context, the major content of the plan is defined as the construction of new transfer station at a designated site in Male' City. In addition to a new transfer station in Male', a waste deposit site for Vilingili residents are taken into consideration to keep the sound function of waste transport equally in the island. The plan for Villingili Island duly include the improvement of existing shipping facility now half broken.

(2) Construction of New Transfer Station

a. Incoming Waste and Vehicles

Estimated volume and type of incoming waste to the transfer station is presented in Table 6-25. The transfer station will accept on average about 200 to 300 ton everyday. Regarding some wastes segregated by generators are expected to be brought separately into the station. Segregated wastes need to be allocated exclusive spaces to store them separately from the others.

Table 6-25 Estimated Incoming Waste Volume

Type of Waste	Estimated Volume in 1999~2010(t/day)
Perishable Waste	103.8~172.2
Mixed Waste (※)	100.2~167.2
Kitchen Waste (hotels and restaurants)	3.6~5.0
Non-Perishable Waste	77.2~106.9
Saw Dust	4.7~6.5
Metal Scrap	1.4~2.0
Construction Waste (sand & concrete debris)	42.2~58.5
Construction Waste (Other than sand & concrete debris)	28.7~39.7
Hazardous Waste (Waste oil, Battery, Hospital)	0.2
Total	181.0~279.1

Note: (※): Mixed waste out of residential, commercial, industrial and business waste

According to the above classification, the waste volume to be reloaded at the station is estimated as shown in Table 6-26. The average number of vehicles coming and going at the station is forecast proportionally to the waste volume as shown below.

Table 6-26 Estimated Vehicle Number Incoming and Outgoing

Type of Vehicle	Estimated Number (Trip Per day)		
	1999	2003	2010
Incoming	386	356	439
Hand cart	63	63	63
Micro-bin	55	0	0
Private car	268	251	317
Compactor truck	0	42	59
Outgoing(for Thlafushi)	36	34	43
Dump truck	36	12	14
Compactor truck	0	22	29
Total	422	390	482

b. Planning Concept

Planned site for new transfer station is facing the south coast of Male' Island and entirely surrounded by streets on four sides. The site has an approximate size of 200 ft in east-west and 400 ft in north south. The planning concept for the facility is summarized below:

- Capacity of stock volume is secured for an equivalent to 3 day generation except perishable waste.
- Perishable waste is removed in a day or two.
- Facility is enclosed with fence which prevents waste and smell dispersion, and noise emission.
- Entrance for transport vehicles is placed on the side facing the sea to mitigate the negative impact by traffic noise.
- Entrance for collection vehicles is placed in the opposite end to the transport vehicle entrance for the convenience of separate access to the station from the collection area.
- Internal vehicle passages are separately assigned to vehicles by their role of collection, transport and administration.
- Transfer station is accompanied by the same administrative function as is currently provided to the Waste Management Section of MCPW.
- Transfer station has the function of daily maintenance and minor repair for the vehicles and loaders used or coming there. Major repair is expected to be done by the special maintenance section of MCPW, BCMW.

c. Selection of Reloading Method

There are three types of reloading method possibly applied to the new transfer station, however, the first one, shovel loading method is most suitable because of smallest investment cost and simplest operation skill as shown in Table 6-27.

Table 6-27. Alternative Reloading Methods

Reloading Method	Definition	Investment Cost	Operation Skill
Shovel Loading	1.Collection vehicle unloads wastes on the ground. 2.Shovel loader loads the wastes onto transport vehicle by scooping them from the ground.	Small	Low
Crane Loading	1.Collection vehicle unloads wastes on the ground. 2.Traveling crane loads the wastes onto transport vehicle by grasping them from the ground.	Medium	Medium
Compactor and Container	1.Collection vehicle unloads wastes into the hopper placed above the compactor fixed on the ground. 2.Compactor compress the wastes into a specially designed container which can be loaded onto transport vehicle mechanically.	Large	High

d. **Layout of Transfer Station**

According to the planning concept and selected reloading method, the outline of the new transfer station is planned as shown in Table 6-28 and Figure 6-5.

Table 6-28 Outline of New Transfer Station

Facility/Equipment	Dimension	Remarks
Perishable Waste House	30m × 35m × 1 floor (5m high)	Storing and reloading of waste is carried out in the house. Floor is paved with concrete to prevent seepage of leachate into the ground.
Non-perishable Waste Yards	15m × 20m, 10m × 20m, 10m × 10m	Divided space by type of segregated waste with concrete floor
Repair House	15m × 15m, single floor	Used for repair of vehicles and shovel loader
Garage for Transport vehicle	52m × 8m, single floor	Used for 15 dump trucks for Thilafushi
Parking Space		Used for administration vehicle with exclusive entrance
Truck Scale	Capacity 30 ton, 2 units	
Truck Washing Machine	able to wash 15- ton truck	
Water Tank	5m × 5m × 5m high	
Rest Room	5m × 5m	
Administration Building	floor area 680 m ² , 2 floors	office: 120 m ² parts stock room: 120 m ² repair room: 100 m ² lodgings for workers: 340 m ² (2nd floor)

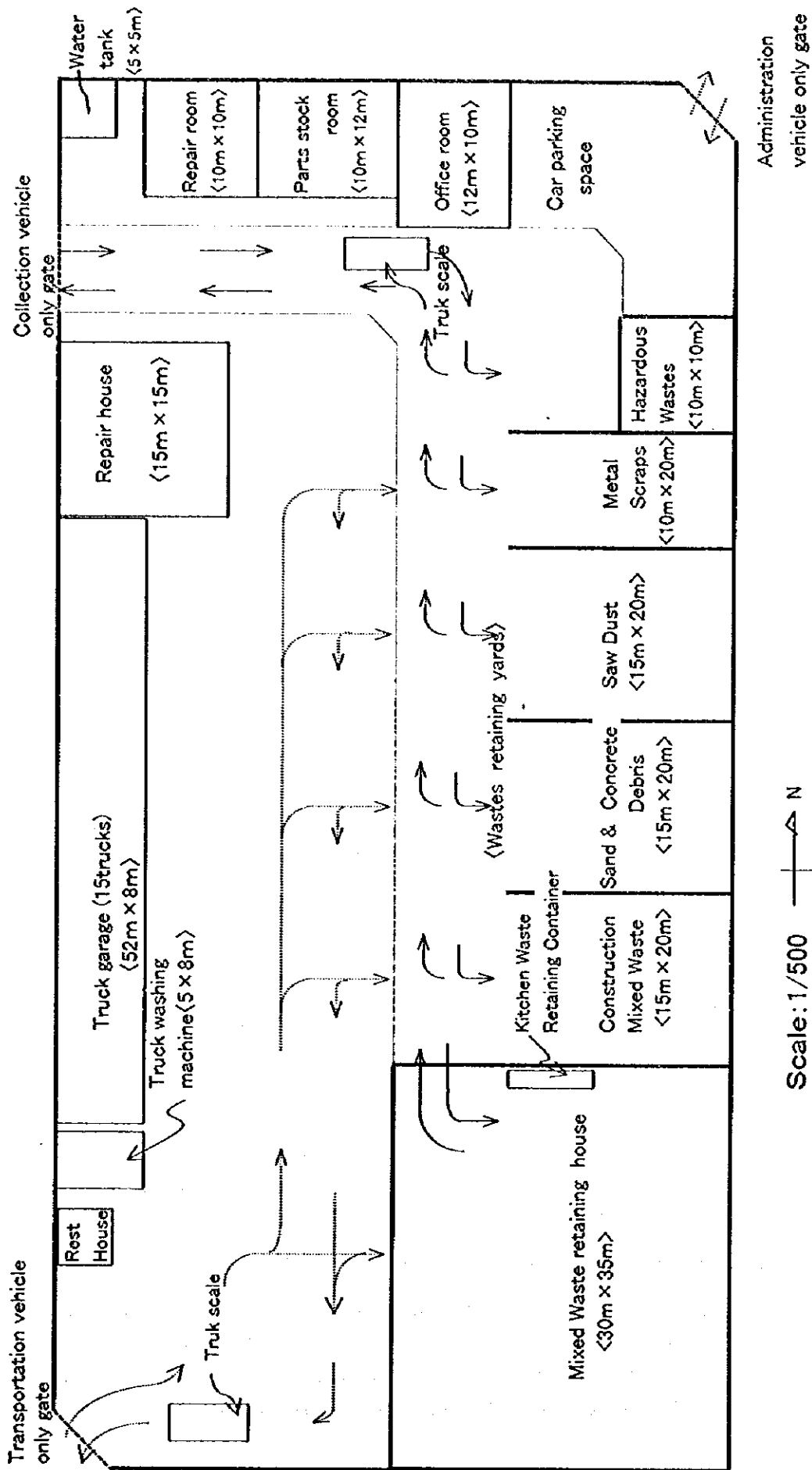


Figure 6-5. Transfer Station Plan (200 feet x 400 feet)

6.3.4 Final Disposal in Thilafushi

(1) Objectives of the Plan

The utmost function of final disposal is to store solid waste in the manner that does not cause minimal adverse effect on living and natural environment. Consequently, solid waste is stabilized and restored to the nature by using metabolism of micro-organism. The master plan aims at realizing the function at Thilafushi Island where the landfill operation is now ongoing and will be continued for a certain time period beyond the target year of 2010. The landfill operation is conducted by forming ponds stepwise with an interval of about one month and is creating approximately 2 ha of land year by year. Therefore there is neither definite disposal site for the use of long term future operation nor improvement plan of deteriorated environment in the island after completion of landfill. Thus the master plan for this aspect consists of the following two target projects:

- a. Construction of New Landfill Site
- b. Improvement of Existing Island

(2) Construction of New Landfill Site

a. Selection of Landfill Type

Possible landfill types of final disposal site are the following three in consideration of financial capacity of MCPW. The characteristics of these types are illustrated in Table 6-29.

i) Alternative 1: Anaerobic sanitary landfill

Daily soil cover is incorporated with present operation in Thilafushi

ii) Alternative 2: Semi-aerobic landfill

This structure is, widely adopted in Japan, has advantages of quick stabilization, cleaner leachate and less methane gas production. These advantages are the effect of the installation of drainage system at the bottom of site, which enables the ventilation inside garbage layer and promotes aerobic decomposition of perishable organic matter.

iii) Alternative 3: Re-circulatory semi-aerobic landfill

This structure is a combination of semi-aerobic landfill and some measures to activate the function of leachate purification. The major features are:

- Installation of vertical vent filled with rubble connecting drainage system.
This enables to expand aerobic zone in the garbage layer.

- Spraying leachate at the top of vertical vent, which promotes leachate purification by activating bio-decomposition, reduction of leachate by evaporation and transpiration, and reduction of methane gas production.

From the viewpoint of sanitary condition, it is recommendable to adopt Semi-aerobic landfill with leachate re-circulation (Alternative 3) that enables more active bio-decomposition, earlier stabilization of site, cleaner leachate and reduction of methane gas production. However, it is very difficult to acquire construction debris, sand or other inorganic material in Maldives at cheap cost. This difficulty suggests that alternatives 2 and 3 are economically not suitable because those alternatives need enough volume of inorganic material to fill out the gap under the water, which allows to form a semi-aerobic condition among the waste above the water. Furthermore, the installation of pump unit for leachate re-circulation pushes initial and operation cost much higher.

As a conclusion, the Alternative 1 (Anaerobic Sanitary Landfill) is the only one choice of the landfill type for the plan. This type of landfill is the same as that adopted in Thilafushi at present. To improve the sanitary condition better than ever, the following measures are proposed to incorporate with the Alternative 1.

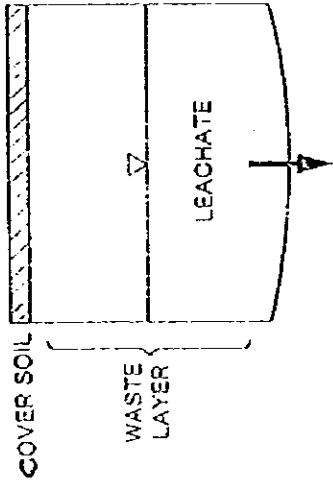
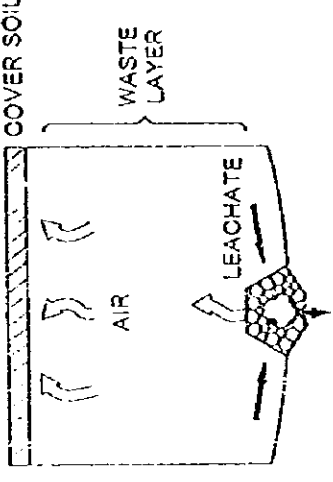
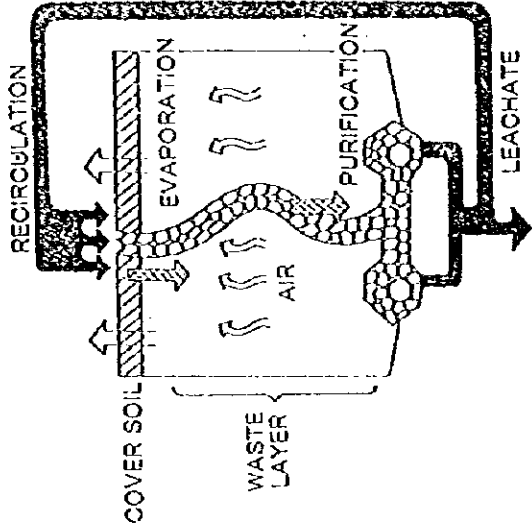
Landfill Type	ANAEROBIC LANDFILL TYPE (A.L.T)	SEMAEROBIC LANDFILL TYPE (S.L.T)	RECIRCULATORY SEMIAEROBIC LANDFILL TYPE (R.S.L.T)
Concept			
Outline	<p>Simply throwing solid waste into a pit. Wastes are soaked and in anaerobic condition. The pace of decomposition of perishable organic matter in waste layer is slow due to anaerobic condition.</p>	<p>Installing leachate drainage pipes at the bottom of pit in order to prompt natural ventilation. Compared with ALT, this structure has such advantages as cleaner leachate, less methane gas generation and earlier stabilization of landfill site.</p>	<p>Adding more efficient purification power to SLT. Installing vertical vent filled with rubble connecting leachate drainage pipe. The vent expands aerobic zone in the waste layer. Re-circulation of leachate through the waste layer prompts bio-decomposition process and improves the purification rate.</p>
Pace of stabilization	Slow	faster than ALT	fastest
Volume of gas generation	$CO_2 : CH_4 = 5 : 5$	$CO_2 : CH_4 = 8 : 2$	$CO_2 : CH_4 = 9 : 1$
Maintenance cost	maintenance free	maintenance free	cost of re-circulation
Construction cost	cheap	more expensive than ALT	much more expensive than SLT

Table 6-29 Landfill Type

b. Concept of Landfill Structure**i) Purification of Leachate**

- Installation of vertical vent with an interval of one per 40m² to form an aerobic zone.
- Installation of vertical impermeable wall around the waste layer to prevent penetrated rain water and leachate from direct seepage through coral base.
- Installation of retention ditch outside vertical impermeable wall to hold the leachate coming out of drain through the wall. The leachate is diluted and aerated by sea water intruding over the seawall, consequently its perishable organic content is transformed into such substance that aquatic plants can absorb easier.
- Installation of seawall filled with rubble around the retention ditch. The seawall allows the sea water to pass through it in accordance with the tidal fluctuation. During the time flowing out, leachate is removed perishable organic matter by micro-organism adhering to the core rubble.

ii) Depth of Bottom Layer

It is necessary to excavate the surface of reef within the planned landfill site in order to take the material for the top cover and temporary bank to enclose a pond for the waste filling. With considering the demand of the above material, the depth of the bottom layer is set at 2.5 m deep from the Low Water Level. Also, this depth is reasonable to excavate by the excavator belong to MCPW.

iii) Layer of Waste Filling

As explained in Depth of Bottom Layer, the bottom elevation of the waste filling would be E.L.-2.5 m. The minimum height of the first layer should be more than 70 cm above the High Water Level including the earth cover, i.e., it becomes E.L.+2.0 m considering the filling operation amid rushing wave on the reef. If the height of the final layer is required more than E.L.+2.0 m to meet the demand of waste volume, there are two options, such as providing second layer over the first layer (multiple layer method), and the first layer covered with whole solid waste (single layer method). As the following conditions, the multiple layer method above E.L. +2.0 m is recommended for this waste filling.

• Aspect of Environment**: One Layer Method**

As the disposed waste is left standing for a long time by final height, the bud odor generation and the sanitary measure to flies, etc. would generated.

: Multiple Layer Method

It is effective that the cover soil at the water level will prevent the offensive odor and the increase of sanitary harmful insects. As the daily

cover for the waste planned in the operation after first layer (above sea level), the daily cover soil would be effective for the prevention of the offensive odor and flies as well as the preservation of peripheral environment.

- Aspect of Operation

- : One Layer Method

The solid waste is filled up above the basement of the operation stage in the first layer. Hence, it is difficult to control the leveling and compacting of the waste. The stockpile area of the covering soil and the banding material would not be kept until the completion of final filling of a part of site. Hence, the area for the stockpile shall be kept at the another site, and these transportation works would be added.

- : Multiple Layer Method

The operation would be able to control the waste filling of layer by layer. The leveling and compacting work is easier than the One Layer Method due to the thickness of the layer for waste filling. However, the material of the cover soil for middle part and these works are added as against the One Layer Method.

- Aspect of Waste Stability

- : One Layer Method

The solid waste is filled up by the final elevation in the first layer so that the sufficient compaction of the waste would not be able to be expected. Hence, the settlement of the landfill area will be continued for a long period after the completion of the landfill.

- : Multiple Layer Method

The solid waste filled under the seawater is compacted at the sea water level after covering soil for the first layer. Also, the waste filled above the seawater is expected with the sufficient compaction on the cover soil layer by layer. Hence, the time for the completion of the settlement is shorter than the One Layer Method.

iv) Height of Waste Layer

The maximum height of waste filling layer is set at E.L. +6.0m for the allowable limit which secures the workability over the surface and the stability of the artificial hill made of filling material. However, with considering the material loss for the top cover and temporary bank to enclose a pond of waste filling, the height of E.L. +4.0m is recommendable for this filling. The waste filling shall be divided into two layers, which is the first layer having 4.5m thickness up to E.L. +2.0m and the second layer having 2.0m thickness up to E.L. +4.0m. The comparison of the cost for the waste filling height is shown in the following table. In order to reduce the construction cost to set, the height of E.L. +4.0m is the most economical way. It would not cause impact on the aesthetic aspect

of environment because the green belt of fast growing trees planted around the filling area would screen the operation of waste filling. The fast growing tree of local species is expected to grow up over E.L. +4.0m in a few years as shown in Figure 6-6.

Table 30. Scale of New Thilafushi

Item	Final Elevation		
	E.L. + 2.0 m	E.L. + 3.5 m	E.L. + 4.0 m
Thickness of Second Layer of the Waste	0.0 m	1.0 m	1.5 m
Required Area	145,300 m ²	117,600 m ²	105,000 m ²
Length of Seawall	2,300 m	1,820 m	1,670 m
*Construction Cost /Weight of Waste(t)	320Mrf / t	270 Mrf / t	250 Mrf / t

*: Costs for the Seawall Construction only

v) Structure of Facilities

The basic feature of the new landfill site is recommended as Figure 6-6. The facilities around new landfill site are adopted on the basis of the concept mentioned in this section and the following conditions are considered for the planning of the facilities.

- Vertical impermeable wall (Steel Sheet Pile with Concrete Coping)

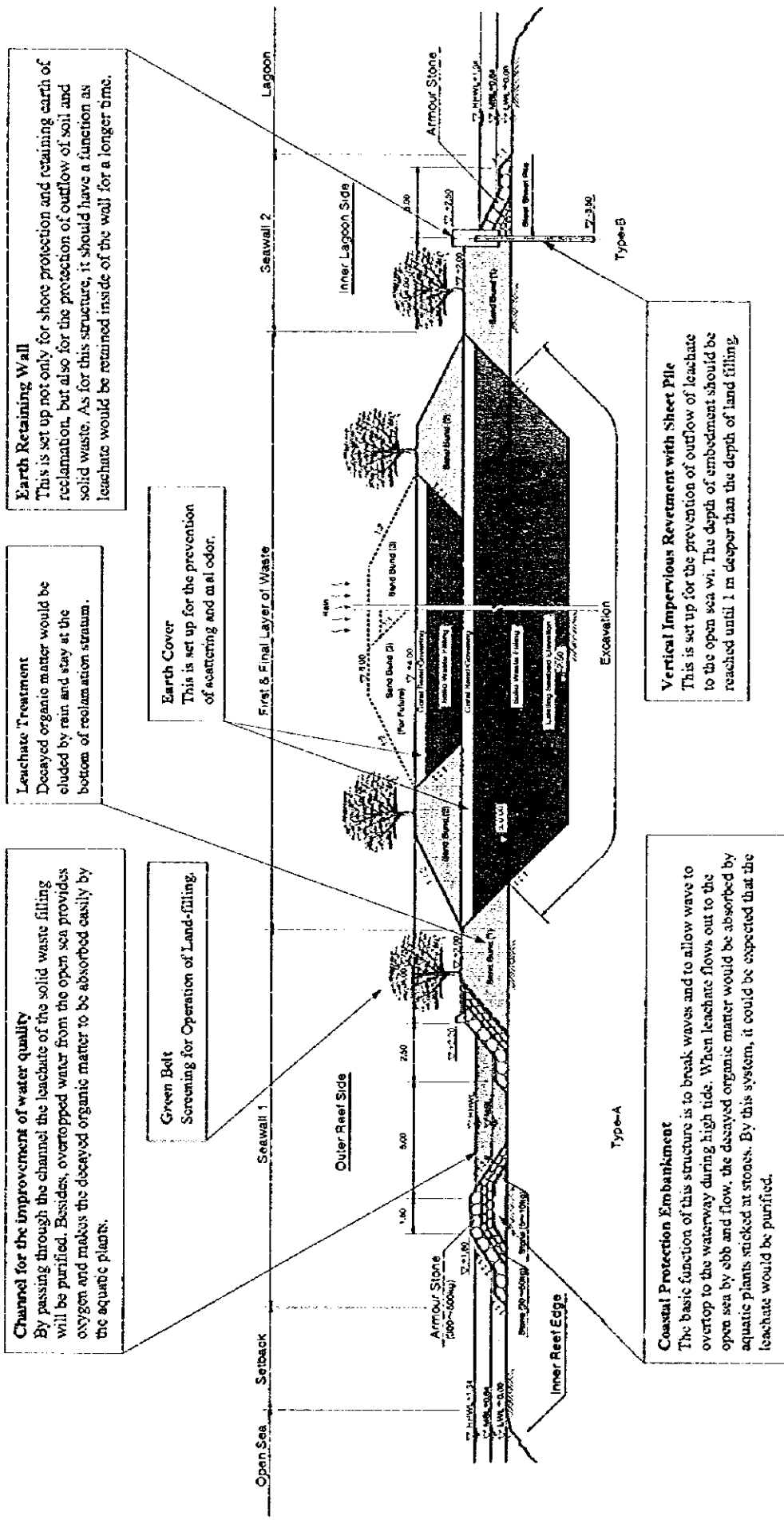
As the test results of the seawater quality around the existing Thilafushi Island, no significant deterioration of the seawater quality was clearly indicated. This result could be interpreted as effective dilution and dispersion of leachate due to sea wave, tides and current. However, the inner lagoon of Thilafushi Island is essentially a semi-enclosed water body. Insufficient dilution and dispersion of the leachate from the landfill are perceived as the cause of progressing eutrophication of this inner lagoon that also resulted in coral disease and mortality. Therefore, the vertical impermeable wall (Steel Sheet Pile Wall) is planned at inner lagoon side only.

According to the model test, it could be expected to have sufficient impermeable effects with the vertical impermeable wall as mentioned in the Supporting Report. This vertical impermeable wall consists of the cantilever steel sheet piles and these piles should be driven up to -3.5 m in order to hold the earth pressure as a function of revetment.

- Coastal Protection Embankment with Retention Ditch (Channel)
(Seawall filled with rubble and armor stones)

This facility is not only to protect the shoreline but also to allow the wave overtopping into the retention ditch. Hence, the area to be installed the facility is requested to be occurred the wave more than 1.0 m for overtopping. The wave occurred inner lagoon is too low to expect these functions. Consequently, this facility shall be installed at the outer reef side only. For the retaining wall of the landfill at the outer reef side, the precast

concrete wall is considerable as alternative structure. However, the result of the comparison of the construction costs for the both structures, the protection with rubble stones covered by armor stones is cheaper than the concrete wall. Therefore, the seawall and the slope protection with the stone structure should be adopted.



Channel for the improvement of water quality
 By passing through the channel the leachate of the solid waste filling will be purified. Besides, overtopped water from the open sea provides oxygen and makes the decayed organic matter to be absorbed easily by the aquatic plants.

Green Belt
 Screening for Operation of Land-filling.

Leachate Treatment
 Decayed organic matter would be eluded by rain and stay at the bottom of reclamation stratum.

Earth Cover
 This is set up for the prevention of scattering and mal odor.

Earth Retaining Wall
 This is set up not only for shore protection and retaining earth of reclamation, but also for the protection of outflow of soil and solid waste. As for this structure, it should have a function as leachate would be retained inside of the wall for a longer time.

Coastal Protection Embankment
 The basic function of this structure is to break waves and to allow wave to overtop to the waterway during high tide. When leachate flows out to the open sea by ebb and flow, the decayed organic matter would be absorbed by aquatic plants stucked at stones. By this system, it could be expected that the leachate would be purified.

Vertical Impervious Revetment with Sheet Pile
 This is set up for the prevention of outflow of leachate to the open sea vi. The depth of embedment should be reached until 1 m deeper than the depth of land filling.

Figure 6-6 Function of Each Structure at Final Disposal in Thilafushi

c. Direction of Extension Plan for Future

Dumping area has been so far extended to westward and southward. For the future filling extension plan, there are three alternatives as indicated in Figure 6-7.

Alternative 1: Extension to north reef flat.

Alternative 2: Extension to south reef flat.

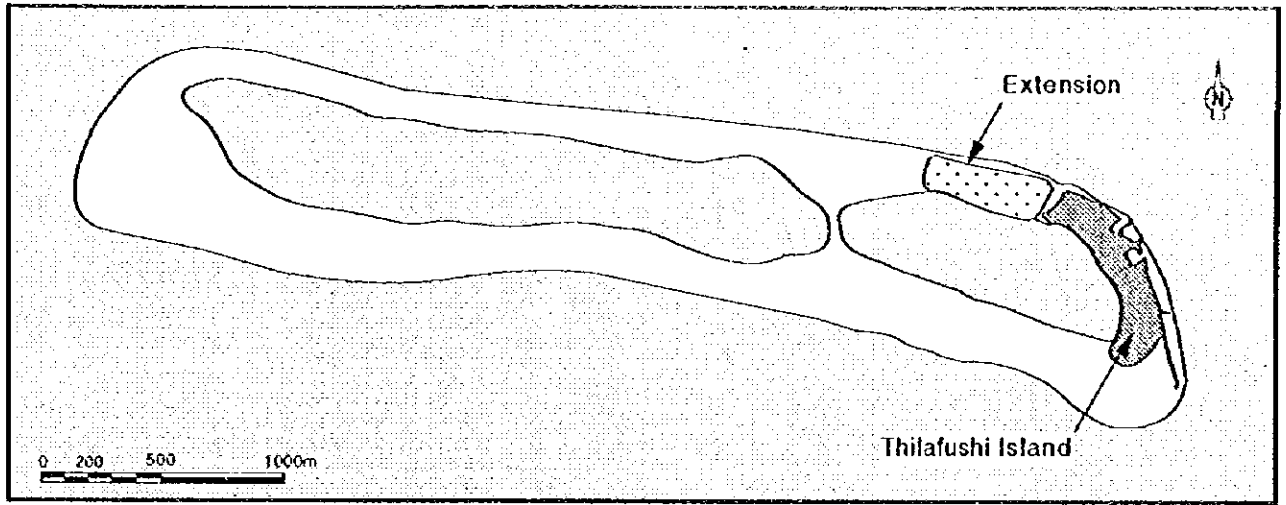
Alternative 3: Extension to both north flat and south flat and inner lagoon (water depth: about 6 m)

Evaluation of each alternative of the extension plan is given in Table 6-31.

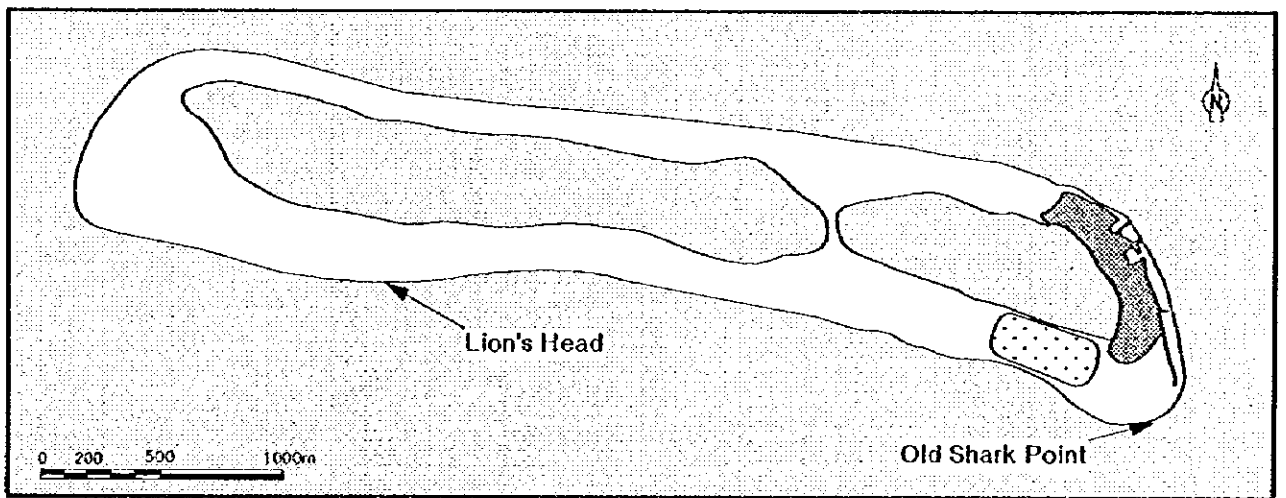
Since high swells are always approaching to south reef (Alternative 2 and 3), construction cost of seawalls will be expensive. Corals along the south flat are very active and there are many attractive diving spots such as Lion's Head and Old Shark Point. Therefore it is not recommendable to extend the filling site to south reef from the technical and environmental points of view.

In addition, since water depth in the inner lagoon (Alternative 3) is about 6 m, it is possible to receive more volume of solid waste. However, cost for the seawall construction in the deep water will be twice compared with the shallow one. At present it is not recommendable to fill the solid waste in inner lagoon. When surrounding reef flat is completely filled, a feasibility study should be made if inner lagoon should be filled with solid waste.

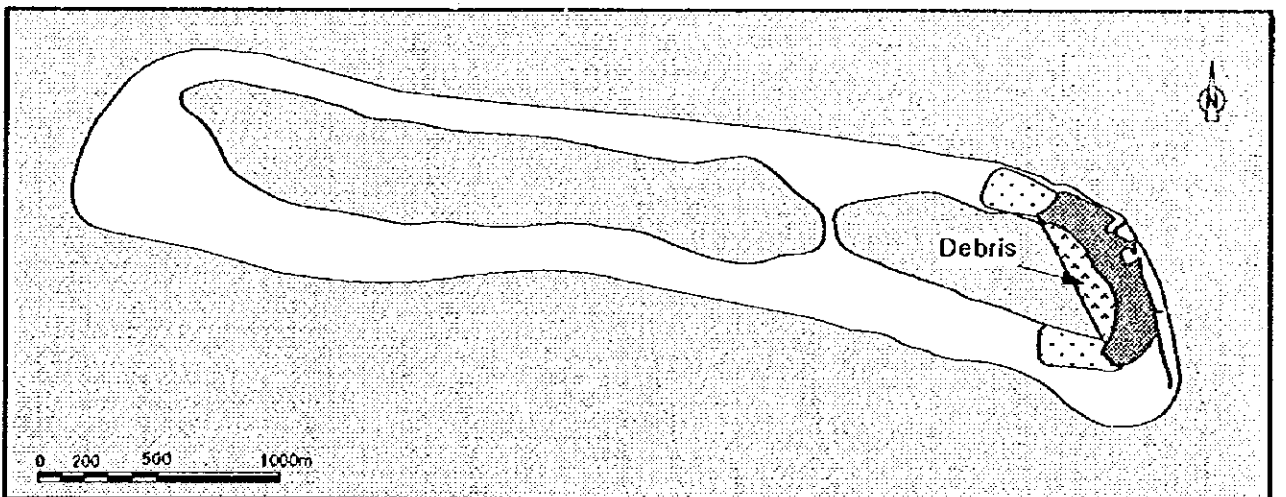
Considering the above reasons, the Study team recommends that the Alternative 1 is the most preferable extension plan at the beginning stage.



Alternative 1



Alternative 2



Alternative 3

Figure 6-7 Alternative Extension Plans in Improvement of Thilafushi Final Disposal Site

Table 6-30 Alternative Extension Plans in Improvement of Thilafushi Final Disposal Site

	Alternative 1	Alternative 2	Alternative 3
Check points			
Definition of Alternative	utilizes northern reef flat (width about 150m)	utilizes southern reef flat (width about 200 m)	utilizes both reef flats in parallel and inner lagoon as well. Inner lagoon is filled with demolition debris only.
Natural Condition of the Site			
Sea wave	Low	high	High
Depth	shallow (EL +0.2 m)	shallow (EL +0.2 m)	deeper in lagoon (EL -6 m)
Aquatic lives	comparably sparse in number of species and population	comparably abundant in number of species and population	same as Alternative 1 & 2 on reef flats, however, very sparse in inner lagoon
Coral reproduction	comparably inactive	comparably active	same as Alternative 1 & 2 on reef flats, however, inactive in inner lagoon
Impacts on Natural Environment			
Sea water exchange in inner lagoon	kept well	disturbed by the artificial land	disturbed by the artificial land
Sightseeing spots	no significant spot in front	Lions head, Shark point are located on the same reef flat	Lions head, Shark point are located on the same reef flat
Dilution of leachate	active on both edges, on outer side and inner side	active on outer edge, however, inactive on inner edge	disturbed by the artificial land
Overall impacts on ecological system	Small	largest	large
Stabilization of dumped waste			
Application of wider aerobic decomposition zone for sooner stabilization of waste layer	The shallower the site lies, the wider aerobic decomposition zone can be formed above sea level in waste layer. Below sea level is desirably filled with demolition debris or other inorganic wastes.	The shallower the site lies, the wider aerobic decomposition zone can be formed above sea level in waste layer. Below sea level is desirably filled with demolition debris or other inorganic wastes.	Demolition debris is mostly exhausted in filling inner lagoon. Therefore a large portion of organic wastes is soaked in the sea water, this means aerobic decomposition zone is hardly formed and the stabilization takes long time. The leachate becomes dirtier.
Performance of seawall as leachate filter	good because of active sea water exchange around the site	medium	bad because of inactive sea water exchange around the site
Construction Cost			
Prevention of silt dispersion during construction	least expensive	expensive because of large sea surge	most expensive because of wider area to be protected
Seawall	least expensive	expensive because of large sea surge	most expensive because of deepest location
Temporary extension	conventional extent of excavation is enough	needs deeper excavation to acquire more coral for protecting "pond" from higher surge	needs deeper excavation to acquire more coral for protecting "pond" from higher surge
Total Construction Cost *)	Rf 111,776,000 Rf 230/ton	Rf 122,015,000 Rf 251/ton	Rf 171,672,000 Rf 353/ton
Competition with the other infrastructure project			
Ship repair yard	not affected	affected	affected

*) The breakdown of construction cost is shown in Supporting Report.

d. Seawall construction and Filling Schedule

Until the commencement of the construction of seawalls (to be expected to start in 2000 in the earliest), present solid waste filling method should be provisionally continued to westward of north reef flat as illustrated in Figure 6-8. Special care in excavating coral fragments should be given not to deteriorate living corals along north reef edge.

1999

To avoid contamination of water quality of inner lagoon, it is recommended to provide individual filling site (island) by providing channel at proper interval instead one long island. Since there is a channel dredged in 1998 near western end of Thilafushi Island, future-filling site should be started after construction of causeway with culverts. Filling should be carried out as narrow as possible in width in order to maintain construction space for seawalls and to minimize the adverse effect to live corals due to excavation of the reef flat.

2000

It is expected in the earliest possibility that the seawall construction for Thilafushi 2 will be started in 2000. Solid waste filling work should be continued westward in the same manner as of 1999

2001

Whole seawalls for new filling site (Thilafushi 2) will be completed and a part of seawalls for existing Thilafushi Island (Thilafushi 1) still continues. Solid waste filling work should be continued in the same manner as of 1999 and 2000.

2002

Remaining seawall construction in Thilafushi 1 will be completed. Solid waste can be filled anywhere in Thilafushi 2 with covering sand. Leachate treatment system should be provided properly.

2003

Solid waste can be filled anywhere in Thilafushi 2 with covering sand, and filling site should be formulated for final section and elevation in order to maintain for several years.

It is recommended to start construction of seawalls for Third Island (Thilafushi 3) for Solid Waste Filling to meet the demand up to 2010.

2004

Construction of seawalls in Thilafushi 2 will be continued. Solid waste filling on Thilafushi 3 can be started.

2005

Construction of seawall in Thilafushi 3 will be completed. Solid waste filling will be continued in Thilafushi 3.

2006 -- 2010

Solid waste filling will be continued in Thilafushi 3.

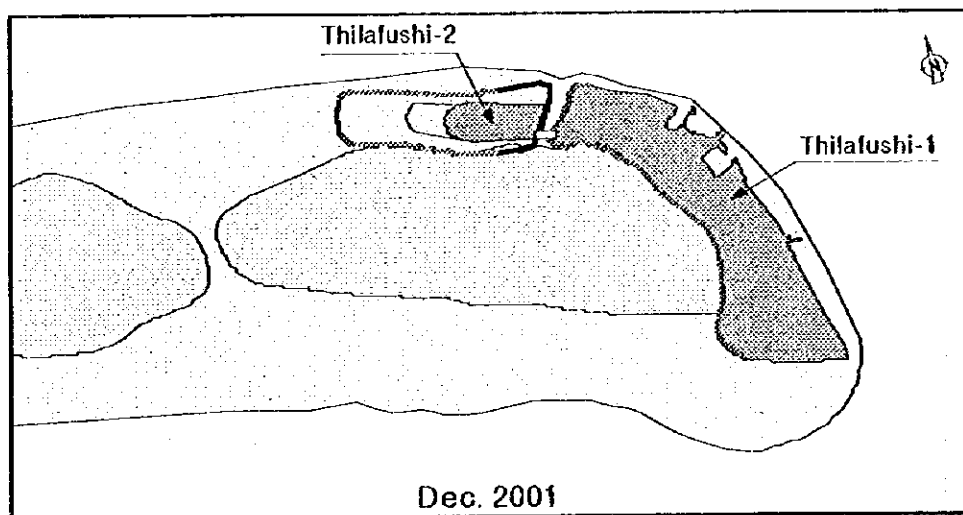
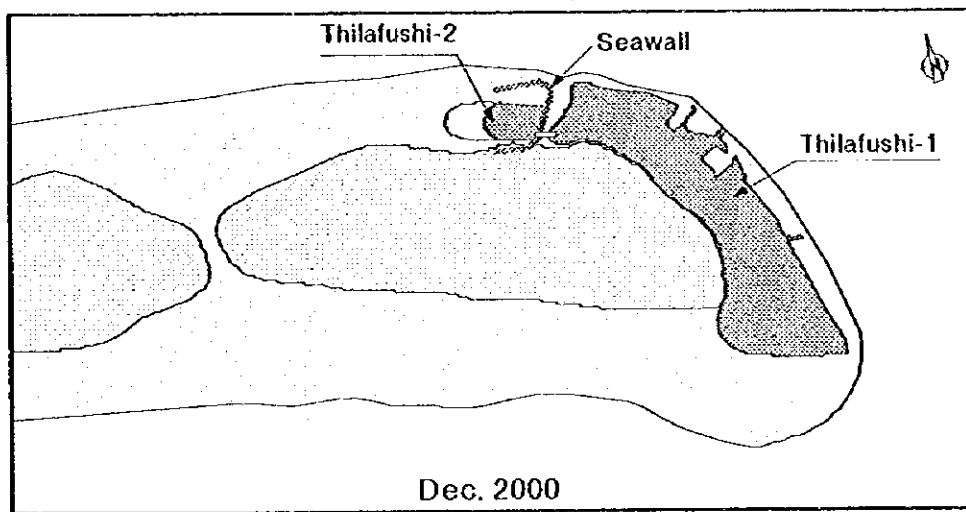
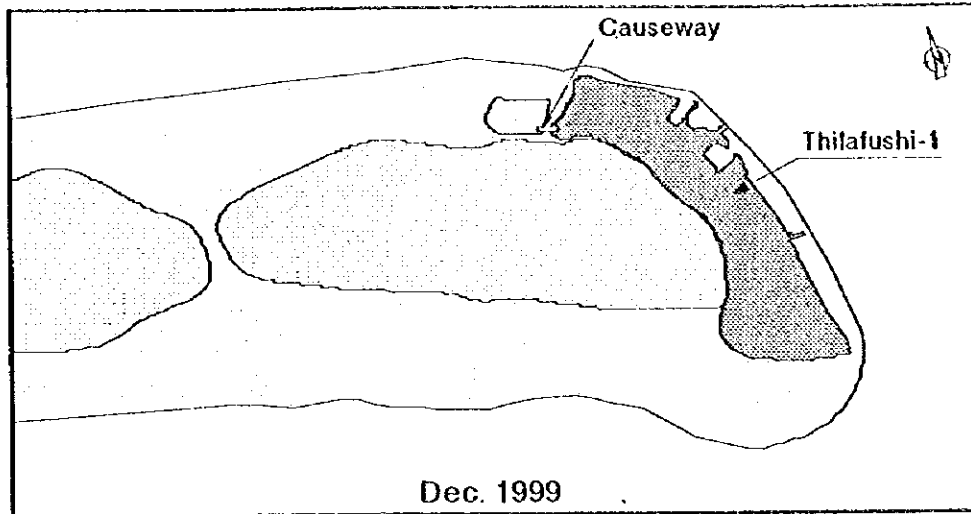


Figure 6-8. Seawall Construction and Filling Schedule (1)

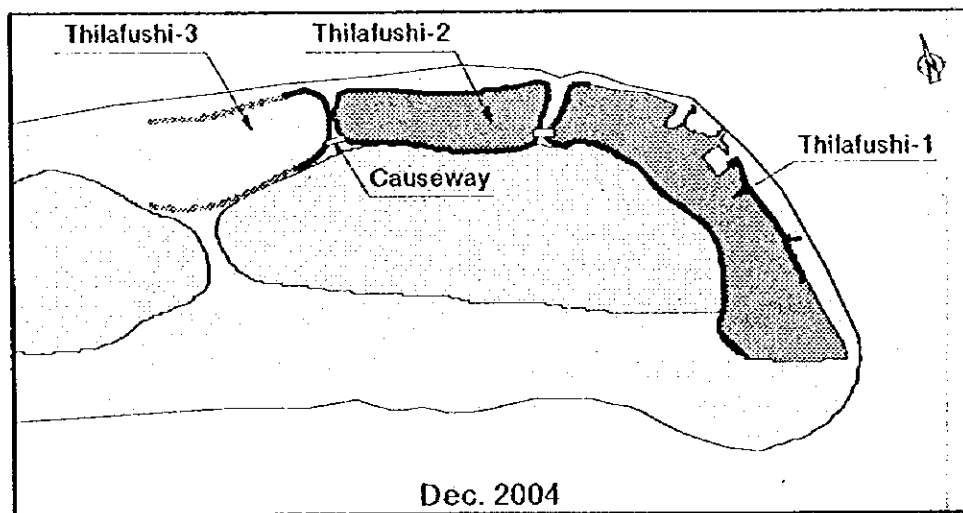
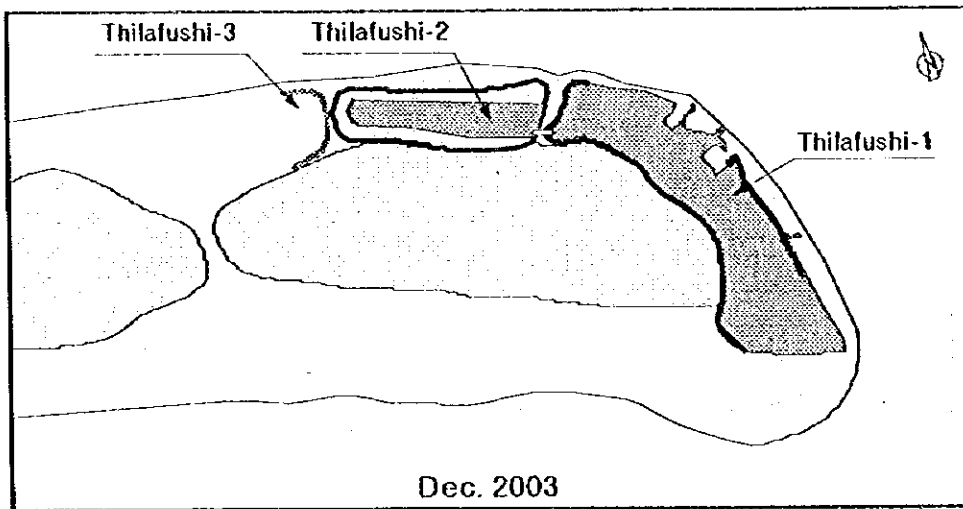
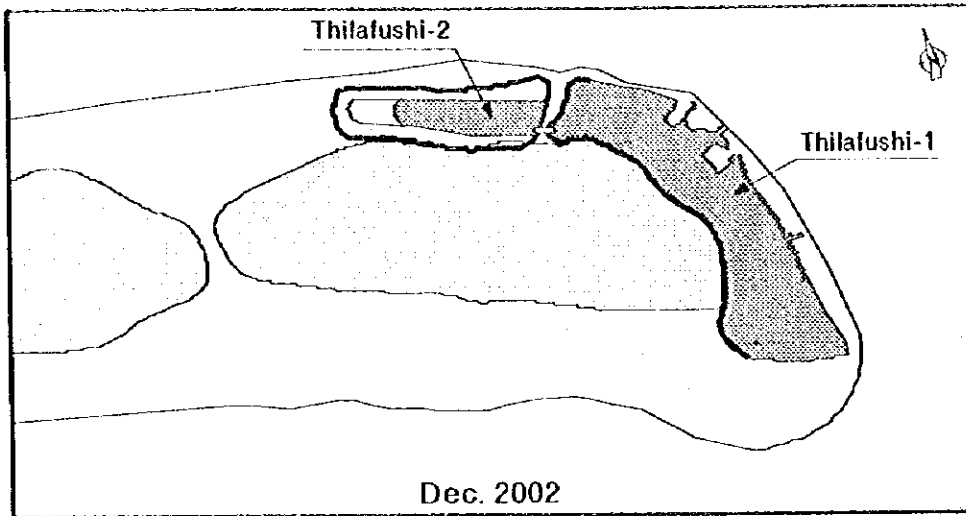


Figure 6-8 Seawall Construction and Filling Schedule (2)

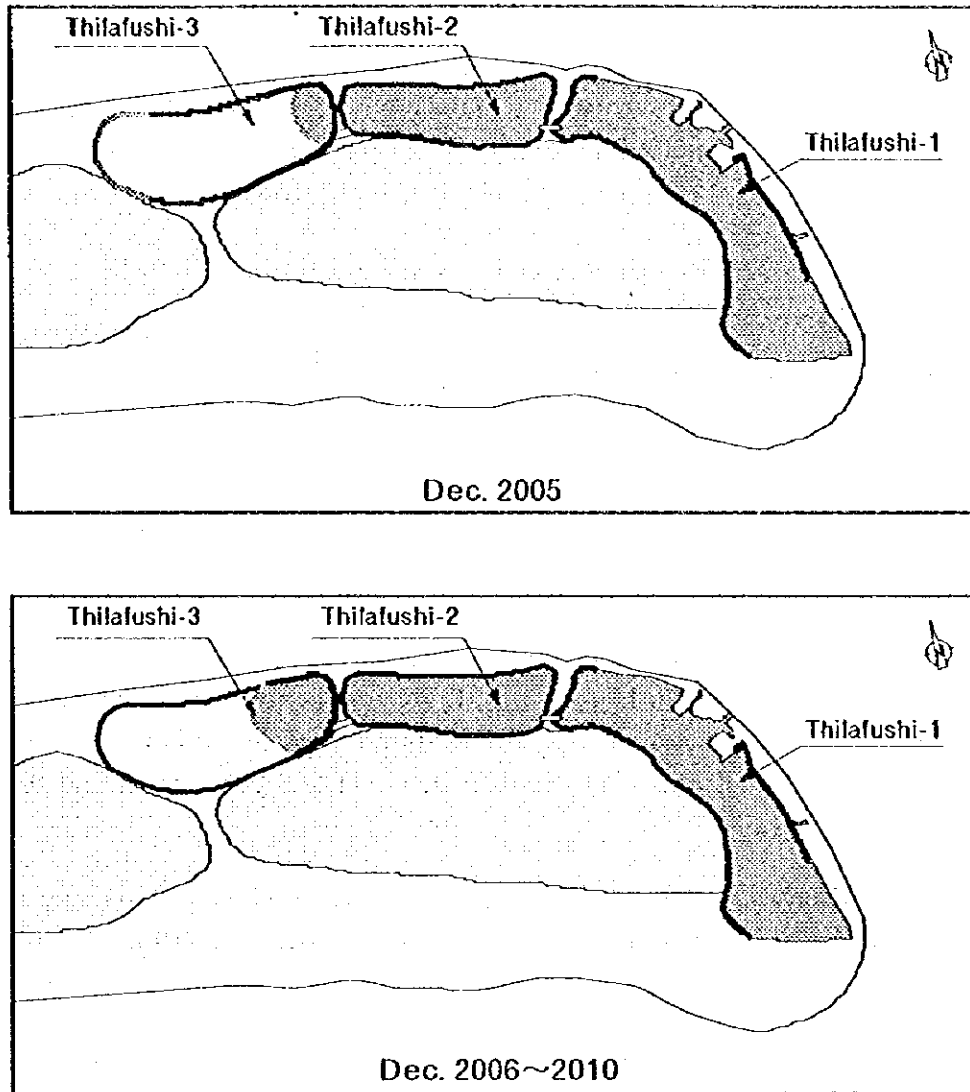


Figure 6-8 Seawall Construction and Filling Schedule (3)

c. Capacity of New Landfill Site

Forecast of solid waste volume from 1998 to 2010 can be obtained from the Table 6-33. Considering the fact that construction waste can be re-utilized for the construction of seawalls or other construction works and the coral mining material costs at about US\$ 30 in Male', it is recommended to stockpile such waste and to be re-used. In calculating the required area for solid waste filling on new Thilafushi from 1999 to 2010, volume for construction waste is included 40% of it. The total required area is obtained in the Table 6-32.

Table 6-32 Required Area for New Landfill in Thilafushi

	Amount (tons)	Amount except construction waste 60% (tons)	Volume except construction waste (60%) (m ³)	Required Area (m ²)
1999-2003	410,990	328,000	402,000	105,000
2004-2010	767,595	629,000	786,000	180,000
Total	1,178,585	957,000	1,188,000	285,000

Note *: Recommended effective filling depth (D) of solid waste: 3.5 m as indicated in Figure 10.

The Government of Maldives started the solid waste dumping from the eastern north corner of Thilafushi reef in 1991. According to topographic survey map indicated in Table 6-7, reclaimed volume of present Thilafushi island from 1991 to July 1998 is estimated at approximately 141,000 cubic meter and the total area is about 12 ha.

Proposed layout of new island to cover required area up to 2003 and 2010 is indicated in Table 6-8. Total length of seawall will be 1,710 m for 2003 and 2,100 m for 2010.

Typical section of the seawalls for new islands is indicated in Table 6-9.

Table 6-33. Forecast of Solid Waste Volume

Year	Amount of Solid Waste in Male'						Domestic Waste in Villingii	Domestic Waste from Resort Islands	Domestic Waste from Nearby Islands	Domestic Waste from Airport	Total Amount per day	Total Amount per day excluding construction waste(60%)	Annual Amount excluding construction waste (60%)	Annual Amount excluding construction waste (60%)	Annual Amount excluding construction waste(60%) after Filling	Accumulated Amount
	Domestic Waste	Commercial Waste	Business & Industrial Waste	Construction Waste	Sub Total in Male'	F										
	t/day	t/day	t/day	t/day	t/day	t/day	t/day	t/day	t/day	t/day	t/d	t/d	t/year	t/year	cu.m	cu.m
1998	48.2	20.5	36.2	68.8	173.7	1.1	19.2	0.2	2.8	197	156	71,905	56,838	68,931		
1999	51	22	37	71	181.0	1	19.8	0.3	3	205	163	74,862	59,313	72,115	72,115	
2000	54	23	38	73	188.0	2	21	0.3	3.3	215	171	78,329	62,342	76,092	148,207	
2001	57	24	40	75	196.0	2	22.5	0.3	3.5	224	179	81,870	65,445	80,058	228,265	
2002	61	26	41	78	206.0	2	24.1	0.3	3.7	236	189	86,177	69,095	84,805	313,070	
2003	64	27	42	80	213.0	3	25.7	0.3	4	246	198	89,790	72,270	88,990	402,061	
2004	70	30	44	83	226.0	3	27.4	0.4	4.3	261	211	95,302	77,125	95,863	497,924	
2005	74	32	45	85	235.9	4	29.1	0.4	4.5	274	223	99,974	81,359	101,092	599,016	
2006	78	33	46	88	245.8	4	30.9	0.4	4.8	286	233	104,354	85,082	105,473	704,489	
2007	83	35	48	90	256.1	5	32.8	0.4	5.1	299	245	109,281	89,571	111,786	816,275	
2008	88	37	49	93	266.7	6	34.8	0.4	5.4	313	258	114,355	93,988	117,836	954,110	
2009	92	39	50	96	277.7	7	36.8	0.5	5.7	328	270	119,611	98,587	123,416	1,057,527	
2010	98	42	52	98	289.0	8	38.9	0.5	6	342	284	124,976	103,514	130,876	1,188,402	
Total Amount (1999-2010)											1,178,877					

$\alpha_1 = 0.7$: Unit weight / for Filled Domestic Waste (ton / cu.m)
 $\alpha_2 = 0.7$: Unit weight / for Filled Commercial Waste (ton / cu.m)
 $\alpha_3 = 0.9$: Unit weight / for Filled Business and Industrial Waste (ton / cu.m)
 $\alpha_4 = 1.6$: Unit weight / for Filled Construction Waste (ton / cu.m)
 $O = (A+F+G+H+I) / \alpha_1 + B / \alpha_2 + C / \alpha_3$
 Construction Wast. 40%

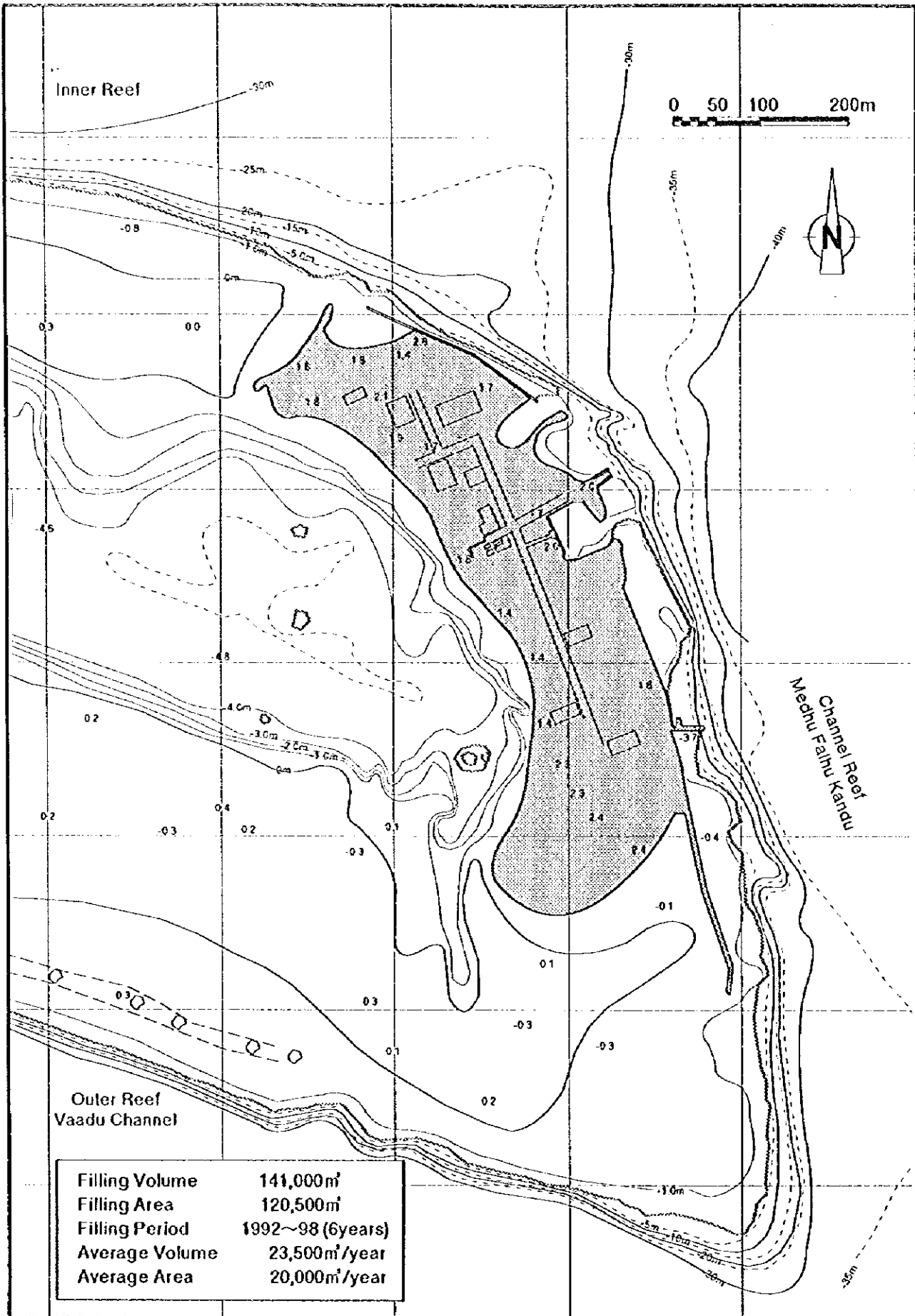


Figure 6-9 Existing Thilafushi (-I) Island

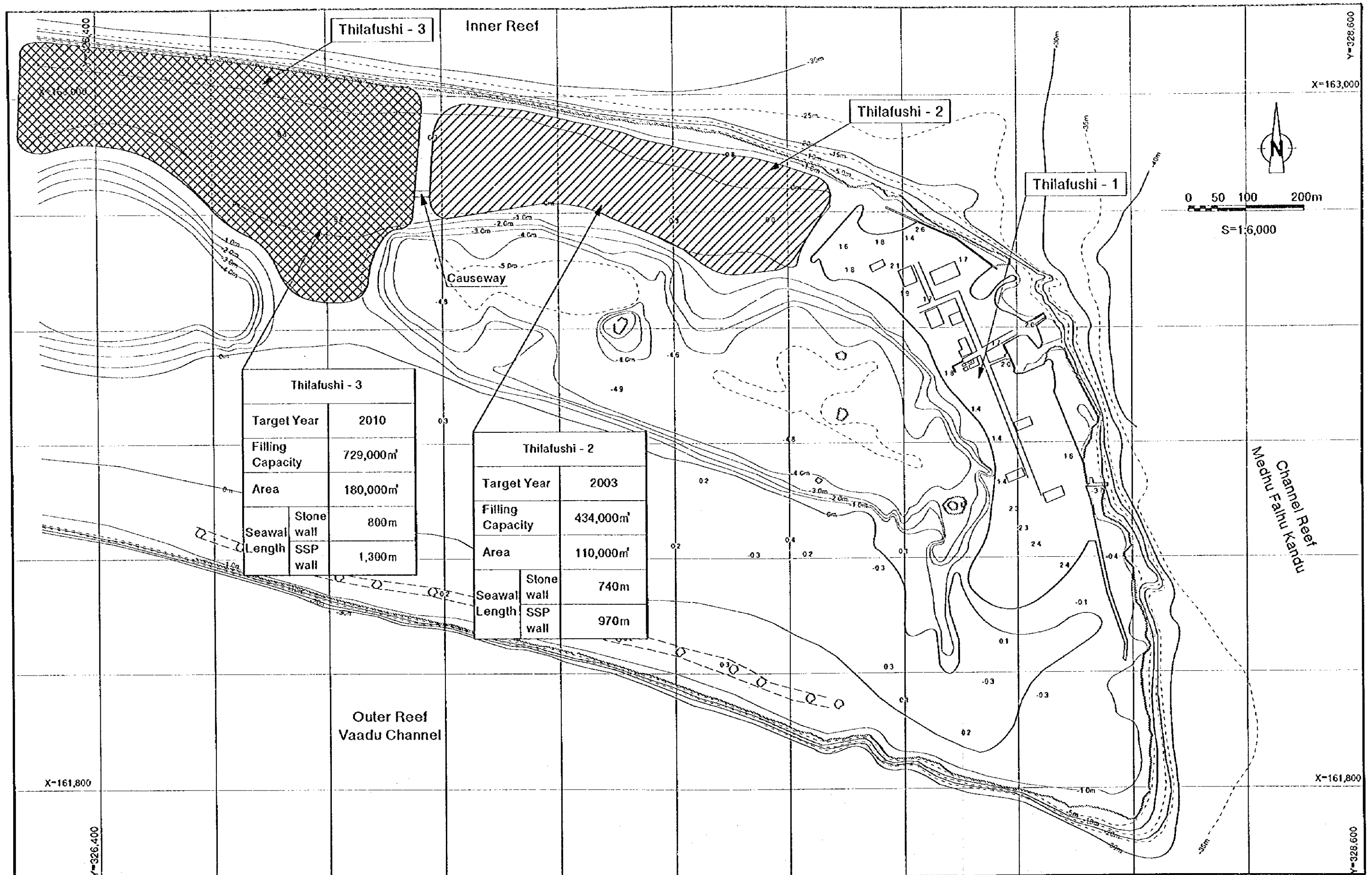


Figure 6-10. Proposed Layout New Thilafushi Island (2003 and 2010)

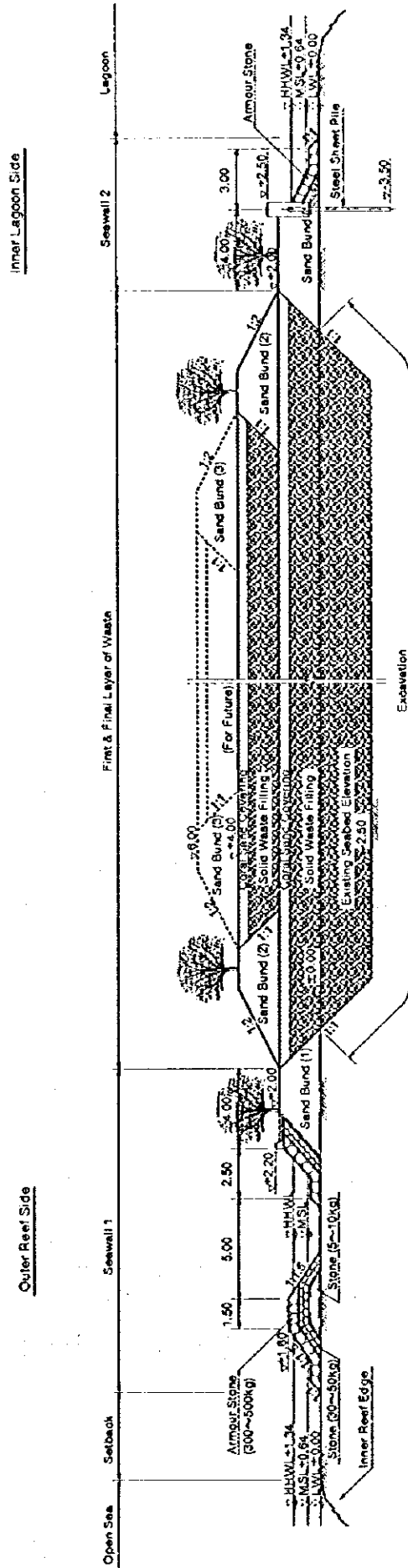


Figure 6-11. Section of Proposed Seawalls and Waste Filling Plan

(3) Improvement of Existing Island

According to MCPW, about two thirds of coast line of the existing Thilafushi Island are facing or occupied by the leasing lots as indicated in Figure 6-12, which are all concluded contracts and the tenants have already started operation in some lots. In these areas, it seems difficult to improve the sanitary condition which requires a line of broad and continuous structure along the coast. In some leasing lots, there may happen an overlapping of land between the leased lot and the structure for improvement. This difficulty is originated from too wide landfill area compared with the space of reef flat. There remains very small space outside the island where some coast protection facilities are placed on. So the protection facility should inevitably go inside the island already forms a part of precious land.

Because of this restriction, there is very little option of measure for the improvement of sanitary condition. It is difficult to identify what are the possible measures to be applied to at this moment because the future situation of island can not be forecasted. At least it can be said that the measure will be limited to affect existing business activities in the island at minimum level. Therefore the Study Team proposes to construct new seawalls of a length of 1320 m along the coast excluding STO site, harbor area and slipway area as indicated in Figure 6-12.

Typical type of structure for proposed seawalls to protect shore on the coast of Thilafushi is selected from the alternatives shown in Figure 6-13. Since Type A is most economical one, the Study Team employs this type for the shore protection facilities on the existing Thilafushi Island. In addition, the utilization of the local materials such as coral stone for the Type A should be taken into account for the Short Term Development Plan.

(4) Overall Plan in Thilafushi

Figure 6-14 indicates overall plan of Thilafushi islands. Proposed facilities can be summarized as follows:

Target Year	2003	2010	Total
Seawall Type-A (Stone Wall)	740 m	800 m	1,540 m
Seawall Type-A (Sheet Pile)	970 m	1,300 m	2,270 m
Seawall Type-B	1,320 m	—	1,320 m
Causeway		50 m	50 m

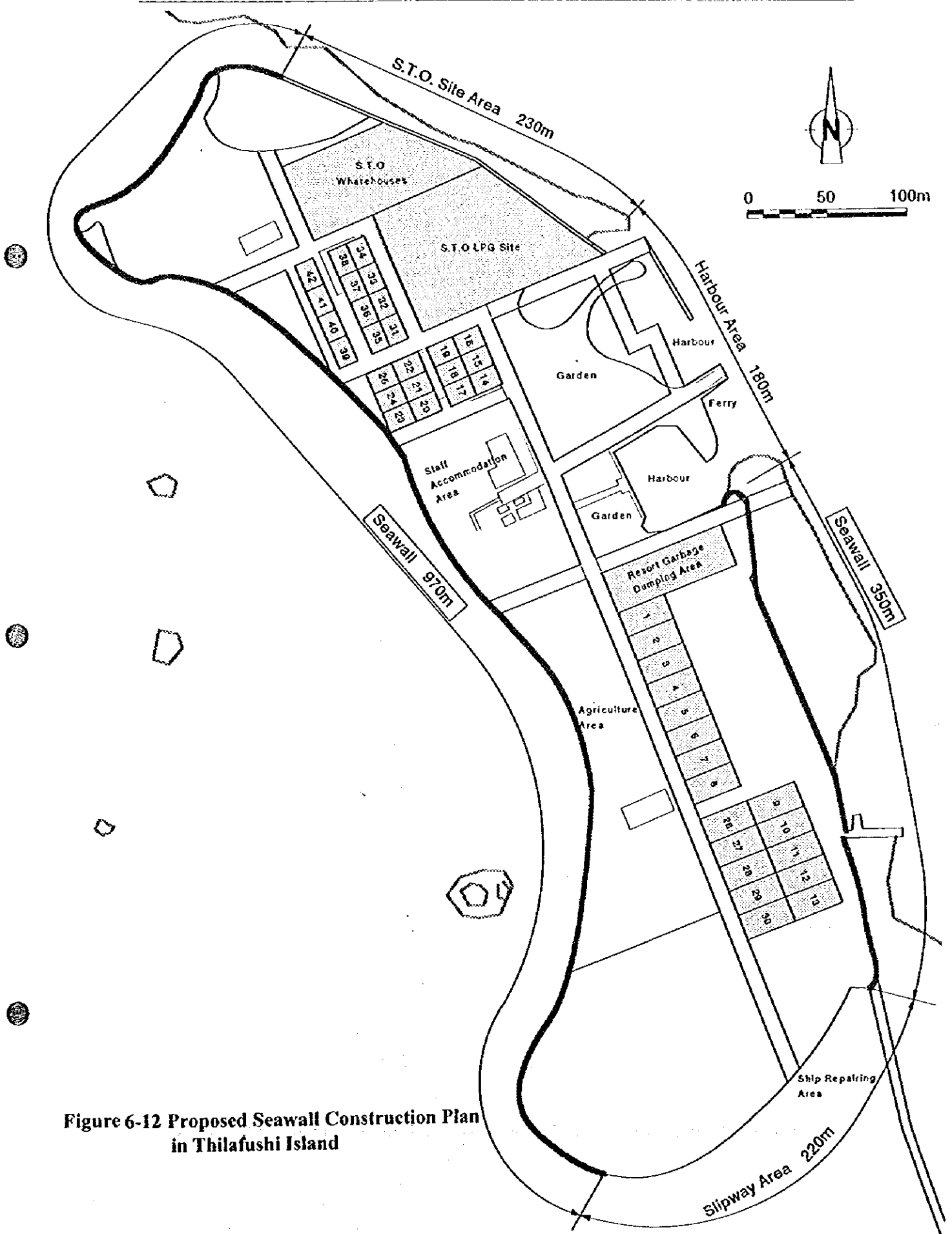
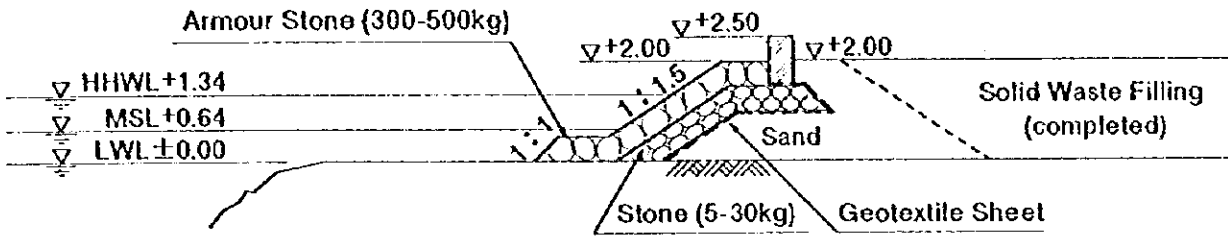
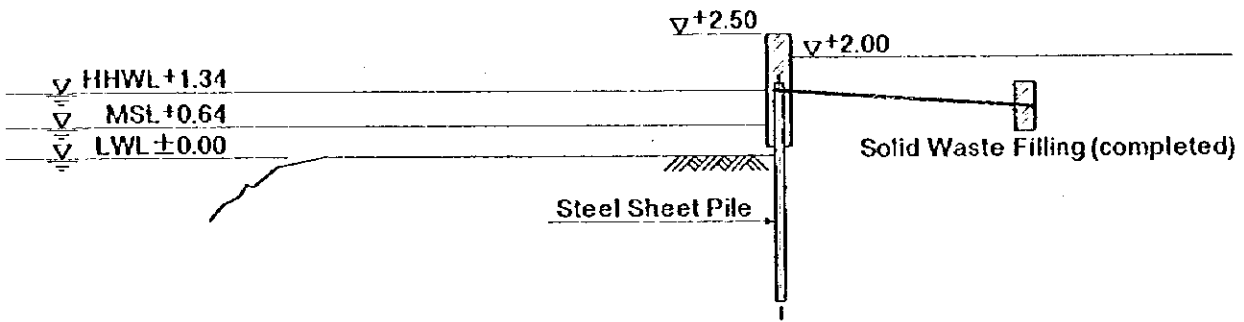


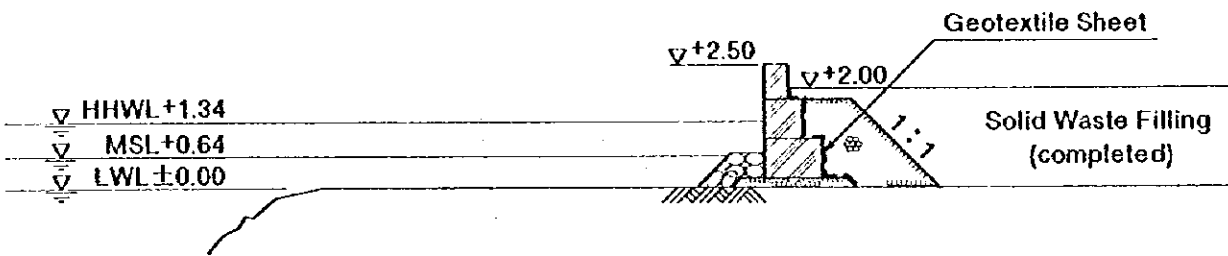
Figure 6-12 Proposed Seawall Construction Plan in Thilafushi Island



Type A : Rubble Stone and Armour Stone Mound Type

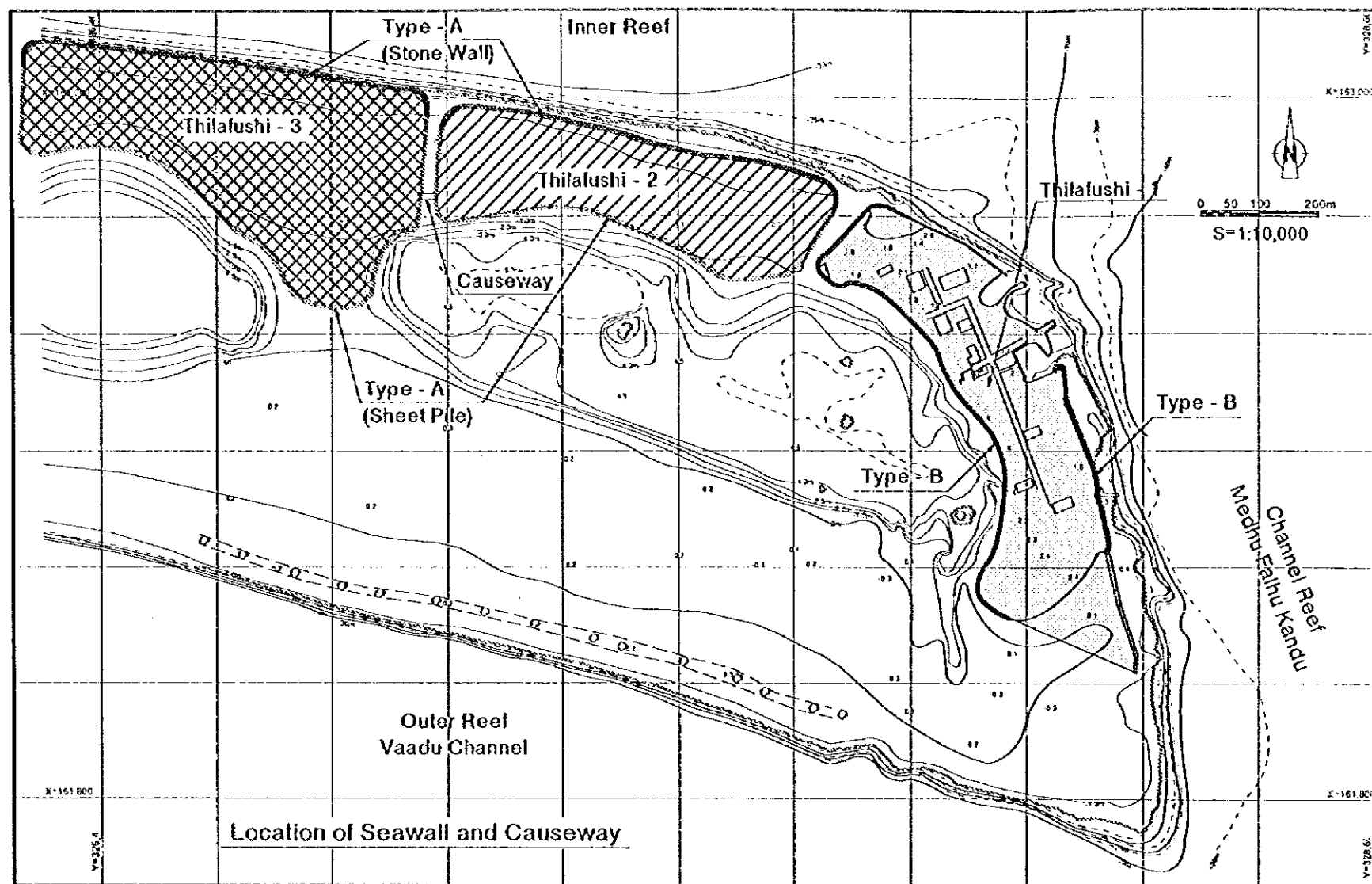


Type B : Steel Sheet Pile Wall Type



Type C : Precast Concrete Block Type

Figure 6-13 Alternative of Seawall for Existing Land filled with Solid Waste



Length of the Proposed Structure (m)

Target Year	Location	Type-A		Type-B	Causeway
		Stone wall	Sheet Pile		
2003	Thilafushi-1	—	—	1,320	—
	Thilafushi-2	740	970	—	50
2010	Thilafushi-3	800	1,300	—	50
	Total	1,540	2,270	1,320	100

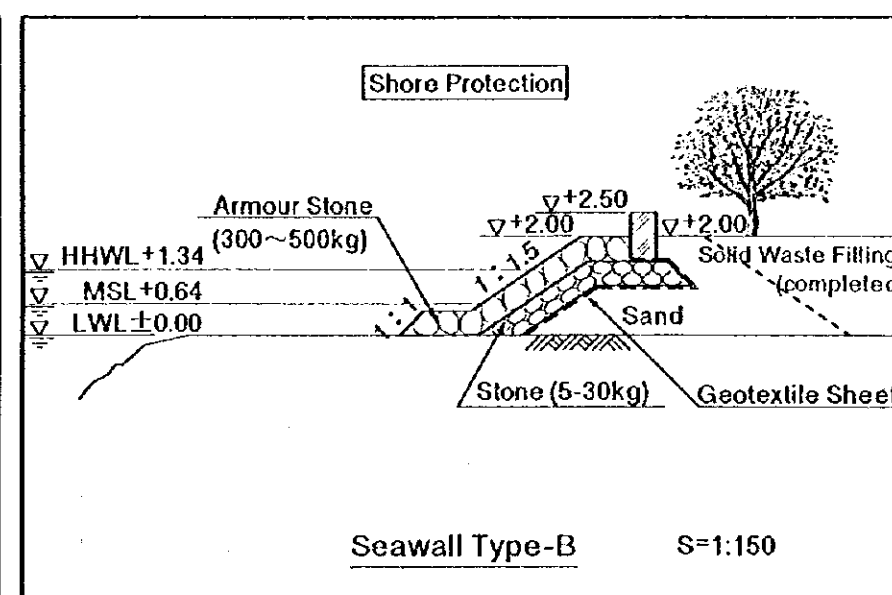
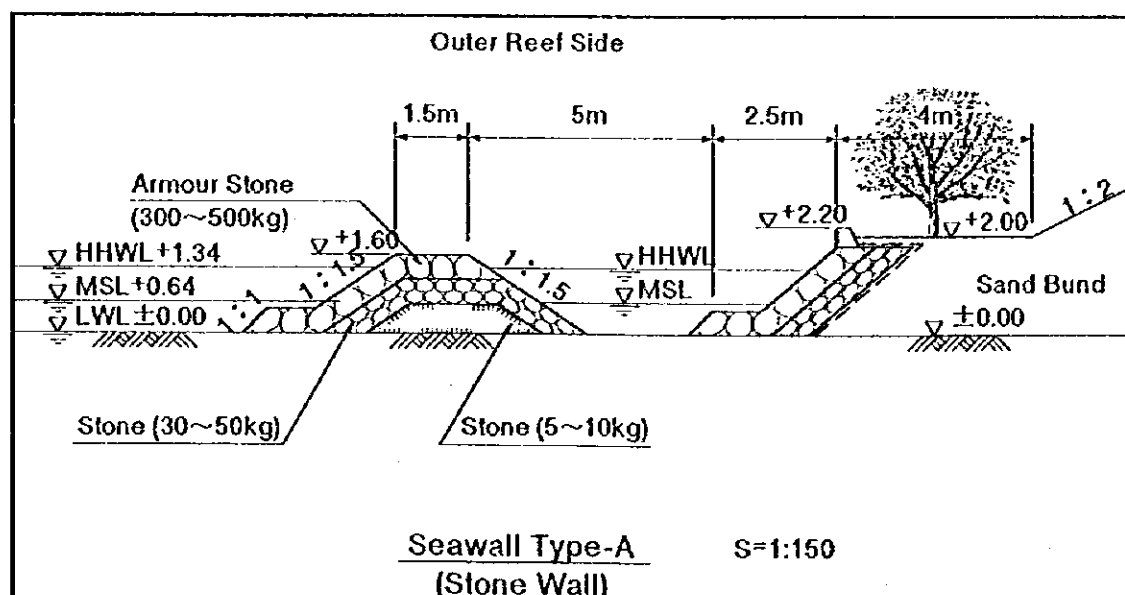
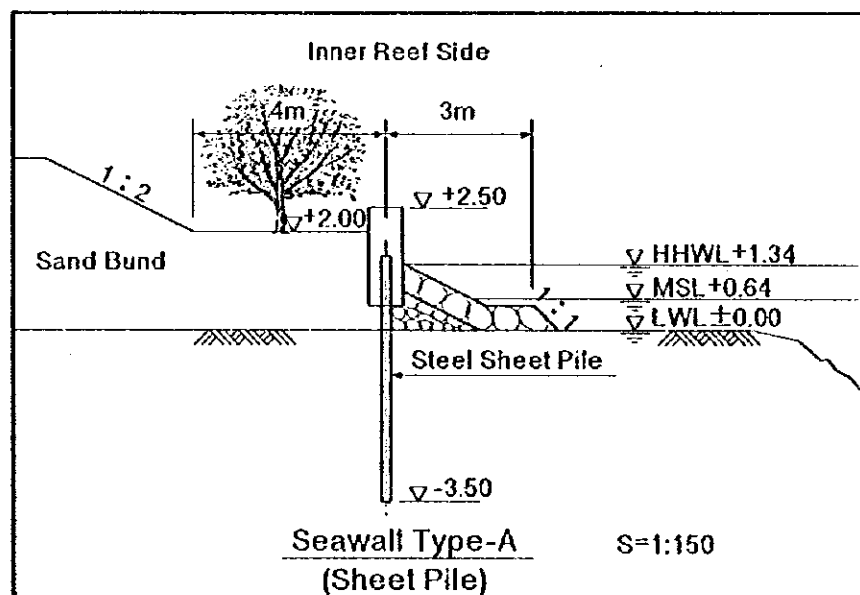
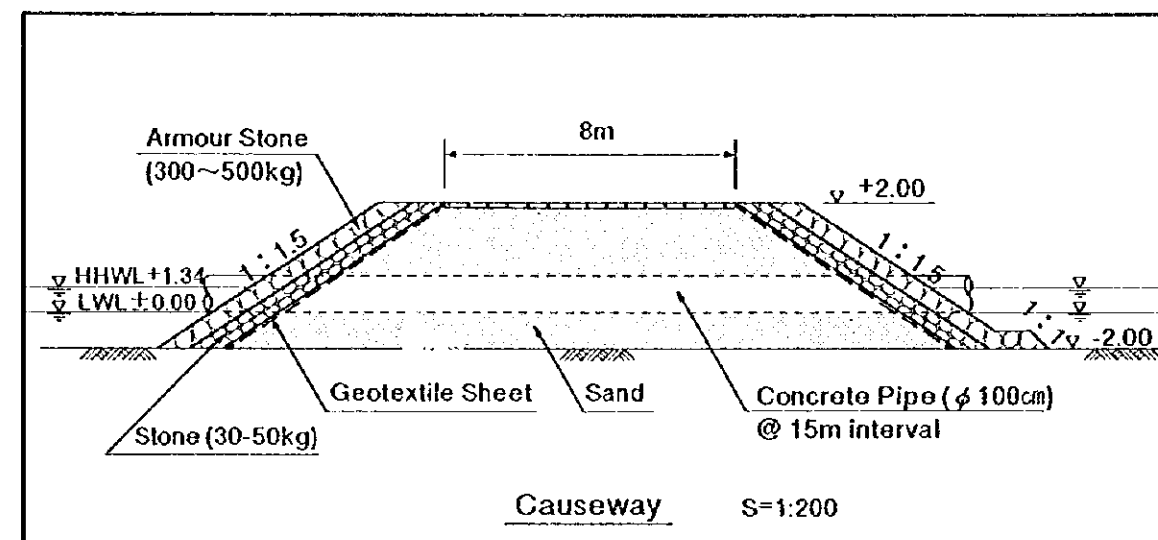


Figure 6-14 Master Plan of Final Disposal Site in Thilafushi 2

6.3.5 Cost Estimate for Project Components

(1) Conditions of Construction in Maldives

In Maldives, local constructors are mainly performing building works and simple civil works, they have very little construction experience for marine and ports works such as small fishing jetty and dredging work by excavator. The large scale marine works are conducted by foreign contractors from Japan, Denmark and New Zealand. Therefore, local contractors could be performed for some aspects of the improvement of transfer stations in Male' and Villingili island.

Local materials are limited to coral sands and rocks, however, these materials are also restricted to gather from new source for the construction in Maldives. These materials which is occurred by the constructions for other purposes, such as dredging work of the port or channel and demolition work of the existing facilities would be allowed to utilize for new construction. Therefore, in this Project, the coral sand and locks occurred by the excavation for the solid waste landfilling in Thilafushi and demolition work would be available.

Small and simple construction equipment, such as small excavator, compactor, small generator, forklift, and simple concrete mixer will be able to lease. The required construction materials and large equipment for this project are almost imported from foreign sources. In Thilafushi island, there is no water for the construction, so the construction water for the project shall be prepared by the contractor.

(2) Basic Assumption for Cost Estimation

1) Unit Price and Exchange Rate

The project costs are estimated based on the unit price as of 1998 and the foreign currency exchange rate of 1US\$ = 11.72 Rf = 130.0 Y.

2) Composition of the Project Cost

The composition of the project cost was composed as schematized below by means of certain percentages of the direct construction cost. The ratio was obtained from the cost estimates for the similar projects, such as the Seawall Construction Project in Male' Island and other construction project in Male' recently completed.

a. Construction Cost (C.C.)

- Direct Construction Cost (D.C.)

Seawall in Thilafushi

Revetment for solid west in Thilafushi

Quay walls in Thilafushi and Villingili

Transfer Station Facilities in Male' and Villingili

Related Utilities

Direct Temporary Construction Cost

- Indirect Construction Cost

Common Temporary Cost (= 10% of C.C)

Site Expenses (= 13% of C.C)

Overhead (= 8% of D.C)

Mobilization cost for materials and equipment is including in the Direct Construction Cost. (including in unit price of the works)

b. Procurement of Equipment

- Equipment Cost on CIF Male' basis (E.C)

- Installation Cost (= 10% of E.C)

- Overhead (= 3.5% of E.C)

c. Engineering Services (BD + DD + SV)

- =8% of Construction Cost (C.C)+ 3% of Procurement (E.C)

d. Physical Contingency

- = 10 % of Construction Cost (C.C)

3) Contingency for Price Escalation

The contingency for the price escalation is not included because it is difficult to predict this with accuracy, especially in the Long - range term, and therefore the price escalation is generally estimated in detail design stage or just before the implementation of the project.

(3) Depreciation Period and Maintenance Cost

1) Depreciation Period

The facilities and equipment of the Project were assumed to be depreciated for a certain period as tabulated below on condition that an appropriate maintenance should be done.

Table 6-34. Life Span of Facilities and Equipment

Facilities/Equipment	Life Span (Year)	Remarks
Seawall/ Revetment	50	Rock / Concrete Type
Quay wall for Ferry	50	Steel Sheet Pile with Concrete
Buildings	35	Work shop, Office, Fence
Pavement of Yard	30	Transfer Station Yard
Collection Car	5~7	Collecting in Male'
Compactor	10	Installation in Transfer Station
Transfer Truck	5	Transfer Station to Thilafushi
Truck Scale	10	Installation in Transfer Station
Container	10	Steel Type

2) Maintenance Cost

Actual maintenance costs for these facilities and equipment have been appropriated on the basis of these actual conditions. However, in this study, it is difficult to assume the conditions. Therefore, the maintenance costs are estimated as a fixed proportion rate of the construction cost and the procurement cost based on the general conditions. The annual maintenance costs for the facilities and equipment is shown in the following table.

Table 6-35. Annual Maintenance Cost Proportion Rate

Facilities / Equipment	Maintenance Cost (Rate)	Remarks
Seawall/ Revetment	0%	Rock / Concrete Type
Quay wall for Ferry	1%	Steel Sheet Pile with Concrete
Buildings	2%	Work shop, Office, Fence
Pavement of Yard	1%	Transfer Station Yard
Collection Car	5%	Collecting in Male'
Compactor	5%	Installation in Transfer Station
Transfer Car	5%	Transfer Station to Thilafushi
Truck Scale	5%	Installation in Transfer Station
Container	5%	Steel Type

(4) Project Cost

Based on the study results, made in the previous sections relevant component costs for the Long Term Development Plan (for 2010) were estimated on the basis of the assumption mentioned on this section. The construction and procurement costs are summarized in Table 6-36, and the breakdown of cost for the facilities are shown in the Supporting Report.

Table 6-36. Summary of the Construction and Procurement Cost

	Items	Cost (1,000MRF)	Cost (1,000US\$)	Remarks
1.	Construction			
1)	Construction of Thilafushi (2)	97,457	8,315	(for 2003)
2)	Construction of Thilafushi (3)	109,505	9,343	(for 2004~2010)
3)	Construction of Existing Thilafushi (Local Rock Type)	11,856	1,012	
4)	Construction in Male'	25,742	2,196	Transfer Station
5)	Construction in Villingili	2,525	215	Rehabilitation
	Sub-Total	247,085	21,081	
6)	Engineering Services	19,767	1,686	{(1)~5)} × 8%
7)	Physical Contingency	24,709	2,108	{(1)~5)} × 10%
	Total (1)	291,561	24,875	
2.	Procurement			
1)	Innovation of Collection System	12,539	1,070	
2)	Enhancement of Transport System	24,489	2,090	
3)	Male' Transfer Station	11,033	941	
4)	Enhancement of Public Space Cleaning			
(1)	Dust Bin in Public park	141	12	
(2)	Port Area Cleaning	616	53	
5)	New Landfill Site in Thilafushi	7267	620	
	Sub Total	56,085	4,786	
6)	Engineering Services	1,680	144	(1)~5)) × 3.0%
	Total (2)	57,765	4,930	
	TOTAL PROJECT COST	349,326	29,805	Total (1) + Total (2)

(5) Project Implementation Schedule

As explained on subsection 6.3.4 Seawall Construction and Filling Schedule, Figure 6-7, the Project shall be taken the solid waste filling schedule into consideration. Based on the project components and the scale of the components, the implementation schedule was described and distributed from 1998 to 2010 which is shown in Figure 6-15.

Figure 6-15 Project Implementation Schedule

Project Component	Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Feasibility Study		█												
Basic and Detail Design			█	█										
Tender				█	█									
Construction of Thilafushi (for 2003)				█	█	█								
Construction of Thilafushi (for 2010)							█	█						
Construction of Male'					█	█								
Construction of Villingili						█								
Procurement for Male'				█	█	█				█				
Procurement for Thilafushi				█	█									
Solid Waste Filling														
(for 2003)			█	█	█	█	█	█	█	█	█	█	█	█
(for 2010)							█	█	█	█	█	█	█	█

6.4 Institutional Arrangement

6.4.1 Waste Reduction and Recycling

(1) Trend of SWM Plan

The world-wide tendency has been requiring the waste reduction and recycling in formulation of the integrated SWM plan in the aspect of environmental conservation, saving of finite resources and lighten the cost burden to the SWM services as a whole.

Island country like the Maldives, possibility for establishing effective waste recycling activities would be low in terms of the size of population and domestic market and disadvantage of transportation cost for trading with overseas markets. However, the Master Plan dare to take this step searching for establishment of appropriate plan and procedures effective in Male' in order to challenge for implementation of the integrated SWM plan.

Development of waste reduction and recycling plans under this section shall be formulated based on the clear understanding of the role of the respective party concerned, planing objectives, planning policies, and strategies to realise consistency of overall SWM planning.

(2) The Role of Each Party Concerned

a. The Role of Each Party Concerned for SWM

Because of involvement of the party concerned, the role of each party shall be defined clearly to formulate the waste recovery/recycling plans; namely,

- ① The Government and the Ministries concerned shall have responsibilities for provision of financial sources, development of technology and legislative set-up;
- ② The local authorities, the implementation agencies including WMS and Male Municipality, shall have be responsibilities for provision of sufficient facilities, regulations and guidance for SWM services; and;
- ③ The waste generators/polluters including residents, enterprises and institutions shall have responsibilities for co-operating with the local authority on the method of waste discharge and bear for the charges.

Especially, the roles of Male Municipality and WMS are the most important and defined in detail the following section accordingly.

b. The Role of Male Municipality and WMS in Operation of Waste Reduction and Recycling Systems

The role and responsibility of each party shall be clarified by the legislative measures to establish effective SWM system for Male'.

Under the legislation, the Male Municipality shall have responsibilities for public campaign and education, encouragement, assistance, co-ordination to form a link between the community based groups and waste recycling activity groups. Implementation of the programs by the community groups, PTA of schools, the youth groups, mosques, etc., will be the most effective and practical means.

MCPW shall have responsibility to formulate national policy and planning, legislation and setting standards concerning the waste reduction, recovery and recycling plans and give guidance to the Male Municipality for implementation of the plans and programs. MCPW is responsible for the implementation of overall waste reduction and recycling plans as part of the national plan. The plan is envisaged to promote, encourage, assist, subsidise, regulate, control and give guidance to all the parties involved in operation of the plans and programs including promotion of foreign makers, recycling industries, investors, buyers, exporters, etc. related with manufacturing and circulation of consumer products and recycling of recovered materials.

Based on the basic role of each party defined, the objectives, planning policy and strategy on waste reduction, recovery and recycling plans are formulated in the following section.

(3) Objective, Planning Policy and Strategy

a. Objective

The objective of the Waste Reduction Plan is to lighten the cost burden and minimising pollution loading to the environment.

The objective of the Recycling Plan is to save finite resources and energy and minimise the landfill space as a result.

b. Planning Policy

- ① The Waste Reduction Plan shall be implemented by performing the role of Government, MCPW, Male Municipality, the beneficiaries/ polluters, importers, and overseas manufacturers; and

- ② The Waste Recycling Plan shall be implemented by promotion, encouragement and assistance of the community groups, interesting parties and the recycling industries

c. Planning Strategy

- ① Male' Municipality shall have the primary responsibilities for operation, promotion, guidance and education to all the waste generators including residents, shops, business establishments, institutions, etc. for Waste Reduction Plan;
- ② WMS shall have the primary responsibilities for promotion, encouragement, guidance and assistance to the community groups, enterprises, recycling industries, etc. for organising and operating the Waste Recycling Plan;
- ③ Waste reduction shall be targeted to domestic, commercial and business, industrial and institutional wastes;
- ④ Initial solid waste recycling shall be implemented for the recyclable materials carried-in to the Transfer Station,
- ⑤ Special Task Team shall carry out the study for introduction of applicable recycling technologies and marketing of the recycled products;
- ⑥ Composting of food waste and saw dust shall be carried out by the appropriate technology and the scale of the facilities for Male'

(4) Waste Reduction and Recovery/Recycling Plans

To implement the trying programs so called the waste generation source management, the more practical and promising methods are proposed in the followings.

a. Generation Source Control

Waste generation control shall be focused on the flow of consumable goods from the activities of production, distribution, sale and consumption to restrict and reduce the waste generation potential in each process.

b. Waste Discharge Control

Waste discharge control shall be practised to encourage self-disposal, reuse of broken equipment after repair, exchange or sale of second hand goods to recover reusable materials at the waste generation sources to reduce the solid waste amount to be collected and disposed.

c. Recovery/Recycling of Materials

Recovery of resources and recycling shall be conducted to store separately the recyclable materials at the Transfer Station. Raising awareness and participation of the society shall be promoted. For the practical operation,

encouragement of the reusable goods bazaars at schools and the activities of the junk dealers will be effective in the initial stage. Pilot plant for food waste-saw dust composting will be also effective after securing the sales routes.

d. Implementation of Plan and Programs

The proposed plan and programs shall be carried out under the co-operation between the Government /MCPW /Male Municipality and society/ residents/ enterprises through legislative measures, public campaign, raising awareness appealing to change the previous habit of the method of waste discharge. The scheme flow was summarised in Figure 6-16.

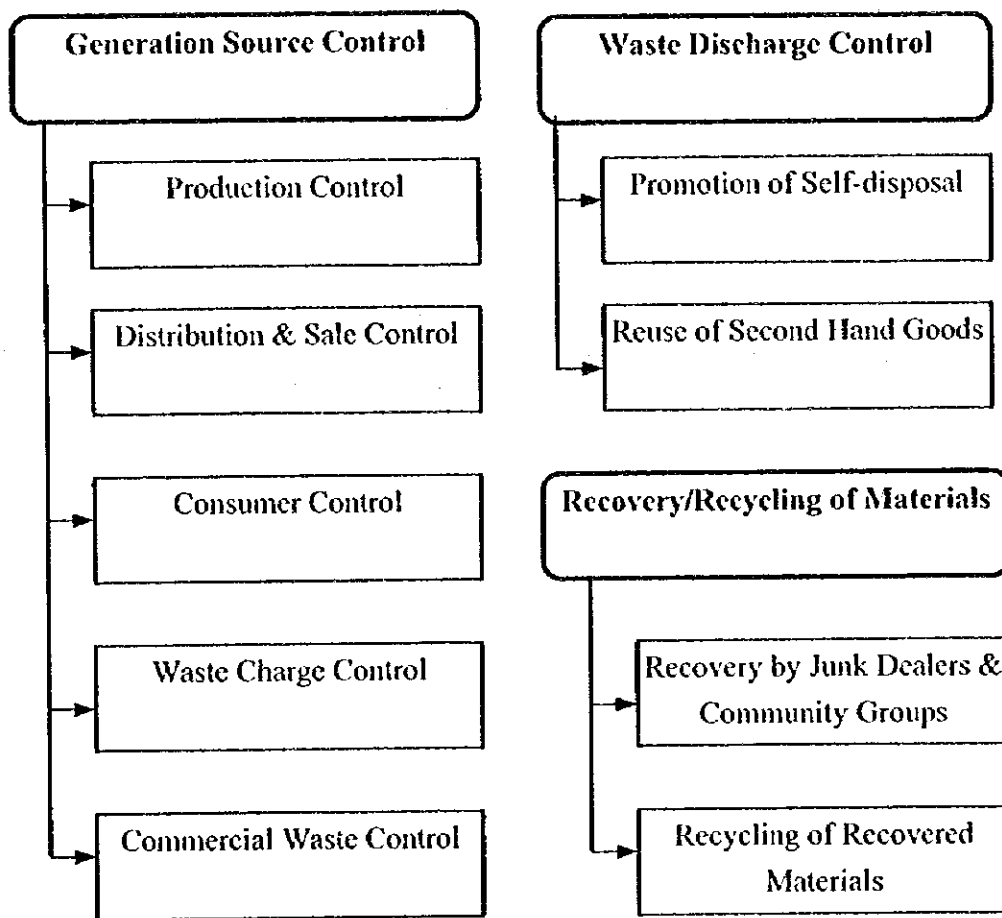


Figure 6-16. Operation Flow of Waste Reduction and Recycling Plans

(5) Establishment of the Special Task Team

A Special Task Team (STT) shall be organised in Male Municipality by recruiting the member of WMS. Male Municipality as the implementing agency to study, develop, organise, assist, and carry out the plan and programs to enable the Waste Reduction and Recovery/Recycling systems operated properly as intended within the time frame.

(6) Proposed Target Levels and Prospects

a. Proposed Target Level

The expectable target level of waste reduction at sources is proposed to realise the ratio of 5 % by 2005 and 10 % by 2010 in terms of the ratio to the total waste generation amount in Male' by weight.

The expectable target level of materials recovery and/or waste recycling is proposed at 5% in total for domestic, commercial and other business wastes and 80 % for construction wastes by 2010 or approximately 30 % of the total amount in average. The target ratio includes the amount of concrete debris and sand recovered for disposal operation at Thilafushi.

b. Estimated Amount of Waste Reduction and Recycling

The expectable waste reduction and materials recovery & waste recycling was estimated at the daily amount of 18.9 tons and 72.3 ton for the amount of waste reduction and materials recovery & recycling respectively. However it shall be noted that the most of the amount is concrete debris and sand recovered for construction of landfill site and for covering soil. Table 6-37 shows the details of the expectable amount of the Waste Reduction Recovery and Recycling Plans.

Table 6-37. Expected Amount of Waste Reduction and Recovery/Recycling (2010)

Waste Categories	Domestic & Commercial Wastes		Business & Industrial Wastes		Construction Waste		Total	
	Weight (t)	Ratio (%)	Weight (t)	Ratio (%)	Weight (t)	Ratio (%)	Weight (t)	Ratio (%)
1) Waste Generation Amount								
Total Organic Waste	109.6	80.0	46.5	90.0	19.5	19.8	175.6	61.8
Total In-organic Waste	27.1	19.8	5.1	9.8	78.6	80.0	110.8	38.0
Total Hazardous Waste	0.3	0.2	0.1	0.2	0.2	0.2	0.6	0.2
Total Weight (ton)	137.0	100.0	51.7	100.0	98.2	100.0	286.9	100
Total Waste Volume (m ³)	646.3		324.6		89.0		1,059.8	
Bulk Density (ton/m ³)	0.212		0.159		1.104		0.271	
2) Waste Reduction Amount	Target	10%	Target	10%	Not applicable for construction wastes			
Total Organic Waste	11.0	80.0	4.6	90.0			15.6	82.7
Total In-organic Waste	2.7	19.8	0.5	9.8			3.2	17.1
Total Hazardous Waste	0.03	0.2	0.01	0.2			0.04	0.2
Total Weight (ton)	13.7	100.0	5.2	100.0			18.9	100.0
3) Waste Discharge Amount								
Total Organic Waste	98.7	80.0	41.8	90.0	19.5	19.8	160.0	59.7
Total In-organic Waste	24.4	19.8	4.6	9.8	78.6	80	107.6	40.1
Total Hazardous Waste	0.2	0.2	0.1	0.2	0.2	0.2	0.5	0.2
Total Weight (ton)	123.3	100.0	46.5	100.0	98.2	100.0	268.1	100.0
Total Waste Volume (m ³)	582		292		89.0		963	
Bulk Density (ton/m ³)	0.212		0.159		1.104		0.278	
4) Waste Recovery Amount	Target	5%	Target	5%	Target 5/ 80%			
Total Organic Waste	4.9	80.2	2.1	90.2	1.0	1.5	8.0	11.1
Total In-organic Waste	1.2	19.8	0.2	9.8	62.9	98.5	64.3	88.9
Total Hazardous Waste	0	0	0	0	0	0	0	0
Total Weight (ton)	6.2	100.0	2.3	100.0	63.8	100.0	72.3	100.0
5) Waste Disposal Amount (Male' & Villingili)								
Total Organic Waste	93.7	80.0	39.8	90.0	18.5	53.7	152.0	56.7
Total In-organic Waste	23.2	19.8	4.3	9.8	15.7	45.7	43.2	16.1
Hazardous Waste Total	0.2	0.2	0.1	0.2	0.2	0.6	0.5	0.2
Total Weight (ton)	117.2	100.0	44.2	100.0	34.4	100.0	195.7	73.0
Total Waste Volume (m ³)	553		278		89		919	
Bulk Density (ton/m ³)	0.212		0.159		1.104		0.213	

Remarks :

Due to utilization of recovered concrete debris & sand for covering material or temporary dike for landfill operation, the total waste disposal amount in Thilafushi amount to 258.6 tons (195.7 + 62.9) in 2010.

(7) Implementation of Waste Reduction and Recovery/Recycling Plans

a. Action Plan and Programs for Waste Reduction

i) Short Term Plan

- ① Special Task Team shall be organised to implement exclusively the Waste Reduction and Recovery/Recycling Plans,
- ② Waste Reduction Plan shall be carried out by means of the "Generation Source Control" and "Waste Discharge Control" through public campaign and education,
- ③ The Generation Source Control shall be commenced with two measures i.e. "Distribution & Sale Control" and "Consumer Control",
- ④ Waste amount reduction shall be realised by means of self-disposal, repair and reuse of broken appliances/instruments, and exchange/sale of second hand goods carried out by the resident supported by the Male Municipality,
- ⑤ Male Municipality shall commence the public campaign and education.

ii) Middle/Long Term Plan

- ① Public campaign shall be made continuously addressed to the residents and business establishments,
- ② The programs of "Production Control", "Waste Charge Control" and "Commercial Waste Control" shall be implemented.

b. Action Plan and Programs for Waste Recovery/Recycling

i) Short Term Plan

- ① Special Task Team shall take actions to collect information, analyse, and study towards formation of waste recovery and recycling in Male',
- ② Recovery/Recycling of materials shall have started with the programs of "Recovery by Junk Dealers",
- ③ Special Task Team shall take proper measures to promote, encourage and support to set up the Buy-back Centre in the compound of Transfer Station in co-operation with WMS,
- ④ Recovery of materials at the Transfer Station shall be made to receive and store separately the wastes carried into the station.
- ⑤ WMS shall start to make use of the recovered concrete debris and sand properly for construction of dikes and for covering soil for disposal operation,
- ⑥ Recyclable materials from the resort islands such as glass bottles, PET bottles, tins & cans shall be separated by the resort islands and stored separately by WMS at the Thilafushi,

- ⑦ Special Task Team in co-operation with WMS shall initiate a pilot scale food waste - saw dust composting and test application of the compost at the Thilafushi.
- ⑧ Male' Municipality shall take proper measures for regular collection and storage of waste dry batteries for safe disposal at Thilafushi in co-operation with WMS,
- ⑨ Special Task Team carry out study on recycling technology after collecting data and information of recovery and recycling activities in the initial stage and formulate the future scheme,
- ⑩ Special Task Team shall take an action to urge, assist and support the interesting investors to play an important role in future development of waste recycling activities,

ii) Middle/Long Term Plan

- ① Special Task Team shall continue the waste recycling and recovery plan based on the result of the study conducted in the previous stage,
- ② Periodic base market for recovered materials shall be opened through the close linkage between Special Task Team and the dealers/ exporters,
- ③ Special Task Team shall promote and assist the investor(s) to develop the Recycling Centre and secure the sale routes,
- ④ The recovery and recycling systems and the activities shall be reviewed by the Special Task Team to increase efficiency and effectiveness for further development of the activities

Figure 6-17 summarize the whole processes of the SWM from waste generation to disposal.

All the details under this section is presented in the Supporting Report E.

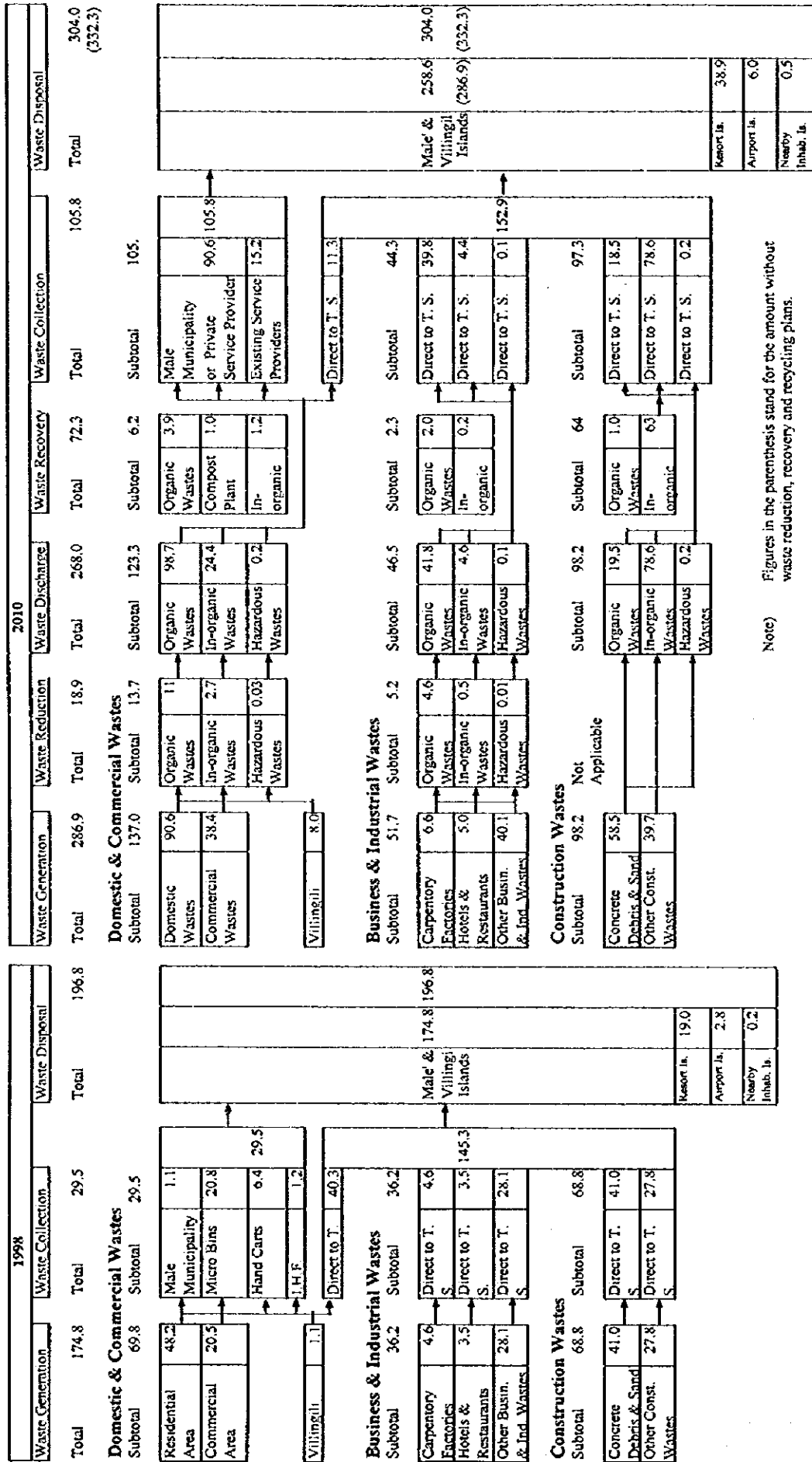


Figure 6-17. Summary of Solid Waste Flow in 1998/2000 (unit : ton / day)

6.4.2 Promotion of Public Awareness and Participation

(1) Findings through the Surveys

The major findings obtained through the Public Awareness Survey and interview survey conducted in connection with execution of the SWM study are summarised as follows:

- ① Almost all of the respondents are co-operative to the Public Awareness Survey and interested in improvement of SWM system,
- ② Housing problem is one of the major concerned of the residents in Male' due to large housing population to accommodate for 14 persons per house in average in addition to small room space,
- ③ Total income of one house reach at 11,152 Rfs per month. Public service charges to the income is comparatively high, i. e. payment for the electricity is about 11 to 15 % while water supply spend about 4 % to the income in average. In addition, the houses receiving waste collection services from the Municipality or private service providers pay 164 Rfs per month in average which is accounted for about 1.5 % to the income,
- ④ Almost all of the house discharge waste every day collected by the Municipality or private operators or carry waste to the near-by micro bins or to the Transfer Station,
- ⑤ More than 80 % of the respondents are interested in waste recovery and recycling plan and wish to participate to the activities as introduced in Male' and 98 % of the respondent agreed to separate wastes as the plan will be implemented in future,
- ⑥ The residents expect of daily collection of kitchen waste and 3 to 4 times collection for other types of wastes. More than 90 % of the respondent agree to pay for the collection services and their replies to the willingness to pay was 149 Rfs per month in average,
- ⑦ Public education for solid waste is conducted occasionally by the Non-formal Education Centre (NFEC) and WMS as one of the subject. NFEC has a weekly radio program for public information including the environmental sanitation and SWM,
- ⑧ Activities of NGOs' were not popular in the Maldives up to these years but their activities have extended to the environmental conservation including solid waste management,
- ⑨ Current operation of SWM services are maintained through the efforts of the top management person having the sole authorities and the directions ordered to the staff. Mandating to the key staff will be able to increase efficiency of daily services.
- ⑩ WMS and/or Male Municipality have not yet implemented regular base public education on SWM although the agencies make announcement to the public through TV and Radio broadcasting as required for operation of the SWM system.

(2) Objective, Planning Policy and Strategy

a. Objective

The objectives of public awareness and participation is to raise awareness of the citizens and all the parties concerned for promoting co-operation to the service provider(s) and direct participation to sustain operation of the improved SWM system(s) in Male'.

b. Planning Policy

The improved SWM system for Male', especially for the waste reduction and recovery/recycling plans and programs, shall be operated and sustained through participation of the citizens and all the parties concerned.

c. Planning Strategy

Raising public awareness shall be made by means of conducting the regular public education to adult and school education to children and students including visiting the operation sites of SWM services. Thorough understanding of the Master Plan among the staff of the implementation agencies will be essential to have a clear idea to which points are important to ask for the co-operation of the society for successful implementation of the plans and programs.

(3) Public Awareness and Education Plan

The plan for raising public awareness is proposed to carry out the educational programs set out in the following 6 programs.

a. Raising Awareness within MCPW/ WMS and Male Municipality

Raising awareness of the implementing agencies, WMS/MCPW and Male Municipality, is a key issue to have effective and efficient operation of the improved SWM system and for its sustainability. It is strongly recommended to study the proposed SWM Master Plan to understand the objectives, policies, strategies and procedures for implementation of the proposed plans and programs to raise their own awareness for the primary responsibilities and the roles for SWM services.

b. Public Announcement of the SWM Master Plan

In the process of studying the proposed Master Plan, it may be required to adjust some part of the plans and programs to enable smooth implementation by taking into consideration of the specific needs and features in the society. Following the modification and decision by the official processes, the outline of the

improved SWM plan shall be announced to the public to urge interest and participation of the citizens and the society.

c. Public Education

Raising public awareness shall be made through public education programs assisted by Non-formal Education Centre (NFEC). The Special Task Team (STT) proposed to set up under the Male Municipality shall prepare the pamphlets and schedule for public education at the public centres, offices, mosques, PTA and any other places wherever convenient for the people gathering. In addition, the public education shall be made through the mass media from time to time. The public education plans and programs is targeted to the adult.

d. School Education

Raising awareness for school children and students shall be made as one of the curriculum for schooling. The Ministry of Education assisted by the STT shall prepare the text for primary schools and for secondary schools. WMS and Male Municipality take a part in school education to invite them for visiting the sites to see the actual field operation of SWM services.

e. Participation to Cleansing of Public Areas and Reduction of Waste

The monthly sea cleaning operation has been implemented as the government project called "Clean Maldives, Independent Maldives". It is proposed to expand and enhance this project in the field of SWM services towards implementation of the Waste Reduction Plan at the generation sources. Participation of more people in the project will be the opportunity for the people to aware the importance of SWM services for protecting public health, the environment and maintaining public cleanliness to keep public spaces aesthetically acceptable for citizens and tourists.

f. Participation to Waste Recycling Activities

The goal of raising public awareness and participation will be reached at successful accomplishment of participation of the people to waste recycling activities and continuous operation of waste reduction at generation sources. The Special Task Team supported by WMS and Male Municipality prepare the plan for waste reduction and recovery of materials, recycling and marketing the recovered materials from the wastes. The plan shall be supported by all the parties concerned, namely the government, SWM service providing enterprises, and the most importantly by the residents.

(4) Implementation of Public Awareness and Education Plan

a. Action Plan and Programs

i) Short Term Plan

- ① "Raising Awareness within WMS and Male Municipality" shall be initiated to organise a committee to study, discuss, adjust or modify and finalise the most appropriate plans and programs for the SWM Master Plan for Male'. The committee members shall be comprised of the government sector, private sector and from academic sector chaired by MCPW. The first committee shall be opened immediately after hand-over of the Master Plan by JICA
- ② "Public Announcement of the SWM Master Plan" shall be made immediately after the approval of the Government. The proposed STT shall prepare the summary of the SWM Master Plan for public announcement in co-operation with the Ministry of Planning, Human Resources and Environment. The announcement shall be made through the mass media and by the pamphlets distributed through the community groups.
- ③ "Public Education" shall be started following to the public announcement of the SWM Master Plan. The Special Task Team and NFEC prepare the contents of public education and schedule for the purpose to educate the residents, commercial and business establishments, institutions and all other waste generators including resort islands operators. Contents of the education shall include the specific requirements asking co-operation to the public for implementation of the SWM Master Plan and the general education of the environmental conservation as well.
- ④ "School Education" shall be carried out continuously every year in accordance with the schooling subjects and schedule prepared by the Ministry of Education in co-operation of the STT. The texts have to be prepared visually to have easy understanding of the contents with key topics for discussion in the homeroom. Also it is recommended to prepare the video programs as a effective tool for school education.
- ⑤ "Participation to Cleansing of Public Areas" shall be implemented in co-ordination with the "Clean Maldives, Independent Maldives" project " to raise awareness of the citizens that participation to the public services is essentially required to keep the country clean.

ii) Middle/Long Term Plan

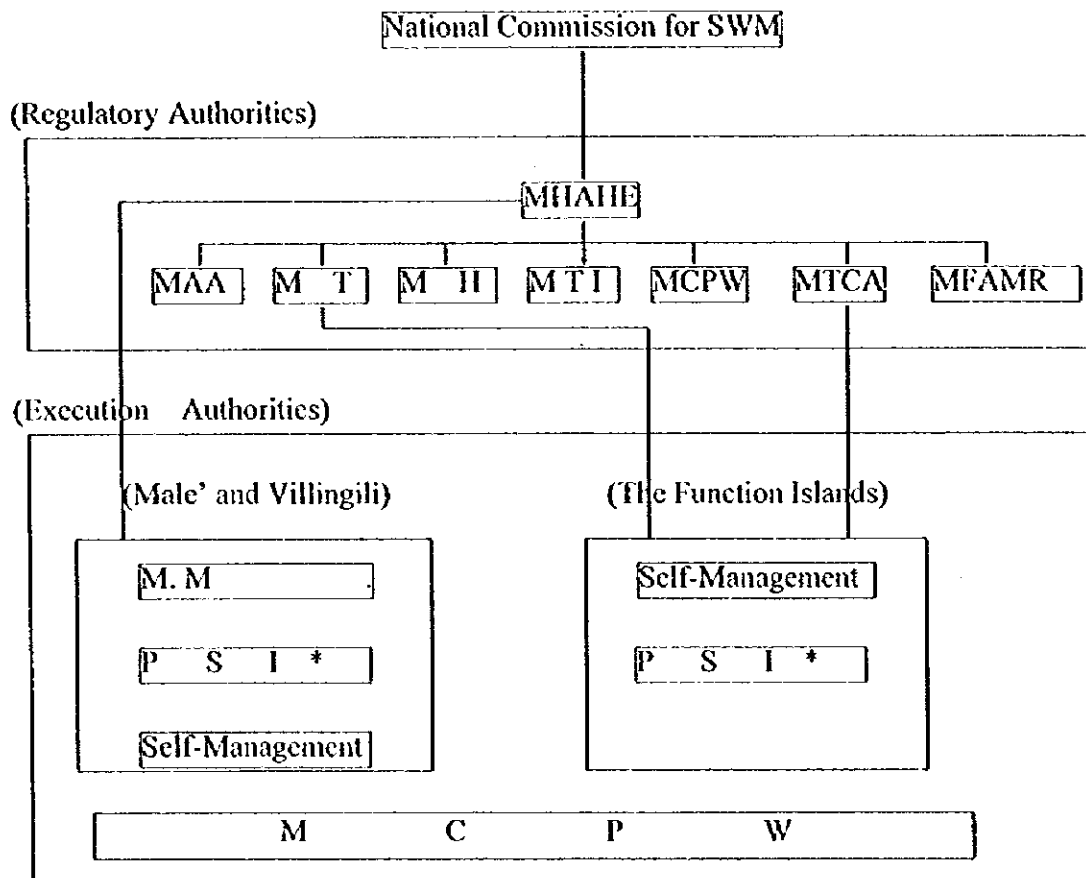
- ① "Participation to Waste Recycling Activities" shall be implemented following to the announcement of MCPW to notify commencement of the Waste Recycling Plan and continuous operation of the Waste Reduction Plan. Prior to implementation of the plan, the Special Task Team shall set up the recycling system including preparation of the materials recovery system, provision of the Buy-back Centre, marketing system involving the government, citizens, enterprises, domestic and foreign dealers to enable sustainable operation of waste recycling activities in Male'.

6.4.3 Effective Management Organization

(1) Demarcation of Tasks among Concerning Bodies

a. Regulatory body

The Institution of SWM of the region shall be as same as that of the whole country.



* Private Sector Involvement

Note; MHAHE (Ministry of Home Affairs, Housing & Environment)

MAA (Ministry of Atolls Administration)

MT (Ministry of Tourism)

MH (Ministry of Health)

MFI (Ministry of Trade & Industries)

MCPW (Ministry of Construction & Public Works)

MTCA (Ministry of Transport & Civil Aviation)

MFAMR (Ministry of Fisheries, Agriculture & Marine Resources)

MM (Male' Municipality)

Figure 6-18. Proposed Organization Chart of SWM in Male' and Vicinity

Although those tasks shall not be limited only in the capital region but also should cover the whole country, those will be allocated to each regulatory body as presented below.

The MPIRE:

Besides taking the responsibility of the secretariat of the proposed National Commission for SWM, with the function as the lead organization of the matters, the MHAHE should perform followings.

- (1) Formation of a comprehensive SWM plan.
- (2) Legislation of the proposed laws such as the National SWM Act of Maldives, the National Waste Management Standard and the National Waste Technical Standard.
- (3) Co-ordination among ministries concerned.
- (4) To provide rules and regulations about hazardous wastes and waste oil disposal
- (6) To provide rules and regulations of construction waste disposal
- (7) Legislation of the Thilafushi SWM regulation

The MT:

The MT will regulate the SWM of the resort islands as used to be.

- (1) The MT should amend current SWM regulation of the Ministry with corresponding to the proposed basic laws.
- (2) Establishment of the prescription regarding the application of waste disposal to Thilafushi especially
- (3) Establishment of the prescription regarding the medical waste disposal being generated from clinics of the resorts

The MH:

The MH should review the waste management rule of the medical waste of hospitals and clinics.

The medical wastes of the clinics in Male' should be carried to the hospitals to be incinerated with their incinerators.

The MTI:

The MTI should mainly establish the rules and regulations on the management of manufacturing product wastes and observe them.

Those mainly are;

- (1) Promotion of recycling and reusing
- (2) Promotion of the reduction of excessive packaging
- (3) Co-operation with the MHAHE in formation of the rules and regulations of the disposal of waste oil, waste batteries and chemical substance wastes.
- (4) Formation of the rules and regulations on the SWM of waste household electric appliances and waste automobiles

The MCPM:

The MCPM should regulate the management of construction waste.

The MCPM has responsibility for supervising and monitoring as to construction waste. The MCPW has to guide the suitable collection and hauling system to the contractors. The contractors have to submit the waste hauling plan before commencement of the construction work.

The MTCA:

The Ministry of Transportation & Civil Aviation should perform followings.

- (1) Formation and observation of the rules and regulations regarding the cleansing of the Male' harbour.
- (2) Formation and observation of the rules and regulations on the throwing away of wastes from ships and boats
- (3) Establishment of the rules and regulations on the SWM of the airport island.

b. Execution Body

Figure 6-20 shows simply the demarcation between the organization concerned. In Male' and Villingili, the demarcation shall be set up between the collection

and disposal of wastes. In those islands 3 way of collection methods, collection by the Male' Municipality, by private sector involvement and by self-disposal shall be afforded. The demarcation in the function islands such as resort islands and the Airport Island shall be set up between transport and final disposal.

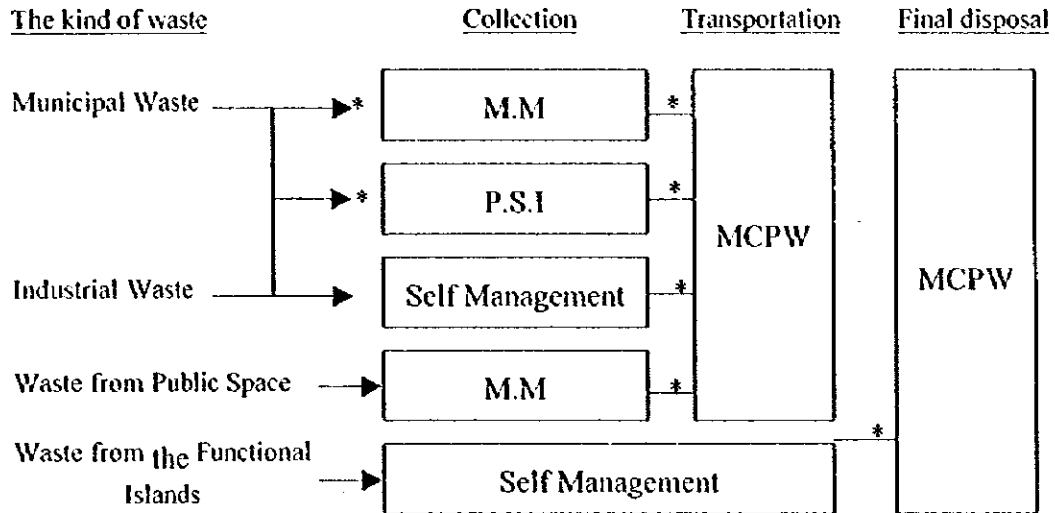


Figure 6-19. Flow of SWM

In this figure, points of (*) marks attached show the points that a transaction on SWM services are carried out, and cause transfer of the management responsibility from customers to suppliers, duties of customers to pay the charges and right of the suppliers to receive the charges.

Matters that shall be changed in existing practice with the proposal are;

(1) Enforcement of the said new collection service to all households in Male';
 The Municipality should be scheduled to carry out new collection service to all households in Male'.

However, this does not mean that the Municipality shall collect all of the wastes discharged from those households. It may be the collection of a minimum level. Therefore, the collection of the wastes other than it will be carried out with the collection by private sector involvement and by self- disposal.

(2) Abolition of the refuse container operation;
 The current practice of collection by the refuse containers should be abolished in accordance with the move to the new collection system.

Matters that the current practices on the WMS of MCPW shall be changed with this proposal are:

(1) Disposal of the medical wastes;

The said wastes shall be incinerated in the hospitals in accordance with the proposal concerned. Therefore MCPW will stop involvement in such waste management at all.

(2) Disposal of waste oil;

The waste oil shall be received by MCPW at the transfer stations and should be incinerated with the incinerator in Thilafushi. The current incineration located inside of the transfer station should be abolished completely.

(3) Composting;

The MCPW shall carry out the composting of wastes in Thilafushi.

c. SWM of Function Islands

In the resort islands, the Airport Island and Thilafushi, the SWM should mainly be carried by the self-disposal in accordance with the proposed laws such as the Basic Act, the National Waste Management Standard, the National Technical Standard and other laws and regulations of the Ministries in charge.

(2) Reinforcement of Function of Concerning Bodies

a. Reinforcement Function of MCPW

Under the new stage, the job of MCPW will require substantial reinforcement on both levels of the management and operation. The biggest factor affected may be the change of practice of the disposal of the wastes that is served at present on free will become on charge. Deskwork and other relating jobs will increase dramatically, to collect fairly the charges of SWM from the clients. Accordingly, MCPW will need to acquire an advanced information data processing capacity besides excellent management and efficient operations.

The new functions proposed by the policy are presented as following.

• **Client management function;**

The entities who will carry wastes to the transfer stations are the Male' Municipality, private sector involvement, enterprises and households. MCPW will fairly impose to and collect from those clients the waste disposal charges. It will need to establish a client management function newly, to carry out this job.

The jobs achieved by this function shall be as follows.

(1) Contract procedure of the said service

(2) Matters relating charges

- Setting up the table of charges
- Collection of the charges
- Cash management of the charges
- Client information management
- Claim counter and Client consultation counter

- Operation of new undertakings;

Three new undertakings proposed will require, as a matter of course, new operation techniques. To carry out those operations, the staffs of the MCPW will be required that they will master the operations practices. For the operation of composting, a special task team shall be organized.

(1) Material recycling

(2) Incineration of waste oil

(3) Composting

- Operation of information processing system;

The data processing is indispensable for the improvement of management and operation. Therefore, the data processing by the computer system should be adopted in the management and operation of the organization. This data processing system will be utilized in the following fields including the improvement of the execution of conventional undertakings. Furthermore, the operation improvement information and environment information regarding the waste disposal undertakings will be able to be accumulated by this data processing system. These matters will be surely availed as a key reliable information for another SWM development projects in the country in the future.

- Client information management system
- Business information management system
- Operation information management system
- Operation cost information management system
- Cash management system and accounting data processing system

- Environment management;

That the WMS of the MCPW should contribute to the improvement of environment is one of the most fundamental rôle among them. Therefore, it is necessary by all means to develop the following functions with regard to environment. An appropriate outsourcing of these jobs, if possible, will be a rational and effective alternative.

- (1) Environment monitoring
- (2) Environment problem solving
- (3) Environment information database

Also, the reinforcement of the conventional functions will be necessary. The reinforcement of the conventional functions proposed will be conducted in the following fields.

- (1) Reinforcement of the truck transport unit
- (2) Reinforcement of the vessels unit
- (3) Reinforcement of conventional functions in Thilafushi

(a) Reinforcement of Management Capacity

• General management

Because of the dramatic increase of additional new jobs, the improvement of the comprehensive management capacity will be necessary.

The director(s) of the organization in charge shall pay attention to the following points to manage well the organization.

First of all, the management resources distribution should be balanced appropriately. Especially the director(s) should avoid excessive investment in plant and equipment as well as excessive employment of personnel. It will be important to take care of the proper capacity utilization of resources.

Secondary, the managers should always examine the priorities among the management themes, and should tackle with more important subjects.

Finally, the management should keep the stance to aim at cost minimizing that will be particularly important goal of the organization. The final disposal that is applied at present on free of charge shall be changed to be on charge under the new order. Therefore director(s) should lead the organization will be able to reduce the level of charges as much as possible, with continuing rationalization efforts.

• Operation management

The advancement of the operation management will be more urgent than the said comprehensive management.

The following three aspects of operation management presented below will be importance among them.

- (1) The staffs should master the key elements such as knowledge, technologies

and skills of the new fields as soon as possible.

(2) To carry out and effective operation. Staffs should particularly continue the systematic efforts that shall bring improvement the efficiency of routine works. To set up operational goal to be achieved to carry out the factor analysis of efficiency improvement performance, a scientific method should be introduced. Efforts should be made to settle the said results into the routine operations.

(3) To improve information data processing capacity, planning capacity and business processing capacity of the organization by use of the computer system.

(b) Organization

The organization of MCPW should be restructured in accordance with the proposed function.

Figure 6-20 is the proposed organization chart of the SWM division.

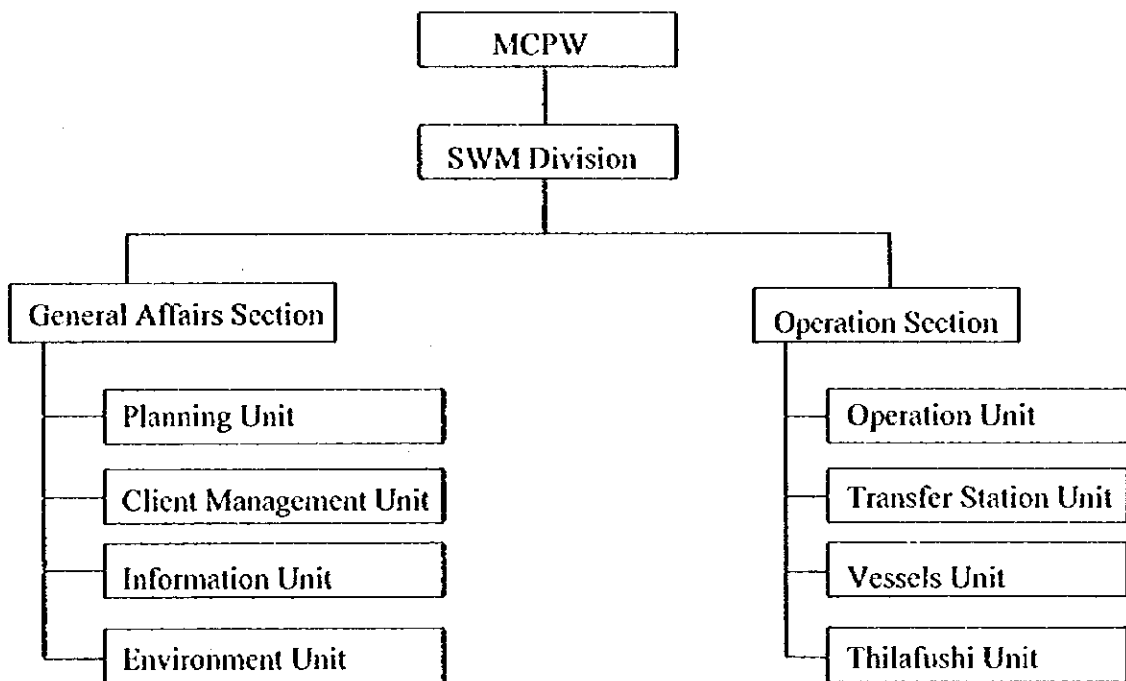


Figure 6-20. Proposed Organization Chart of SWM Division (MCPW)

b. Reinforcement of SWM Organization of Male' Municipality (M. M)

Based on the proposed policy, the Male' Municipality will introduce the proposed new collection system by replacing the existing system, to whole households of Male'. Major work of the Municipality is presented in Table 6-7 of this report.

The job contents of the SWM organization of the Municipality shall be changed to large extent. Reinforcement will be required not only by the change of the collection system accompanied by the expansion of service area but also by the dramatic increase of the numbers of clients.

The reinforcement of the function of the organization concerned shall be provided as following.

- Planning and Publicity function;

Decrease, sorting and other proper discharge of the wastes will become more important subject in the future.

The Male' Municipality should be the most suitable authority among them to play the role to the enlightenment of those. The Municipality should make effort concerning the improvement of this subject thorough the public relations to the citizens continually.

- Function for Regal Provision;

It shall be necessary to legislate a new cleansing and SWM by-law of the Municipality in accordance with the new state of the SWM. This organization should cooperate with the legal unit of the Municipality on the provision of the said matter.

The by-law shall be legislated with the People's Majilis through the proper procedure.

- Client Management function;

To offer the service of the new collection system to the citizen neatly, the Municipality should conclude a contract to all households in the area. It will fairly impose and collect charges on the services assisted by the client management function proposed.

The undertakings that should be achieved by this function shall be as follows.

(1) Waste collection service contracts

(2) setting and collection of the charges

(The charges will be set up properly by the organization for SWM. However, as for the collection of the charges, the cashier of the Municipality will be in charge of collection of the charges as same as the present practice. Therefore, The SWM organization will not take charge of collection of charges and the

cash management of them.)

(3) Client information management

(4) Claim counter and Client consultation counter

• Operation of the Collection System;

By the abolition of the refuse container collection system and start of the new service, the organization shall be restructured.

Smooth operation of the service should be performed with standardization. Service manual and operation manual should be provided to assist improvement of the said services.

The size itself of the organization will become big as a whole. However because of a uniform operation, the organization should consist of units that each of them could operate based on own decision and responsibility of individual unit. Therefore, the reinforcement and development of middle managers will be an urgent task.

• Maintenance function;

The reinforcement of the repair and maintenance capacity will be required by the increase of the application vehicles.

• Cleansing of Public Space;

The cleansing of public space of the Villingili will be succeeded from the Maldives Housing and Urban Development Board. As for the said function and organization, it will be one of the best alternatives that the Municipality will take over those from the Board.

• Operation of the Information Management System;

The data processing is indispensable to the improvement of management and operation. This data processing by the computer system should be adopted. This data processing system will be utilized in the following fields.

(1) Client information management system

(2) Business information management system

- Operation information management system
- SWM cost information management system

• Setting up of a Branch Function in the Villingili

The organization will need to set up necessary functions, in order to carry the cleansing of the public space of the Villingili.

Only the direct operation function will be set in there and indirect functions such as publicity etc., shall be covered by the headquarters of Male'.

(a) Reinforcement of Management Capacity

It is expected that the various problems will arise at the early stage of the new service execution, because the services will expand at once. Particularly in this stage, many difficult cases being required sophisticated judgement will be charged on the higher management. As a person alone could not physically solve problems from beginning to the end, the decentralization of the management power should be introduced, first of all.

Secondary, the director should always examine the priorities among the management theme to tackle with more important subjects.

Finally, the director(s) should keep the stance to aim at cost minimizing that will be particularly important goal of the organization.

The advancement of the operation management will be more urgent than the comprehensive management.

The excellent result that the individual unit shall perform the highest efficiency in operations management should be requested. Therefore, introduction of management theory to give a goal to middle management class shall be recommended.

(b) Organization

The organization for the waste collection of the Municipality should be restructured in accordance with the proposed functions.

Figure 6-21 is the proposed organization chart of SWM division.

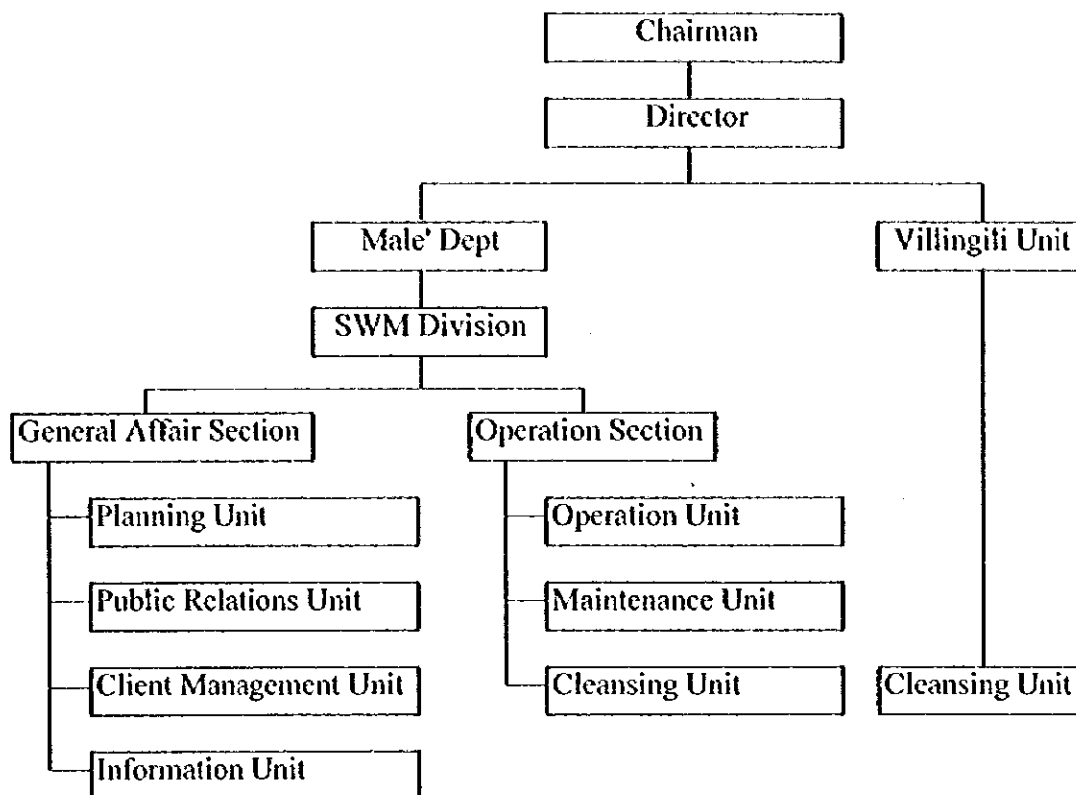


Figure 6-21. Proposed Organization Chart of SWM Division (Male' Municipality)

(c) Privatization of the collection service

Based on the framework of the master plan, another restructuring will be required in the future. The Municipality shall be proposed to start privatization of the collection service from 2004. The full privatization executed by tender of private sector involvement shall be completed in 2007.

Accordingly, as the Municipality will abolish the collection service, the organization for SWM shall have to be reduced to large extent. A large numbers of staffs and labours shall be re-allocated or fired. It will be one option to transfer them to the private sector involvement through buy out of the operation department.

(3) Capacity Building of Staff of Concerning Bodies

Capacity building of staff is a significant subject of those government bodies who undertake practical operation in SWM such as MCPW and Male' City. Most of staff in charge of SWM in the said authorities are foreigners employed on yearly contract basis. Capacity building should cover these foreign workers to secure minimum level of daily operation in SWM. On the other hand, administrative staff, usually assigned Maldivian officials, also need to be trained to manage the operation at a designated efficiency and quality.

To satisfy the necessity of capacity building, a series of operation manual for each process of SWM should be prepared and disseminated to all the workers involved in a specific process. Draft of operation manual will be provided as part of output of feasibility study that follows the master plan in accordance with the recommended measures of treatment. MCPW and Male' City is expected to train their workers with the manual as an essential part of daily operation by themselves.

As for administrative staff, they need to attend some training courses to acquire advanced knowledge related to their responsible field. There are a few graduates in Male' from training courses for SWM in abroad. These educated people can be the instructor for the training course for the administrative staff. Another opportunities to send some selected personnel to training courses offered by international assistance organization or to invite some experts as temporary instructors are also effective way of capacity building.

Both MCPW and Male' City lack a skilled technician of heavy equipment and vehicles. It is difficult for those authorities to create or train this kind of special technician within their routine of SWM. There are two choices to acquire capable maintenance technician, those are:

- ① to hire at special rate from either domestic or foreign sources
- ② to commission a capable maintenance company including technician

Either way may cost higher than to employ the other ordinary workers, however, it is probably worth investing. The cost for expert acquisition can be recovered by the rise of operating rate of expensive equipment.

(4) Private Sector Involvement

a. Method of PSI

Private sector involvement (PSI) may provide a solution to improve the delivery of solid waste services which are either too costly or of poor quality. World-wide experience has demonstrated this. In this context, privatisation should be

considered as a means: to improve the quality of services, to enhance efficiency and reduce cost, and to mobilise private sector capital for capital investment.

Waste collection is an experienced field for private sector and is considered most likely converted to private activity. Meanwhile the proposed option of collection system by private sector imposes entirely unacquainted operation on Male' Municipality.

However, the private companies have not enough capabilities to carry out the SWM services at the present time in Male'. Therefore, the plan of SWM services has to consider under the initiative of the services by Municipality and PCMW.

The solid waste generated in Male' is roughly categorised four kind of waste, i.e. residential, commercial, business and construction waste. The Municipality is responsible to the collection & haulage of residential waste and supervising & monitoring for collection & hauling of all other waste from private waste generation source. And the Municipality make a collection plan to provide a minimum level services for residential waste in whole area. The collection service will cover the almost residential waste that share 46 % of total generated waste except construction waste. The responsibility of collection and transportation of commercial and business waste which share 54 % of the total waste belong to the waste generators. The Municipality will enhance supervision and monitoring of these waste's management.

There are two ways for promotion and introduction of PSI for collection services;

i) PSI for High Quality Services

At the present, the private waste collection companies and the Municipality collect approximately 8.64-ton/day (HIF 1.22-ton/day, Handcart 6.36-ton/day, the Municipality 1.06 ton/day), and collect service charge from the waste generators. The collection coverage ratio of the door to door collection services by the service providers amount to 12.5 % of the total generation amount of municipal waste.

The new waste collection services by Male' Municipality will provide minimum level of services, which was is called by "Vehicle station – go round collection" and the collection, made for the waste carried by the residents. The existing collection service providers will be able to continue and increase the more contracts with the waste generators since the people who discharge waste through the collection service providers still need the high quality door to door services.

ii) PSI for Minimum Level Services

Male' Municipality has the primary duty of SWM in the City, however, this does not necessarily mean that the Municipality has to collect the waste by itself. Hence, it is considered the private companies will not have a budget capability to purchase the collection vehicles to provide minimum level service to whole the collection area in near future.

To purchase required number of vehicles for the minimum level services would not be difficult for the government organisation due to larger scale of financial ability comparing with private sectors. This means that the ownership of equipment for collection service inevitably belongs to the government. Though the ownership of vehicle lies in the government, the practical operation by using the vehicles can be transferred to private sector is equally required efforts to adopt to the new system, so that the attempt to promote private sector involvement can be started in this field at any time. The following scenario is presented for reference to Male' Municipality to step forward.

b. Preparatory Action for PSI

Considering the introduction of PSI in near future, the existing waste collection services by the private service providers must be regulated by the Male' SWM By-law including the provisions at least with the following conditions.

- Male Municipality has primary duty for collection and disposal of the waste generated in the municipal area,
- No one can collect, dispose and charge the waste generated in the municipal area except permitted by the Male' Municipality,
- Male' Municipality can provide high quality collection services by the request of all parties upon full recovery cost charge,
- Male' Municipality can contract out the collection services to private companies through competition among the companies.

The By-law suggested above allows any private person or companies can provide waste collection services by charging. In order to run the initial PSI, registration/permission of the service providers and monitoring of their activities will be required. The service provider have to run the business on the conditions permitted by the Municipality and the registration/permission will be nullified for the service providers do not comply with the conditions.

Introduction of PSI requires the preparatory actions and considerable time span for commencement. The major preparatory actions to promote PSI include in the followings shall be prepared and executed prior to implementation of the improved SWM system.

Table 6-38. Major Preparation Work and Implementation Work

Year	Activities
1999 ~2003	<ul style="list-style-type: none"> • Capacity Building program • Restructuring of SWM organisation • Legislation of Male' By-law on SWM • Introduction of registration/permission system of private service providers for waste collection services • Establish the monitoring system
2004 ~ 2007	<ul style="list-style-type: none"> • Preparation of the contract system to contract-out the collection service to private sectors • Review the monitoring system
2008 ~	<ul style="list-style-type: none"> • Make a contract with the private sectors for minimum collection services • Review the monitoring system • Review the contract-out cost • Review the waste charge

c. Switchover Schedule and Waste Amount to be Collected by Private Sector

The shortest switchover schedule to PSI is shown in Table 6-39 and Figure 6-22.

Table 6-39. Switchover Schedule to PSI

Year	~ 2002	2003 ~ 2007	2008
Main body of collection work	Total Municipal Waste -Generator 57.5% -PSI 11% -M.C.V. 1.5% -Micro-bin 30%	Residential waste -The Municipality Commercial Waste -Existing PSI (11% of total waste) -Generator	Residential waste - New PSI (The Municipality) Commercial Waste -Existing PSI (11% of total waste) -Generator
Note	Existing System	Micro-bin system will be abolished	New PSI will start for collection of the municipal waste

Considering the above factors, the total amount of waste collected by The Municipality is estimated as follows.

Table 6-40. Projection of Total Waste Amount Collected by the Municipality

Year	Municipal Waste			Collection Method			
	Total	Residential	Commercial	Generator	PSI	M.C.V.	Micro-bin
1999	72.6	51.0	21.6	41.6	8.0	1.1	21.9
2000	77.2	54.2	23.0	44.3	8.5	1.2	23.2
2001	81.8	57.4	24.4	47.1	9.0	1.2	24.5
2002	86.6	60.8	25.8	49.8	9.5	1.3	26.0
New System	Residential Waste			Commercial Waste			
	Generation (t/d)	Municipality (t/d)	New PSI (t/d)	Generation (t/d)	Generator (t/d)	Existing PSI (t/d)	
2003	64.3	64.3	0	27.3	17.2	10.1	
2004	68.0	68.0	0	28.9	18.2	10.7	
2005	71.7	71.7	0	30.4	19.2	11.2	
2006	75.4	75.4	0	32.0	20.2	11.8	
2007	79.1	79.1	0	33.6	21.2	12.4	
2008	82.9	0	82.9	35.2	22.2	13.0	
2009	86.7	0	86.7	36.8	23.2	13.6	
2010	90.6	0	90.6	38.4	24.2	14.2	

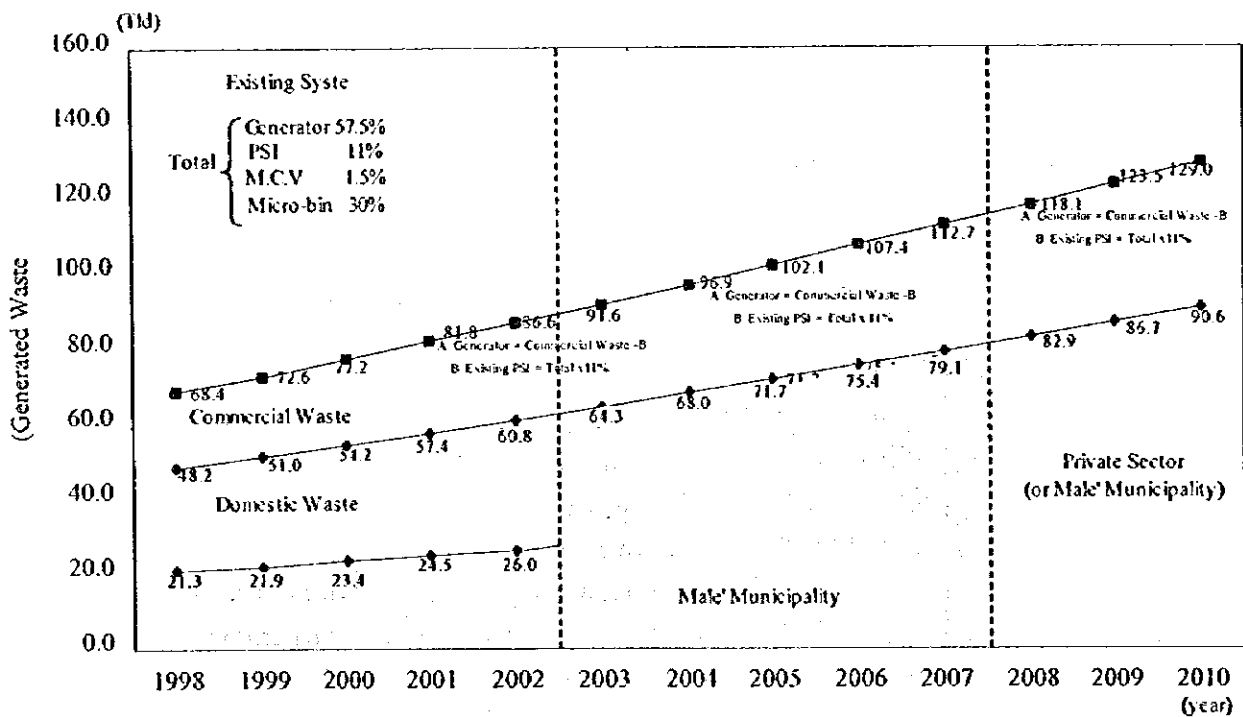


Figure 6-22. The Switchover Schedule to PSI

6.5 Financial Arrangement

6.5.1 Fund Requirement for Project Components

(I) Initial Cost

a. Male' and Vicinities Project

The JICA Study Team comes up with two alternatives regarding the construction of the loading station in Male': compactor system and shovel loading system. Also, the team submits two choices, that is, construction by imported materials and construction by local materials regarding the improvement of the existing Thilafushi. Eventually, the team proposes the shovel loading system and construction by local materials respectively in consideration of cost involved.

Further, three options have been conceived for both collection vehicle fleet and transportation vehicles/equipment in Male'. Finally, option 3 (vehicle station collection system) in the former and option 2 (compactor-truck system) in the latter were selected on account of their cost effectiveness.

Regarding the height of the seawalls in Thilafushi islands, 4 m was adopted considering various factors including cost.

The initial cost of the Male' and Vicinities Project is estimated as follows:

(Unit: Rf. thousand)

Item	Amount
I. Transportation and Disposal	
1. Construction Cost in Thilafushi	218,818
2. Construction Cost in Male' & Villingili	28,267
3. Procurement Cost	42,789
4. Engineering Services	21,050
5. Physical Contingencies	24,708
Total	335,632
II. Collection	
1. Procurement Cost	12,539
2. Engineering Services	376
Total	12,915
III. Cleaning	
1. Procurement Cost	
(1) Dust Bin	141
(2) Port Area Cleaning	616
2. Engineering Services	22
Total	779
Grand Total	349,326

In calculating the engineering service cost it was assumed that it will be 8% of construction cost plus 3% of procurement cost. Physical contingencies were calculated on the assumption that it will be 10% of construction cost.

As the above table shows, the total initial cost comes to Rf. 349,326,000 or US\$ 29,806,000 or ¥ 3,874,776,000.

For more detailed breakdowns of the initial cost, refer to Table 7 in Supporting Report G.

b. Atolls Project

The initial cost of the Atolls Project is estimated as follows:

(Unit: Rf. thousand)

Item	Amount
I. One Atoll	
1. Construction Cost	12,206
2. Procurement Cost	2,005
3. Engineering Service	1,037
4. Physical Contingencies	1,221
Total	16,468
II. 20 Atolls	
Total	329,360

As the above table shows, the total initial cost comes to Rf. 329,360,000 or US\$ 28,102,000 or ¥ 3,653,311,000.

Combined initial cost of the above two projects works out to Rf. 678,686,000 or US\$ 57,908,000 or ¥ 7,528,087,000.

For more detailed breakdowns of the initial cost, refer to Table 7 in Supporting Report G.

(2) O & M Cost

(Unit: Rf. thousand)

Item	Male' and Vicinities Project			Atolls Project		
	O & M	Depreciation	Total	O & M	Depreciation	Total
2003	14,088	13,954	28,042	570	2,967	3,537
2010	16,543	17,397	33,940	1,900	9,892	11,792

(Unit: Rf. thousand)

Item	Male' and Vicinities Project				
	Collection	Transportation	Disposal	Administration	O & M Total
2003	2,910	9,065	1,495	618	14,088
2010	3,889	10,541	1,495	618	16,543

As the above table shows, the operation and maintenance cost (including depreciation) of the SWM projects for Male' and Vicinities and Atolls is estimated to total Rf. 33,940 thousand and Rf. 11,792 thousand respectively in the target year of 2010.

In the O & M activities in Male' and Vicinities, transportation occupies a major position, accounting for 63.7% of the O & M cost, followed by collection with 23.5%, disposal with 9.0% and administration with 3.7% in 2010. Also, it is to be noticed that depreciation is greater than the O & M cost.

For more details, refer to Table 8 in Supporting Report G.

(3) Implementation Schedule

The implementation schedule of the two projects is proposed to be as follows:

I. Male' and Vicinities Project

Item	2000	2001	2002	2003	2004	2005	2006
Construction in Thilafushi		■	■		■		
Construction in Male'			■	■			
Construction in Villingili			■				
Procurement for Male'				■		■	■
Procurement for Thilafushi		■					

Item	2007	2008	2009	2010
Construction in Thilafushi				
Construction in Male'				
Construction in Villingili				
Procurement for Male'	■	■	■	
Procurement for Thilafushi				

2. Atolls Project

Item	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Implementation										

In the Atolls Project, it is assumed that the SWM facilities will be constructed for two Atolls every year, starting from 2001 to 2010.

6.5.2 Establishment of Cost Charging System

(1) Target Cost Items and Payers

a. Target Cost Items

Cost-Bearers

Cost Items	Government	MCPW	MM	Beneficiaries
Initial Cost				
Grants	Yes	-	-	-
Loans	Yes	-	-	(Yes)*
Budget	Yes	-	-	-
O & M Cost				
O & M Cost	-	-	-	Yes
Depreciation	-	Yes	Yes	(Yes)**

Note: *=in case repayment cost is borne by beneficiaries.

**=in Atolls Project.

As the above table shows, it is proposed that the central government basically bear the initial cost. If the initial cost is financed by grants of external countries, the fund is provided without repayment obligations to the government and the fund is allocated to suffice the initial cost. If it is financed by bond raising, domestic bank loans and/or external loans, it is proposed that the government take care of repayment. However, in case the size of initial cost is not so big, the repayment will be in principle made by the beneficiaries as in atolls project. In the case of loan, interest will be incorporated in the O & M cost. If the initial cost is allocated from the government revenues, it means that the central government uses the import duty, tourism tax, lease and rents of government property, etc. for this purpose. Although the JICA Study Team does not recommend it because of environmental reasons, supposing MCPW utilizes the land plot in Thilafushi 2 and Thilafushi 3 for renting, then the rents can join the government revenues.

The O & M cost (not including depreciation) is proposed to be borne by the beneficiaries in the Male' and Vicinities Project. On the other hand, depreciation will be borne by MCPW and MM.

b. Payers

Item	Male' and Villingili	Resort Islands	Airport Island	Inhabited Island
Payers of SWM Cost	1. Central Gov't. 2. MCPW (WMS) 3. MM 4. Beneficiaries	Owners of Resorts	Maldives Airports Authority	1. Central Gov't. 2. Beneficiaries

As the above table shows, it is proposed that the SWM in resort islands be entirely taken care of by the management of resorts. In the same way, Maldives Airports Authority will be totally responsible for the SWM of the Hulhule Airport. That is to say, both resort proprietors and the Maldives Airport Authority must self-finance whatever works and O & M to be required for SWM.

In the case of the SWM of Male' and Villingili, four parties will be involved as the payers of SWM cost. It is proposed that in general the initial cost be borne by the central government, depreciation by MCPW (WMS) and MM, and O & M cost by the beneficiaries. In the same way, for the inhabited islands, two parties will be involved: the initial cost will be borne by the government, and both depreciation and O & M cost will be borne by the beneficiaries.

(2) Target Level of Cost Recovery

As already mentioned in the preceding sections, the initial cost is proposed to be taken care of by the central government. In case it is gotten through bond raising or loans, it is proposed to be taken care of by either the government or beneficiaries depending on the size of initial cost.

It is proposed that the O & M cost be entirely recovered through the introduction of solid waste charge from the beneficiaries. Regarding depreciation, it will be borne by MCPW (WMS) and MM in the Male' and Vicinities Project. MCPW (WMS) will take care of the depreciation related to the replacement/rehabilitation of transportation and disposal facilities, while MM will allocate the budget for the depreciation related to the replacement/rehabilitation of collection vehicles. In the Atolls Project, depreciation will also be borne by the beneficiaries because it was clarified that they can afford to shoulder both O & M cost and depreciation.

Under the above conditions, the average monthly payment by the beneficiaries works out as follows:

Solid Waste Charge (monthly average per beneficiary)

Beneficiaries	Male' and Vicinities Project		Atolls Project
	Male'	Villingili	Inhabited Islands
	2003-2010 Average	2003-2010 Average	2001-2010 Average
Houses	Rf.14,410x1.3% x88.5%	Rf.9,691x0.5% x177.0%	Rf.6,527x1.6% x36%
	Rf.166	Rf.86	Rf.38
Establishments/ Institutions	Rf.1,292 x88.5%	Rf.1,292 x88.5%	Rf.879 x36%
	Rf.1,143	Rf.1,143	Rf.316

From 2003 to 2010 in Male' a house with the average monthly income of Rf. 14,410 is proposed to pay Rf. 166 per month as solid waste charge, which accounts for 1.15% of its income, that is, 88.5% of 1.3%, its willingness to pay. In the same way, an establishment or institution will pay Rf. 1,143 per month on average as solid waste charge, that is, 88.5% of its willingness to pay.

From 2003 to 2010 in Villingili a house with the average monthly income of Rf. 9,691 is proposed to pay Rf. 86 per month as solid waste charge, which accounts for 0.885% of its income, that is, 177.0% of 0.5%, its willingness to pay. In the same way, an establishment or institution will pay Rf. 1,143 per month on average as solid waste charge, that is, 88.5% of its willingness to pay.

It is to be reminded that solid waste charge for houses as the percentage of willingness to pay in Villingili is proposed to be twice as high as in Male'. It is because willingness to pay for houses in Villingili is less than half compared with Male'.

From 2001 to 2010 in an Atoll a house with the average monthly income of Rf. 6,527 is proposed to pay Rf. 38 per month as solid waste charge, which accounts for 0.58% of its income, that is, 36% of 1.6%, its willingness to pay. In the same way, an establishment or institution will pay Rf. 316 per month on average as solid waste charge, that is, 36% of its willingness to pay.

For more details, refer to Tables 10 and 11 in Supporting Report G.

Solid waste charge in terms of the price per unit weight will be structured as follows:

Solid Waste Charge (price per ton)

Beneficiaries	Male' and Vicinities Project		Atolls Project
	Male'	Villingili	Inhabited Islands
	2003-2010 Average	2003-2010 Average	2001-2010 Average
Houses	Rf. 92,780,000 /225,826 tons	Rf. 4,446,000 /14,199 tons	Rf. 57,669,000 /786,210 tons
	Rf. 411	Rf. 313	Rf. 73
Establishments/ Institutions	Rf. 47,971,000 /493,334 tons	-	-
	Rf. 97	-	-

It is expected that Rf. 92,780,000 will be collected from domestic beneficiaries as solid waste charge in Male' from 2003 to 2010. On the other hand, 225,826 tons of domestic solid waste is estimated to generate in the Capital City in the same period. Therefore, domestic solid waste charge is calculated at Rf. 411 per ton. Likewise, Rf. 47,971,000 will be collected from non-domestic beneficiaries as solid waste charge, while 493,334 tonnes of non-domestic solid waste will be generated. As a result, non-domestic solid waste charge comes to Rf. 97 per tonne.

Rf. 4,446,000 is expected to be collected from domestic beneficiaries as solid waste charge in Villingili from 2003 to 2010. On the other hand, 14,199 tonnes of domestic solid waste is estimated to generate in the island in the same period. Therefore, domestic solid waste charge is calculated at Rf. 313 per ton. There is not enough information to estimate non-domestic solid waste charge per ton.

In the Atolls, Rf. 57,699,000 will be collected from domestic customers as solid waste charge from 2003 to 2010, while 786,210 tons of domestic solid waste will be generated. It means that domestic solid waste charge will be Rf. 73 per ton. There is not enough information to estimate non-domestic solid waste charge per ton.

Solid Waste Disposal Charge for Airport and Resort Islands (per month)

Beneficiaries	Male' and Vicinities Project
	2003-2010 Average
Airport Island	Rf. 219,000/8 years/12 months
	Rf. 2,281
Resort Islands	Rf. 1,413,000/8 years/12 months
	Rf. 14,719

The solid waste disposal cost will be shouldered among the three parties, namely Male' and Villingili residents, the airport island and resort islands.

To meet the disposal cost, the authorities are proposed to collect Rf. 219,000 and Rf. 1,413,000 from 2003 to 2010 from the airport island and resort islands respectively. The average monthly solid waste disposal charge during the same period is, therefore,

calculated at Rf. 2,281 and Rf. 14,719 for the airport island and resort islands respectively. Supposing the number of resort islands is 37, the monthly charge per resort island works out to Rf. 398.

(3) Fee Collection System

There are two major ways for collecting solid waste charge. They will be explained hereunder.

a. Regular Bill Collection System

This is the system under which the authorities regularly collect the solid waste charge by visiting each and every client on a monthly basis.

There will be two concepts concerning the tariff under the system.

1. Uniform Rate

Under this concept, every client in the same category and area will pay the same amount of solid waste charge. The table titled Solid Waste Charge (monthly average per beneficiary) in the preceding section (2) Target Level of Cost Recovery fully presents the tariff according to this way of thinking.

2. Payment According to Affordability

Under this concept, the solid waste charge will differ in accordance with the plot size, floor size, amount of income, number of people, etc. in houses, establishments and institutions.

The first concept appears to be easier to be implemented, although it is not fair from the standpoint of social justice. On the other hand, the second concept is easier said than done, but it is socially reasonable and acceptable. It is to be reminded that the total revenue to be collected must be the same for both concepts.

It is recommended that the solid waste charge bill be collected together with water or electricity bill.

b. On the Spot Payment System

Under this system a customer will pay solid waste charge according to the weight of solid waste he wants the authorities to take away at the spot the transaction occurs. The charges will be different depending on the categories of the waste and the areas. The table titled Solid Waste Charge (price per ton) in the preceding section (2) Target Level of Cost Recovery fully presents the tariff according to this system. The transaction will occur at the transfer stations.

It goes without saying that the final amount of revenue to be collected is the same in both systems.

(4) Disbursement Procedure

Comparison of Revenues and O & M Cost

(Unit: Rf. 000)

Item	Male' and Vicinities Project	Atolls Project
	Male' and Villingili	Inhabited Islands
	2001-2010	2001-2010
Revenues		
from Solid Waste Charge	142,920	74,921
from General Revenue Budget	126,575	-
Total	269,495	74,921
O & M Cost		
O & M Cost	127,856	10,450
Depreciation	115,075	54,403
Total	242,931	64,853

Allocation of Revenues and O & M Cost between MCPW and MM in Male' and Vicinities Project

(Unit: Rf. 000)

Item	Male' and Vicinities Project	
	2001-2010	
	MCPW	MM
Revenues		
from Solid Waste Charge	112,519	30,401
from General Revenue Budget	109,868	16,707
Total	222,387	47,108
O & M Cost		
O & M Cost	100,659	27,197
Depreciation	99,890	15,185
Total	200,549	42,382

As the above tables show, the revenue amounting to Rf. 142,920,000 is assumed to be collected from the beneficiaries as solid waste charge. The collected charge will be used to recover the O & M cost estimated at Rf. 127,856,000 under the Male' and Vicinities Project from 2001 to 2010. The general revenue budget amounting to Rf. 126,575,000 will be used to cover the depreciation amounting to Rf. 115,075,000. The revenue from solid waste charge will be split between Ministry of Construction and Public Works (MCPW) (Waste Management Section (WMS)) and Male' Municipality

(MM) according to the O & M cost involved. Also, the general revenue budget will also be split between them in accordance with the depreciation involved.

Although the JICA Study Team does not immediately recommend it because of environmental considerations, supposing MCPW uses the land plot to be newly available in the new Thilafushi islands for renting to industrial and other clients, the rents thus to be raised can be appropriated to meet depreciation.

Under the Atolls Project from 2001 to 2010, the revenue amounting to Rf. 74,921,000 is assumed to be collected from the clients as solid waste charge, which will be used to cater for both the O & M cost and depreciation estimated at Rf. 64,853,000 in total.

The surplus from the solid waste charge revenue, if any, will function as contingencies or will be used for expansion of facilities.

For more details, refer to Tables 8, 10 and 11 in Supporting Report G.

6.5.3 Financial Arrangement

Financial statements were projected for both the Male' and Vicinities and Atolls projects so that the authorities concerned may proceed with the projects in a financially sustainable manner.

To reach the stage where such statements are prepared, a lot of projections and estimations have to be made.

First of all, cost and revenue have to be estimated in the years to come up to the target year of 2010.

Regarding cost estimation, it is shown in detail in Tables 7 and 8 in Supporting Report G. In section 6.5.1 there is an overall description on it. To allocate depreciation in the years to come depreciation periods must be fixed for facilities and equipment to be constructed/installed.

The detail on the periods is shown in Table 7 in Supporting Report G. They can be summarized as follows:

Item	Yards and the Like	Other Civil Engineering Works	Buildings	Construction Vehicles	Other Construction Equipment
Depreciation Periods	30	50	35	5	10

As regard to the estimation of revenue and budget allocations, the overall explanation is added hereunder. It is also presented in detail in Tables 10 and 11 in Supporting Report G.

(1) Estimation of Revenue and Allocations from Public Budget**Domestic Customers**

Item	Male' and Vicinities Project				Atolls Project	
	Male'		Villingili		Inhabited Islands	
	2003	2010	2003	2010	2003	2010
Population	77,097	88,822	3,587	9,106	70,578	285,543
No. of Houses (Theoretical)	5,384	6,203	317	806	5,931	23,995
Income (Rf./m/house)	12,971	15,874	8,724	10,675	6,048	7,402
Payment for SWM as % of Income	1.3%x 88.5%	1.3%x 88.5%	0.5%x 177.0%	0.5%x 177.0%	1.6%x 36%	1.6%x 36%
Revenue (Rf. 000)	9,159	12,914	279	868	2,355	11,663

Population in Male', Villingili and Atolls was projected based on the official data prepared by MPHRE and Maldives Housing and Urban Development Authority. Population was statistically converted into the number of houses according to the average size of household. Monthly income per house was estimated based on the results of socio-economic questionnaire surveys. It was assumed to grow in parallel with the growth of per capita income. The growth of per capita income was projected from the estimated growths of population and the economy. Payment for SWM was determined in such a way that the ultimately calculated revenue might cover the O & M cost. In the above table, 1.3%, 0.5% and 1.6% are the willingness to pay for SWM in the respective three areas. Finally, the number of houses, income and payment for SWM were multiplied to arrive at revenue.

Non-Domestic Customers

Item	Male' and Vicinities Project				Atolls Project	
	Male'		Villingili		Inhabited Islands	
	2003	2010	2003	2010	2003	2010
No. of Establish./ Institutions	404	465	19	48	259	1,046
Payment for SWM (Rf.)	1,163x 88.5%	1,423x 88.5%	1,163x 88.5%	1,423x 88.5%	814x 36%	996x 36%
Revenue (Rf. 000)	4,740	6,676	223	689	865	4,276

The number of establishments/institutions was projected to grow in parallel with the growth of population. The willingness to pay for SWM was assumed to go up in parallel with the growth of per capita income. Payment for SWM was determined in such a way that the ultimately calculated revenue might cover the O & M cost. In the above table, Rf. 1,163, 1,423, etc. are the willingness to pay for SWM in the respective years and

areas. Finally, the number of establishments/institutions was multiplied by payment for SWM to arrive at revenue.

In estimating the number of establishments/institutions in Villingili, the ratio of the number of establishments/institutions to population in Male' was used. In the Atolls it was assumed that the said ratio would be by 30% less than in Male'. Also, in the Atolls it was assumed that the willingness to pay in establishments/institutions would be by 30% less than in Male'.

Allocation from Public Budget

Item	Male' and Vicinities Project	
	2003	2010
MCPW Budget Estimates (Rf. 000)	162,468	252,756
Allocation Ratio	6.67%	6.67%
Allocations	10,837	16,859
MM Budget Estimates (Rf. 000)	21,710	33,345
Allocation Ratio	7.65%	7.65%
Allocations	1,660	2,550

The future magnitude of the expenditure budget of MCPW was estimated by employing regression analysis on the assumption that it is correlated with GDP. The same method was employed to estimate the future expenditure budget of MM. The analysis and the results are shown in Table 9 in Supporting Report G. The ratios to be allocated for SWM were determined in such a way that the allocated amount might cover depreciation. In the case of MCPW the ratio came to 6.67%. For MM it is 7.65%. It is to be reminded that currently MCPW and MM are estimated to appropriate 7.0% and 8.3% for SWM.

For overall preconditions for the projection of financial statements and its results, refer to 6.7.2 Project Evaluation (4) Evaluation on Financial Sustainability.