

*E. Solid Waste Amount, Composition  
and Recycling*



## **E. SOLID WASTE AMOUNT, COMPOSITION AND RECYCLING**

### **1. Present Situation**

#### **1.1 Solid Waste Amount, Generation Sources and Composition**

##### **1.1.1 Existing Data**

###### **(1) Waste Amount Carried Out from Transfer Station in Male'**

Numbers of trucks operated for transportation of waste to Thilafushi has been recorded by the Waste Management Section, MCPW since 1992. Table 1-1 and Figure 1-1 show the summary of the result of the operation records.

The number of times of transportation by trucks have increased from 278 times in 1992 to 741 times in 1997 but dropped to 652 times in 1998 in terms of monthly average number of times of transportation. Remarkable increase in the number of truck operation has been made since March in 1996 when new barge, Ufuli III, has commenced services.

The solid waste amount is estimated from the relation between the number of times of the truck operation and the estimated unit amount of loading per truck. The waste amount survey conducted by the Study Team indicate the unit loading rate at 5.4 tons per truck per trip. From this unit loading, the waste amount transported to the Thilafushi is estimated at 58 tons per day in 1992 and increase to 152 tons per day in 1997 but the rate is decreased to 136 tons per day in 1998 in the record up to May, 1998 as shown in Figure 1-1.

###### **(2) Waste Amount Transported Directly to the Thilafushi Disposal Site**

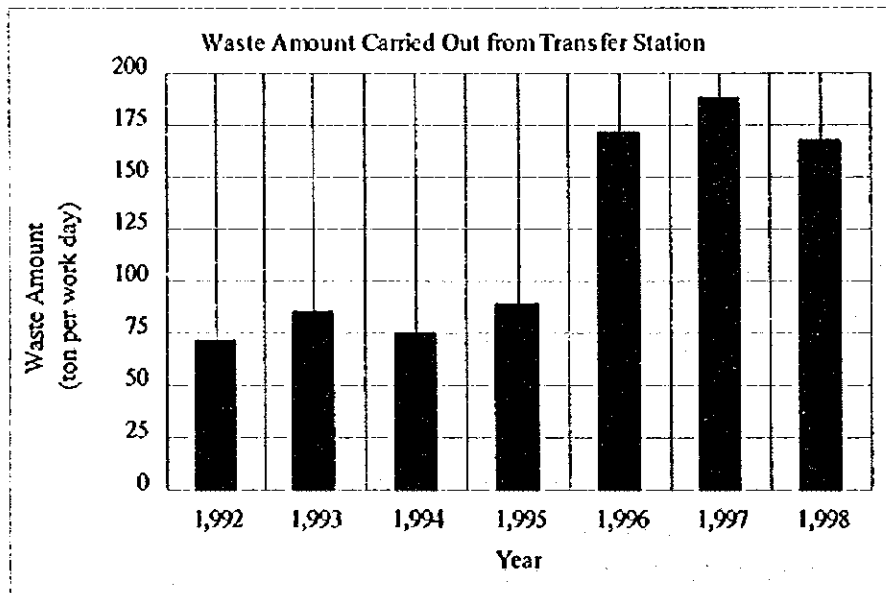
The waste disposal site, Thilafushi, receive waste not only from Male' but also from other islands including Villingili, Hulhule and from many resort islands. The records from January to May in 1998 obtained from Solid Waste Management Section, MCPW indicate the total numbers of times of hauling by truck reaches at 129, 846 and 73 trucks for Villingili, resort islands and Hulhule respectively. Assuming the loading at 5.4 tons per truck for Villingili, and the loading at 2 tons per truck for Hulhule and resort islands, the total amount of wastes in the five month is estimated at 2,535 tons or 507 tons per month or 17 tons per day approximately.

Medical waste, waste oil and expired food wastes are carried to Thilafushi from time to time but the waste amount is not so much in respect of waste amount estimation.

**Table 1-1 Operation Records of Solid Waste Transportation**

Month	Numbers of Trucks (trucks/month)						
	Year						
	1992	1993	1994	1995	1996	1997	1998
January		453	243	467	360	769	457
February		396	281	390	392	649	562
March		226	353	433	608	1098	719
April	161	431	188	399	640	823	850
May	324	265	56	231	688	754	673
June	310	291	211	331	617	737	
July	210	323	413	352	611	745	
August	293	319	394	364	968	728	
September	230	371	348	289	845	724	
October	301	259	413	169	773	582	
November	319	299	363	381	707	622	
December	357	389	305	391	893	664	
<b>Total (year)</b>	<b>2,505</b>	<b>4,022</b>	<b>3,568</b>	<b>4,197</b>	<b>8,102</b>	<b>8,895</b>	<b>3,261</b>
<b>Monthly Average</b>	<b>278</b>	<b>335</b>	<b>297</b>	<b>350</b>	<b>675</b>	<b>741</b>	<b>652</b>
<b>Estimated Waste Amount Carried out from Transfer Station</b>							
Annual (ton/year)	13,427	21,558	19,124	22,496	43,427	47,677	17,479
Monthly (ton/month)	1,492	1,796	1,594	1,875	3,619	3,973	3,496
Daily (ton/day) -work day	58	69	61	72	139	152	136

(Data Source : Waste Management Section, MCPW)

**Figure 1-1 Estimated Waste Amount Carried Out from Transfer Station**

## 1.1.2 Waste Amount and Composition Survey

Waste amount and composition survey was conducted for two inhabited islands, two resort islands and for Male' from June to September, 1998 and summarised in the following subsections.

### (1) Inhabited Islands

#### a. Waste Amount in Inhabited Islands

Waste amount and composition survey was carried out for 10 days from 9 to 24 June, 1998 to take 1 sample each from 10 houses in Villingili and Thulusdhoo island respectively. The results are summarised and tabulated in Table 1-2 and 1-3. In Villingili, waste amount taken for the sample was 83 kg per day in average ranging from 59 kg in minimum and 126 kg in maximum discharge from 10 residential houses of 115 population. Ten (10) sample houses in Thulusdhoo discharge waste about 96 kg per day in average ranging from 65 to 165 kg from 119 population.

Learned from the samples from 4 - 10th days, the waste generation rate in Villingili is obtained at 621 grams per capita per day or 7.1 kg per house per day. Meanwhile, in Thulusdhoo, the waste generation rate obtained from the samples of 4 - 11th days reach at 698 grams per capita per day or 8.3 kg per house per day. The average waste generation rate of two islands is estimated at 662 grams per capita per day or 7.7 kg per house per day.

#### b. Waste Composition in Inhabited Islands

Waste composition in Villingili is characterised by the high ratio of inorganic waste with 41 %, which is generated mostly from construction wastes from building house in progress in several lots while organic waste takes about 59 %. Meanwhile, food waste is discharged about 21.6 % followed by paper and plastic with the ratio at 7.0 and 5.9 % respectively.

Ratio of organic waste in Thulusdhoo shows 88.0 %. Yard waste has the highest ratio at about 50.9 % followed by food waste with the ratio about 22.2 %.

Yard waste is one of the major waste generated in two islands, the ratio shows about 13.9 % and 50.9 % for Villingili and Thulusdhoo respectively. The high ratio of yard waste in Thulusdhoo is mainly caused of the coconuts shell drops which are not discharged normally but discharged in the occasion of the waste survey. In other words, it is considered that the waste generation rate and composition in normal condition might be different from that of the survey result in terms of heavy wastes.

Table 1-2 Result of Waste Amount and Composition Survey in Inhabited Island ( Villingili)

Survey Date	Year 1998	9 June	10 June	11 June	12 June	13 June	14 June	15 June	16 June	17 June	18 June			
Day of the Week	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fine			
Weather	Fine	Shower	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine			
Objective Population	115													
Waste Composition	1st Day	2nd Day	3rd Day	4th Day	5th Day	6th Day	7th Day	8th Day	9th Day	10th Day	Max.	Min.	Avg.	Ratio (%)
<b>Organic Waste</b>														
Food Waste	24,700	24,620	24,000	6,200	15,600	21,500	19,500	6,500	6,660	29,950	29,950	6,200	17,923	21.64
Paper	10,000	3,700	3,000	4,250	3,500	1,600	1,740	2,810	2,600	3,600	10,000	1,600	3,680	4.44
Cardboard	590	1,640	2,200	430	2,500	3,500	640	1,910	2,890	1,000	4,300	590	2,117	2.56
Paper (Total)	10,590	5,340	5,200	8,550	6,000	5,100	2,380	4,720	5,490	4,600	10,590	2,380	5,797	7.00
Plastics	2,150	2,450	1,900	1,030	4,100	1,500	1,960	2,830	2,930	1,580	4,100	1,030	2,243	2.71
Bottle & Others	870	1,000	4,700	940	250	20	3,040	3,940	4,020	1,400	4,700	20	2,018	2.44
PET	590	540	680	900	500	400	420	930	820	100	930	100	588	0.71
Plastic (Total)	3,610	3,990	7,280	2,870	4,850	1,920	5,420	7,700	7,770	3,080	7,770	1,920	4,849	5.86
Rubber & Leather	10	2,340	2,780	980	840	Nil.	640	2,770	2,370	1,500	2,780	10	1,581	1.91
Textiles	3,150	13,550	1,940	1,190	3,100	100	660	2,200	2,520	2,200	13,550	100	3,061	3.70
Yard Waste	5,550	16,000	6,600	26,200	18,200	5,100	5,150	9,600	10,100	12,600	26,200	5,100	11,510	13.90
Wood	1,230	4,130	3,740	2,630	7,000	1,600	520	3,840	3,020	340	7,000	340	2,805	3.39
Other Org. Waste	0	3,030	9,960	0	0	0	0	0	0	0	9,960	0	1,299	1.57
Subtotal (Organic Wastes)	48,840	73,000	61,500	48,620	55,590	35,320	34,270	37,330	37,930	54,270	73,000	34,270	48,825	58.96
<b>In-organic Waste</b>														
Glass	60	380	640	780	260	Nil.	920	2,020	2,040	520	2,040	60	847	1.02
Broken Glass	780	1,200	2,500	1,200	1,220	3,300	760	3,240	3,400	1,220	3,400	760	1,882	2.27
Bottle	840	1,580	3,140	1,980	1,480	3,300	1,680	5,260	5,440	1,740	5,440	840	2,729	3.30
Glass (Total)	1360	1940	4300	2160	3950	3500	840	3570	3750	2400	4300	840	2777	3.35
Tin Cans (Steel Cans)	100	nil.	100	100	420	100	220	980	420	none	980	100	305	0.37
Aluminum cans	1600	2240	2780	1020	800	nil.	660	1,020	980	200	2,780	200	1,256	1.52
Other Metals	42,540	47,400	30,400	29,180	32,900	30,430	25,450	10,450	11,400	6,800	47,400	6,800	26,695	32.24
Dir. Ash, Stone, Sand	46,440	53,160	40,720	34,440	39,550	37,330	28,850	21,280	21,990	11,140	53,160	11,140	33,761	40.77
Subtotal (Inorganic Wastes)	30	40	260	160	420	20	220	420	420	220	440	20	223	0.27
Hazardous Waste (Batteries)	none	none	none	none	none	none	none	none	none	none	none	none	none	none
Other Hazardous Waste	30	40	260	160	420	20	220	420	420	220	440	20	223	0.27
Subtotal (Hazardous Waste)	95,310	126,200	102,480	83,220	95,560	72,670	63,340	59,030	60,140	65,850	126,200	59,030	87,809	100.00
Total Weight (g)	244	342	342	312	342	294	234	304	254	294	342	234	296	
Total Waste Volume (lit.)	0.391	0.369	0.300	0.267	0.279	0.247	0.271	0.194	0.237	0.224	0.391	0.194	0.280	
Bulk Density (kg/lt.)														

**Table 1-3 Result of Waste Amount and Composition Survey in I**

Survey Date Day of the Week Weather	14 June		15 June		16 June		17 June		18 June		20 June		21 June		22 June		23 June		24 June										
	Tue	Wed	Thu	Fri	Sat	Sun/Mon	Tue	Wed	Thu	Fri	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine									
Objective Population	119																												
Waste Composition	1st Day	2nd Day	3rd Day	4th Day	5th Day	6&7th Day	8th Day	9th Day	10th Day	11th Day	Max	Min.	Avg.	Ratio (%)															
<b>Organic Waste</b>																													
Food Waste				31,090	12,660	26,100	14,560	24,060	22,560	16,560	31,090	12,660	18,449	22.22															
Paper				580	2,780	2,400	1,200	2,540	2,300	600	2,780	580	1,550	1.87															
(Cardboard)				2,440	1,940	2,300	500	980	940	1,180	2,440	500	1,285	1.55															
Paper (Total)				3,020	4,720	4,700	1,700	3,520	3,240	1,780	4,720	1,700	2,835	3.41															
Plastics				1,300	2,900	1,200	1,520	1,540	1,480	2,280	2,900	1,200	1,528	1.84															
(Bottle & Others)				200	460	400	940	600	650	1,160	1,160	200	551	0.66															
PET				nil.	none	40	200	340	320	Nil.	340	40	113	0.14															
Plastic (Total)				1,500	3,360	1,640	2,660	2,480	2,450	3,440	3,440	1,500	2,191	2.64															
Rubber & Leather				140	none	400	380	2,220	1,990	None	2,220	140	641	0.77															
Textiles				2,300	1,320	1,300	1,800	1,100	1,490	2,320	2,320	1,100	1,454	1.75															
Yard Waste				51,010	60,710	73,960	22,600	63,200	60,600	5,680	73,960	5,680	42,220	50.85															
Wood				nil.	320	100	940	Nil.	380	9,800	9,800	100	1,443	1.74															
Other Org. Waste				0	1,220	2,750	8,620	3,490	3,630	11,100	11,100	0	3,851	4.64															
Subtotal (Organic Wastes)				89,060	84,310	110,950	53,260	100,070	96,340	50,680	110,950	50,680	73,084	88.03															
<b>In-organic Waste</b>																													
Glass				1,000	480	none	880	1,320	1,140	nil.	1,320	480	603	0.73															
(Broken Glass)				360	800	640	740	Nil.	980	740	980	360	533	0.64															
(Bottle)				1,360	1,280	640	1,620	1,320	2,120	740	2,120	640	1,135	1.37															
Glass (Total)				1,140	900	2060	680	5,160	4,460	1,240	5,160	680	1,955	2.35															
Tin Cans (Steel Cans)				nil.	60	40	200	220	180	280	280	40	123	0.15															
Aluminum cans				nil.	100	120	720	500	620	180	720	100	280	0.34															
Other Metals				11,430	8,450	1,350	10,120	3,750	3,950	11,450	11,450	1,350	6,310	7.60															
Dir. Ash, Stone, Sand				13,930	10,790	4,210	13,340	10,930	11,310	13,890	13,930	4,210	9,803	11.81															
Subtotal (Inorganic Wastes)				40	nil.	40	420	240	180	180	420	40	138	0.17															
Hazardous Waste (Batteries)				0	none	0	0	0	0	0	0	none	0	0.00															
Other Hazardous Waste				40	0	40	420	240	180	180	420	40	138	0.17															
Subtotal (Hazardous Waste)				67,990	148,880	164,970	103,030	95,100	115,200	67,020	111,260	107,830	64,750	83,024	100.00														
Total Weight (kg)				488	362	390	186	312	332	312	488	186	298																
Total Waste Volume (lit.)				0.211	0.263	0.295	0.360	0.357	0.325	0.208	0.360	0.208	0.279																
Bulk Density (kg/lit.)																													

**(2) Resort Islands**

**a. Waste Amount in Resort Islands**

Waste amount and composition surveys for Kanifinol and Thulhagiri resort islands were conducted for 10 day-samples respectively. The period of survey was extended more than 10 days due to rough sea condition. The result of survey were summarised in Table 1-4 and 1-5.

During the survey period, the average numbers of hotel guests and hotel staff were 150 and 356 in Kanifinol Resort Island and 73 and 125 in Thulhagiri Resort Island respectively.

Waste generated in the target resort islands amounted to 1,030 kg per day and about 590 kg per day in Kanifinol and Thulhagiri respectively. Generation rate per hotel guest is estimated at 6.9 kg and 8.1 kg for Kanifinol and Thulhagiri respectively which include also the wastes discharged by the hotels staff. Total amount of waste samples and numbers of hotel guest in bed-nights reached at 15,610 kg and 2159 person. From these survey data, waste generation rate per hotel guest is estimated at 7,230 kg per day.

**b. Waste Composition in Resort Islands**

The high waste generation rate caused of the amount of yard waste such as trimmings of trees and plants, fallen leaves and sand stick to the fallen leaves. The ratio of yard waste, dirt and sand amount to about half of the waste collected as 58.0 % by weight in Kanifinol and 43.9 % in Thulhagiri.

Other major wastes generated in the resort islands are food waste - 26.5/43.3 %, glass bottles - 4.0/1.3 % and carton box (cardboard) - 3.1/2.8 % in Kanifinol and Thulhagiri respectively.



**Table I-4 Result of Waste Amount and Composition Survey in Resort Island (Kanifinol Resort Island)**

Survey Date 1998 22 June 24 June 25 June 26 June 27 June 28 June 29 June 30 June 1 July 4 July Average  
 Nos. of Hotel Guests 146 149 138 141 149 163 156 148 158 152 150  
 Weather Fine Fine Fine Cloudy Cloudy Cloudy Cloudy Fine Fine Cloudy Cloudy

Waste Composition	(unit : grams)										Ratio (%)			
	1st Day	2nd Day	3rd Day	4th Day	5th Day	6th Day	7th Day	8th Day	9th Day	10th Day		Max.	Min.	Avg.
<b>Organic Waste</b>														
Food Waste	340,850	276,000	220,800	276,000	276,000	281,000	248,400	276,000	282,100	248,400	340,850	220,800	272,555	26.45
Paper	4,100	12,950	10,140	9,220	14,400	15,490	23,560	22,500	61,070	45,600	61,070	4,100	21,903	2.13
Cardboard	29,260	23,720	27,300	28,250	56,640	23,500	35,300	19,620	35,300	35,400	56,640	19,620	31,429	3.05
Total	33,360	36,670	37,440	37,470	71,040	38,990	58,860	42,120	96,370	81,000	117,710	23,720	53,332	5.18
Plastics	2,150	1,980	1,500	3,550	2,400	3,200	6,100	2,200	3,120	7,930	7,930	1,500	3,413	0.33
Bottle & Others	2,010	1,330	1,030	12,200	1,670	2,730	7,800	0	2,780	7,300	12,200	0	3,885	0.38
PET	1,100	880	1,780	2,400	930	4,250	5,420	6,350	7,860	6,830	6,830	880	3,190	0.31
Total	5,260	4,190	4,310	18,150	5,000	10,180	19,320	8,550	7,860	22,060	26,960	2,380	10,488	1.02
Rubber & Leather	0	0	0	20	4,200	none	1,800	none	2,400	6,450	6,450	0	1,487	0.14
Textiles	1,000	2,250	1,120	3,000	3,890	3,650	2,200	7,100	3,300	4,900	7,100	1,000	3,241	0.31
Yard Waste	1,224,000	450,000	360,000	360,000	270,000	270,000	270,000	270,000	270,000	270,000	1,224,000	270,000	401,400	38.96
Wood	240	8,120	4,610	2,100	nil.	7,570	9,180	7,500	13,340	13,700	13,700	240	6,636	0.64
Other Org. Waste	0	27,250	33,170	12,850	28,300	47,200	65,360	8,400	200	47,450	65,360	0	27,018	2.62
Total (Organic Wastes)	1,604,710	804,480	661,450	709,590	658,430	658,590	675,120	619,670	675,570	693,960	1,802,130	518,140	776,157	75.33
<b>In-organic Waste</b>														
Glass	1,740	0	340	1,100	1,290	680	0	2,750	1,000	3,800	3,800	0	1,270	0.12
Bottle	110,240	38,040	23,600	20,650	26,050	44,110	34,800	29,700	36,600	44,650	110,240	20,650	40,844	3.96
Total	111,980	38,040	23,940	21,750	27,340	44,790	34,800	32,450	37,600	48,450	114,040	20,650	42,114	4.09
Tin Cans (Steel Cans)	8,500	9,760	8,550	14,080	6,940	15,650	9,440	15,550	5,200	13,950	15,650	5,200	10,762	1.04
Aluminum cans	870	1,230	450	1,170	700	650	1,750	920	600	7,750	7,750	450	1,609	0.16
Other Metals	540	100	3,920	980	1,250	1,380	3,750	4,750	900	2,800	4,750	100	2,037	0.20
Dirt, Ash, Sand	104,950	300,000	240,000	240,000	180,000	180,000	180,000	180,000	180,000	180,000	300,000	104,950	196,495	19.07
Total (Inorganic Wastes)	226,840	349,130	276,860	277,980	216,230	242,470	229,740	233,670	224,300	252,950	442,190	131,350	253,017	24.56
<b>Hazardous Waste</b>														
Batteries	Nil.	0	0	0	nil.	nil.	nil.	nil.	260	340	340	0	60	0.01
Other Hazardous Waste	Nil.	600	none	880	6,350	540	800	980	260	980	6,350	260	1,139	0.11
Total (Hazardous Waste)	0	600	0	880	6,350	540	800	980	520	1,320	6,690	260	1,199	0.12
Total Weight (kg) :	1,831,550	1,154,210	938,310	988,450	881,010	901,600	905,660	854,320	900,390	948,230	2,251,010	649,750	1,030,373	100.00

**Table 1-5 Result of Waste Amount and Composition Survey in Resort Island (Thuihagiri Resort Island)**

Type of Waste	Survey Date										Ratio (%)			
	1998 22 June	24 June	25 June	26 June	27 June	28 June	29 June	30 June	1 July	4 July		Average		
	66	N.A.	76	94	85	69	79	65	60	65	73			
	Rain		Fine	Cloudy	Cloudy	Cloudy	Cloudy	Fine	Cloudy	Cloudy				
	1st Day	2nd Day	3rd Day	4th Day	5th Day	6th Day	7th Day	8th Day	9th Day	10th Day	Max.	Min.	AVG.	(unit : grams)
<b>Organic Waste</b>	364,400	Waste	248,400	220,800	220,800	276,000	248,400	250,800	276,000	193,200	364,400	193,200	255,422	43.30
Food Waste	8,550	cleared	4,020	3,700	6,380	0	13,950	18,450	0	14,200	18,450	0	7,694	1.30
Paper	26,400	before	23,410	10,820	3,100	0	13,450	40,700	0	28,500	40,700	0	16,264	2.76
Cardboard	34,950	arrival	27,430	14,520	9,480	0	27,400	59,150	0	42,700	59,150	0	23,959	4.06
Total	1,100		2,230	1,970	150	0	4,600	7,100	0	7,450	7,450	0	2,733	0.46
Plastics	6,660		2,900	3,360	3,520	0	5,450	6,450	0	6,850	6,850	0	3,910	0.66
Film	2,680		4,950	870	2,450	0	5,950	4,270	0	5,350	5,950	0	2,947	0.50
Bottle & Others	10,440		10,080	6,200	6,120	0	16,000	17,820	0	19,650	20,250	0	9,590	1.63
PET	0		0	0	0	0	0	980	0	2,350	2,350	0	370	0.06
Total	1,420		1,300	200	200	0	200	3,020	0	2,480	3,020	0	980	0.17
Rubber & Leather	68,200		67,800	161,100	62,650	161,100	179,000	89,500	179,000	447,500	447,500	62,650	157,317	26.67
Textiles	0		880	0	0	0	8,200	8,480	0	14,500	14,500	0	3,562	0.60
Yard Waste	78,850		54,000	4,430	950	0	950	26,100	0	33,050	78,950	0	22,037	3.74
Wood	558,260		409,890	407,250	300,200	437,100	480,150	455,850	455,000	755,430	990,020	255,850	473,237	80.22
Other Org. Waste	0		660	100	820	0	0	2,500	0	2,300	2,500	0	709	0.12
Total (Organic Wastes)	16,090		3,080	1,630	3,700	0	9,100	7,120	0	26,730	26,730	0	7,494	1.27
Inorganic Waste	16,090		16,090	16,090	16,090	16,090	16,090	16,090	16,090	16,090	16,090	16,090	16,090	1.59
Glass	3,470		1,870	4,900	3,280	0	8,100	7,450	0	7,550	8,100	0	4,069	0.69
Broken Glass	1,400		2,520	500	70	0	620	1,890	0	4,100	4,100	0	1,233	0.21
Bottle	420		880	10	570	0	2,420	2,840	0	2,800	2,840	0	1,104	0.19
Total	35,750		45,000	107,100	41,650	107,100	119,000	53,550	107,100	297,500	297,500	35,750	101,528	17.21
Tin Cans (Steel Cans)	57,130		54,010	114,240	50,090	107,100	139,240	75,350	107,100	340,980	341,770	35,750	116,138	19.69
Aluminum cans	0		0	0	0	0	0	0	0	0	0	0	0	0.00
Other Metals	340		400	150	150	0	300	1,800	0	1,400	1,800	150	519	0.09
Other Hazardous Waste	620		400	400	400	0	300	1,800	0	1,400	1,800	490	557	0.09
Total (Hazardous Waste)	960		400	400	400	0	300	1,800	0	1,400	1,800	490	557	0.09
Total Weight (kg)	616,350		464,300	521,640	350,290	544,200	619,690	533,000	562,100	1,097,810	1,333,930	292,090	589,931	100.00

**(3) Waste Amount, Sources and Composition in Male'**

**a. Waste Amount Carried-in to Transfer Station**

The survey was conducted in two phase from 17 to 20 August and from 25 August to 12 September in 1998 for weighing the gross weight and tare weight of all vehicles including municipality collection vehicles, private vehicles and hand carts entering to the Transfer Station from 5 a.m. to 10 p.m. The results are summarised in Table 1-6.

Total carried-in waste amount in the 19 days amount to 3,844 tons or 202 tons per day. Solid wastes in residential and commercial area are generated about 80 tons per day or 39 % of total waste discharged. Wastes from business and industrial activities including institutional wastes are generated 42 tons per day or 21 % and construction wastes is discharged about 80 tons per day or 40 %. Among four types of collection & transportation modes, vehicles collect about 75 %. Hand carts collect a little fewer than 4 % and collection by micro bins amount to 12 %. Wastes carried by the individual person nearby the Transfer Station and wastes transported vehicles from midnight to early morning amount to about 10 %.

**b. Waste Amount Carried-out from Transfer Station**

Carried-out waste amount was surveyed for 10 days from 22 to 24 August and from 13 to 20 September in 1998. All the waste transportation trucks belong to MCPW were checked with the tare weight in the beginning of the survey and weighed the gross weight in every trip to the Thilafushi. Table 1-7 shows the results of the 10 days' survey.

Two hundred ninety (290) trips were made and carried out 1,555 tons of wastes in total. The net loading per trucks is estimated at 5.36 tons. The results shows that 29 trips by the trucks carry about 155 tons of waste to the Tilafushi every day.

Table 1-6 Summary of Waste Amount Survey in Male'

Generation Source Category	Code	Total - 19 days (ton)	Average- per day (ton)	Ratio (%)
Residential Area by Vehicles	A1	463.38	24.39	12.06
Hand Cart		70.48	3.71	1.83
Individual, Midnight to Morning Waste		69.72	3.67	1.81
Micro Bin	A2	461.10	24.27	12.00
Sub Total	(A1&2)	1064.67	56.04	27.70
Commercial Area (General) by Vehicles	B-1	271.30	14.28	7.06
Hand Cart		70.48	3.71	1.83
Individual, Midnight to Morning Waste		69.72	3.67	1.81
Commercial Waste (STO)	B-2	40.26	2.12	1.05
Sub Total	(B1&2)	451.76	23.78	11.75
<b>Total (A+B)</b>		<b>1516.44</b>	<b>79.81</b>	<b>39.45</b>
Buildings (Government Office)	C-1	133.99	7.05	3.49
Building (Private Office & Shops)	C-2	231.55	11.79	5.83
Sub Total	(C1&2)	365.54	19.24	9.51
Fruits Market & Parks	D	107.57	5.66	2.80
Restaurant & Hotels	E	77.37	4.07	2.01
Home Industry (Carpentry - Saw Dust)	F-1	100.88	5.31	2.62
Home Industry (Metals)	F-2	30.29	1.59	0.79
Home Industry (Others)	F-3	100.16	5.27	2.61
Sub Total	(F1 to 3)	231.33	12.18	6.02
School*1	G	1.84	0.10	0.05
Hospital & Clinics	H	18.26	0.96	0.48
<b>Total (C-H)</b>		<b>801.92</b>	<b>42.21</b>	<b>20.86</b>
Construction Waste (Sand & Concrete Debris)	I-1	679.44	35.76	17.68
Midnight to Morning Concrete Debris & Sand	I-1	229.05	12.06	5.96
Construction Demolition Waste	I-2	268.36	14.12	6.98
Construction Waste (Mixed)	I-3	348.31	18.33	9.06
<b>Total (I)</b>	(I1 to 3)	<b>1525.16</b>	<b>80.27</b>	<b>39.68</b>
<b>Ground Total</b>	<b>(A to I)</b>	<b>3843.51</b>	<b>202.29</b>	<b>100.00</b>

\*1 : Most of the wastes of schools are collected together with the item "Residential Area by Vehicle" and the survey record do not show actual amount of wastes collected from schools.

**Table 1-7 Summary of Carried-out Waste Amount from Transfer Station**

Summary : Transportation Loading by Truck Number			
Plate No. of Vehicle	Total Weight (ton)	Total Times of Transportation (time)	Truck Loading per Trip (ton)
T03-2598	141.80	24	5.91
T03-2590	158.56	28	5.66
T03-2589	137.62	26	5.29
T03-2588	136.91	26	5.27
T03-1491	163.37	29	5.63
T03-1490	151.42	29	5.22
T03-1446	4.60	4	1.15
T03-1353	6.59	4	1.65
T03-1320	55.45	9	6.16
T03-1271	204.91	34	6.03
T03-1270	8.83	1	8.83
T03-1217	119.75	29	4.13
T03-1149	6.46	1	6.46
T03-1148	152.99	27	5.67
<b>Total</b>	<b>1554.87</b>	<b>290</b>	<b>5.36</b>

**e. Sources and Composition of Wastes in Male'**

**i) Generation Sources of Solid Wastes**

Solid waste amount by generation sources in Male' is learned from Table 1-6. Wastes collected from residential houses amount to 28 % or 56 tons per day and the amount added the wastes from the shop&residence houses and shops reach at 39.4 % or 79.8 tons approximately.

Industrial waste collected from office buildings, restaurants & hotels, home industries, hospitals & clinics amount to 20.9 % or 42.2 tons per day. Among the industrial waste sources, private office & shop buildings, discharge 5.8 % or 11.8 tons followed by government office buildings, carpentry factories and other home industries at the ratio of 5.8%, 3.5 %, 2.6%, 2.6 % respectively.

Waste from construction works indicate the largest waste generator, which is discharged about 39.7 % or 80.3 tons per day. Among the construction wastes, concrete debris and sand amount to 23.7 % or 47.8 tons per day followed by mixed construction wastes and demolition wastes of the ratio 9.1 and 7.0 % respectively.

**ii) Waste Composition**

The result of waste composition survey of 39 samples, the total weight of samplings amount to 5,659 kg, were summarised in Table 1-8. The analysis were made to combine the results together with the waste generation sources survey and prepared Table 1-9 and Table 1-10 to indicate the amount of waste by generation sources and by composition.

As an average solid waste composition in Male indicated in Table 1-10, organic wastes amount to 54.9 %, in-organic waste amount to 41.7 %, hazardous wastes amount to 0.2 % and other mixed wastes amount to 3.2 % of the waste amount of 202.3 tons collected daily except for Friday. Among individual elements of the composition, the wastes including dirt, ash & sand and concrete debris show the largest ratio of 37.4 % and followed by waste wood, food waste, cardboard, and paper reach at 11.8 %, 11.8 %, 7.5 % and 7.2 % by weight respectively.

**Table 1-8 Result of Waste Composition Survey in Male'**

Survey Period : August - September, 1998  
 Nos. of Samples : 39 samples  
 Total Weight of Samples : 5,659 kg

Type of Waste	Residential Area - General		Residential Area - Micro Bins		Commercial Area - General		Buildings - Government Offices		Buildings - Private Offices & Shops		Market & Public Areas		Hotels & Restaurants		Schools		Construction Wastes - Mixed	
	Total Weight (g)	Ratio (%)	Total Weight (g)	Ratio (%)	Total Weight (g)	Ratio (%)	Total Weight (g)	Ratio (%)	Total Weight (g)	Ratio (%)	Total Weight (g)	Ratio (%)	Total Weight (g)	Ratio (%)	Total Weight (g)	Ratio (%)	Total Weight (g)	Ratio (%)
<b>Organic Waste</b>	81,450	10.96	279,900	36.27	91,430	12.83	6,650	4.63	38,100	21.08	137,580	40.27	635,610	82.98	24,590	20.40	0	0.00
Food Waste	54,560	7.34	56,080	7.27	112,360	15.76	70,840	49.36	34,250	18.95	27,010	7.91	12,020	1.57	19,170	15.91	19,360	1.03
Paper	35,260	4.74	37,110	4.81	221,290	31.04	6,050	4.22	52,940	29.28	26,030	7.62	30,530	3.99	17,970	14.91	67,770	3.61
Cardboard	89,820	12.09	93,190	12.08	333,650	46.81	76,890	53.58	87,190	48.23	53,040	15.52	42,550	5.55	37,140	30.82	87,130	4.64
Subtotal	21,990	2.96	33,530	4.35	41,390	5.81	4,040	2.82	5,680	3.14	18,430	5.41	16,180	2.11	5,600	4.65	47,750	2.54
Film	41,610	5.60	10,740	1.39	18,420	2.58	3,840	4.07	5,270	2.92	6,640	1.94	6,830	0.89	2,750	2.28	8,050	0.43
Bottle & Others	5,320	0.72	3,880	0.50	11,250	1.58	3,500	2.44	1,640	0.91	2,550	0.75	2,470	0.32	900	0.75	700	0.04
PET	68,920	9.27	48,150	6.24	71,060	9.97	13,380	9.32	12,590	6.96	27,670	8.10	25,480	3.33	9,250	7.68	56,500	3.01
Subtotal	8,320	1.12	6,680	0.87	8,210	1.15	630	0.44	2,980	1.65	4,650	1.36	4,650	0.60	0	0.00	2,480	0.13
Rubber & Leather	25,300	3.40	20,140	2.61	19,440	2.73	630	0.44	2,520	1.39	3,740	1.09	3,900	0.51	1,640	1.36	760	0.04
Textiles	112,890	15.19	66,700	8.64	50,330	7.06	36,080	25.14	8,310	4.60	16,820	4.92	3,060	0.40	10,310	8.55	17,450	0.93
Yard Waste	48,270	6.50	6,130	0.79	8,570	1.20	1,740	1.21	2,570	1.42	2,140	3.36	2,500	0.33	2,720	2.26	146,590	7.80
Wood	66,640	8.97	126,190	16.35	37,970	5.33	2,420	1.69	5,150	2.85	21,410	6.27	2,500	0.33	9,050	7.51	11,450	0.61
Other Org. Waste	501,610	67.50	647,030	83.86	620,660	87.07	138,420	96.45	159,410	88.18	276,380	80.89	715,600	93.42	94,700	78.58	322,360	17.15
<b>In-organic Waste</b>	2,900	0.39	3,750	0.49	2,520	0.35	0	0.00	750	0.41	1,900	0.56	3,390	0.44	1,350	1.12	0	0.00
Glass	18,410	2.48	13,160	1.71	4,860	0.68	1,850	1.29	2,250	1.24	9,470	2.77	13,080	1.71	2,150	1.78	800	0.04
Broken Glass	21,310	2.87	16,910	2.19	7,380	1.04	1,850	1.29	3,000	1.66	11,370	3.33	16,470	2.15	3,500	2.90	800	0.04
Bottle	28,490	3.83	18,990	2.45	13,150	1.84	1,840	1.28	3,220	1.78	11,510	3.37	22,310	2.91	9,980	8.28	19,900	1.06
Subtotal	3,490	0.47	2,960	0.38	5,970	0.84	1,020	0.71	900	0.50	3,140	0.92	2,410	0.31	3,900	3.24	850	0.05
Tin Cans (Steel Cans)	18,760	2.52	4,920	0.64	2,440	0.34	180	0.13	0	0.00	520	0.15	8,650	1.13	2,450	2.03	26,170	1.39
Aluminum cans	168,370	22.66	79,120	10.25	59,880	8.40	0	0.00	13,050	7.22	37,380	10.94	0	0.00	5,750	4.77	494,050	27.51
Other Metals	240,420	32.35	122,800	15.91	88,820	12.46	4,890	3.41	20,170	11.16	63,920	18.71	49,820	6.50	25,580	21.22	541,770	30.51
DIRT, Ash, Sand	610	0.08	880	0.11	2,800	0.39	0	0.00	940	0.52	380	0.11	380	0.05	240	0.20	0	0.00
Hazardous Waste	460	0.06	860	0.11	560	0.08	200	0.14	260	0.14	1,000	0.29	220	0.03	0	0.00	15,000	0.80
Batteries	1,070	0.14	1,740	0.23	3,360	0.47	200	0.14	1,200	0.66	1,380	0.40	660	0.08	240	0.20	15,000	0.80
Other Hazardous Waste	743,100	100.00	771,620	100.00	712,840	100.00	143,510	100.00	180,780	100.00	341,680	100.00	766,020	100.00	120,520	100.00	879,130	100.00
Hazardous Waste Total	3,165		2,610		4,760		1,440		1,760		1,720		2,080		860		2,480	
Total Weight (kg)	0.235		0.296		0.150		0.100		0.103		0.199		0.368		0.140		0.758	
Total Waste Volume (lit.)																		
Bulk Density (kg/lit.)																		

Table 1-9 Result of Waste Generation Sources & Composition Survey in Male

Survey Period: August - September, 1996  
 Waste Amount Collected per day: 202.29 Tons  
 Total Weight of Samples of Waste Composition Survey: 5,019 kg

Type of Waste	Residential Area - Channel (A-1)		Residential Area - Micro Area		Commercial Area - Channel		Commercial Area - Government Offices		Buildings - Private Offices & Shops		Markets & Public Areas		Home & Business		Construction Waste (Metal)		Construction Waste (Concrete, Deter)		Home Industry (Carpeting - Sew Dust)		Home Industry (Metal)		Others		Total
	Weight (ton)	Ratio (%)	Weight (ton)	Ratio (%)	Weight (ton)	Ratio (%)	Weight (ton)	Ratio (%)	Weight (ton)	Ratio (%)	Weight (ton)	Ratio (%)	Weight (ton)	Ratio (%)	Weight (ton)	Ratio (%)	Weight (ton)	Ratio (%)	Weight (ton)	Ratio (%)	Weight (ton)	Ratio (%)	Weight (ton)	Ratio (%)	
<b>Organic Waste</b>	31.77	15.72	24.27	12.23	3.05	1.51	7.45	3.66	11.79	5.84	3.66	1.82	4.77	2.36	14.12	7.01	47.52	23.76	5.31	2.65	1.59	0.78	6.53	32.79	
Food Waste	3.48	10.96	4.40	13.73	36.27	112.83	0.25	4.63	2.46	21.05	2.24	40.27	3.38	62.96	0.00	0.00	0.00	0.00	5.31	1.59	1.59	0.00	6.53	32.79	
Paper	2.33	7.34	1.76	5.47	7.27	22.76	3.06	49.28	2.23	16.95	0.45	7.91	0.64	1.57	0.19	1.01	0.00	0.00	5.31	1.59	1.59	0.00	6.53	32.79	
Cardboard	3.51	10.96	4.40	13.73	36.27	112.83	0.25	4.63	2.46	21.05	2.24	40.27	3.38	62.96	0.00	0.00	0.00	0.00	5.31	1.59	1.59	0.00	6.53	32.79	
Subtotal	3.48	10.96	4.40	13.73	36.27	112.83	0.25	4.63	2.46	21.05	2.24	40.27	3.38	62.96	0.00	0.00	0.00	0.00	5.31	1.59	1.59	0.00	6.53	32.79	
Plastic	0.04	0.12	0.04	0.12	0.04	0.12	0.04	0.12	0.04	0.12	0.04	0.12	0.04	0.12	0.04	0.12	0.04	0.12	0.04	0.12	0.04	0.12	0.04	0.12	
Film	0.04	0.12	0.04	0.12	0.04	0.12	0.04	0.12	0.04	0.12	0.04	0.12	0.04	0.12	0.04	0.12	0.04	0.12	0.04	0.12	0.04	0.12	0.04	0.12	
Books & Others	1.76	5.47	1.76	5.47	1.76	5.47	1.76	5.47	1.76	5.47	1.76	5.47	1.76	5.47	1.76	5.47	1.76	5.47	1.76	5.47	1.76	5.47	1.76	5.47	
PEB	0.23	0.72	0.12	0.36	0.56	1.76	0.18	0.54	0.11	0.33	0.04	0.12	0.04	0.12	0.04	0.12	0.04	0.12	0.04	0.12	0.04	0.12	0.04	0.12	
Subtotal	2.96	9.27	3.51	10.81	4.24	12.97	0.29	0.89	0.22	0.69	0.46	1.38	0.14	0.42	0.05	0.15	0.04	0.12	0.04	0.12	0.04	0.12	0.04	0.12	
Rubber & Leather	0.36	1.12	0.21	0.67	0.27	0.83	0.04	0.12	0.19	0.58	0.04	0.12	0.04	0.12	0.04	0.12	0.04	0.12	0.04	0.12	0.04	0.12	0.04	0.12	
Textile	1.06	3.40	0.63	1.95	2.01	6.23	0.03	0.09	0.44	1.39	0.06	0.18	0.09	0.27	0.01	0.03	0.04	0.12	0.04	0.12	0.04	0.12	0.04	0.12	
Yard Waste	4.83	15.19	2.10	6.54	1.64	5.06	7.06	35.14	0.54	4.40	0.26	0.82	0.02	0.06	0.17	0.09	0.00	0.00	5.31	1.59	1.59	0.00	6.53	32.79	
Wood	2.04	6.50	0.19	0.59	1.29	3.95	1.23	6.09	1.17	1.42	0.91	3.36	0.02	0.06	0.17	0.09	0.00	0.00	5.31	1.59	1.59	0.00	6.53	32.79	
Other Org. Waste	2.85	8.97	3.97	12.35	1.27	3.95	0.13	0.39	0.34	2.65	0.35	1.05	0.01	0.03	0.11	0.06	0.00	0.00	5.31	1.59	1.59	0.00	6.53	32.79	
<b>Organic Waste Total</b>	21.44	67.50	30.26	93.06	49.32	152.70	71.19	354.65	10.39	84.15	4.54	14.09	3.40	16.74	17.15	85.61	47.62	237.84	5.31	16.44	1.59	0.78	6.53	32.79	
<b>Inorganic Waste</b>	10.26	51.04	10.26	51.04	10.26	51.04	10.26	51.04	10.26	51.04	10.26	51.04	10.26	51.04	10.26	51.04	10.26	51.04	10.26	51.04	10.26	51.04	10.26	51.04	10.26
Glass	0.12	0.39	0.12	0.39	0.12	0.39	0.12	0.39	0.12	0.39	0.12	0.39	0.12	0.39	0.12	0.39	0.12	0.39	0.12	0.39	0.12	0.39	0.12	0.39	
Brick	0.79	2.48	0.41	1.26	0.68	2.09	0.10	0.31	0.15	0.45	0.16	0.48	0.07	0.21	0.01	0.03	0.04	0.12	0.04	0.12	0.04	0.12	0.04	0.12	
Subtotal	0.91	2.87	0.53	1.65	0.80	2.48	0.10	0.31	0.20	0.60	0.19	0.57	0.09	0.27	0.01	0.03	0.04	0.12	0.04	0.12	0.04	0.12	0.04	0.12	
Tin Cans (Steel Cans)	1.22	3.83	0.59	1.82	0.44	1.34	0.10	0.31	0.28	0.86	0.09	0.27	0.12	0.36	0.01	0.03	0.04	0.12	0.04	0.12	0.04	0.12	0.04	0.12	
Aluminium cans	0.15	0.47	0.09	0.28	0.30	0.92	0.05	0.15	0.06	0.18	0.05	0.15	0.01	0.03	0.01	0.03	0.04	0.12	0.04	0.12	0.04	0.12	0.04	0.12	
Other Metals	0.60	1.85	0.15	0.47	0.64	1.95	0.24	0.74	0.13	0.39	0.08	0.24	0.01	0.03	0.01	0.03	0.04	0.12	0.04	0.12	0.04	0.12	0.04	0.12	
Dirt, Ash, Sand	7.29	22.66	2.49	7.64	10.23	31.09	0.00	0.00	0.85	2.62	10.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.31	1.59	1.59	0.00	6.53	32.79	
<b>Inorganic Waste Total</b>	10.26	51.04	10.26	51.04	10.26	51.04	10.26	51.04	10.26	51.04	10.26	51.04	10.26	51.04	10.26	51.04	10.26	51.04	10.26	51.04	10.26	51.04	10.26	51.04	10.26
<b>Household Waste</b>	0.03	0.09	0.03	0.09	0.03	0.09	0.03	0.09	0.03	0.09	0.03	0.09	0.03	0.09	0.03	0.09	0.03	0.09	0.03	0.09	0.03	0.09	0.03	0.09	
Household Waste (Electronics)	0.03	0.09	0.03	0.09	0.03	0.09	0.03	0.09	0.03	0.09	0.03	0.09	0.03	0.09	0.03	0.09	0.03	0.09	0.03	0.09	0.03	0.09	0.03	0.09	
Other Household Waste	0.02	0.06	0.03	0.09	0.11	0.32	0.04	0.12	0.02	0.06	0.03	0.09	0.03	0.09	0.03	0.09	0.03	0.09	0.03	0.09	0.03	0.09	0.03	0.09	
<b>Household Waste Total</b>	0.05	0.14	0.06	0.18	0.14	0.41	0.07	0.21	0.04	0.12	0.06	0.18	0.06	0.18	0.06	0.18	0.06	0.18	0.05	0.14	0.06	0.18	0.05	0.14	
Home Industry (Others)																									
School																									
Hospital & Clinics																									
<b>Total Weight (kg)</b>	31.77	100.00	24.27	100.00	23.78	100.00	7.45	100.00	11.79	100.00	5.84	100.00	4.07	100.00	14.12	100.00	47.62	100.00	5.31	100.00	1.59	100.00	0.78	100.00	
<b>Estimated Waste Volume (m<sup>3</sup>)</b>	115		82		119		75		115		26		11		30		140		19		2		27		
<b>Bulk Density (ton/m<sup>3</sup>)</b>	0.233		0.298		0.198		0.100		0.100		0.366		0.366		0.754		1.600		0.754		0.754		0.233		



Table 1-10 Summary of Waste Composition by Waste Generation Sources in Male'

Survey Period : August - September, 1993

Daily Average Waste Amount Collected during Survey Period:

202.29 ton/day

Type of Waste	Domestic & Commercial Wastes		Business & Industrial Wastes		Construction Waste		Total	
Total Weight	79.81		42.20		80.27		202.29	
Sampling Weight & Composition Ratio	Weight (ton)	Weight (ton)	Ratio (%)	Weight (ton)	Ratio (%)	Weight (ton)	Ratio (%)	
<b>Organic Waste</b>								
Food Waste	15.33	8.49	20.11	0.00	0.00	23.82	11.78	
Paper	Paper	7.84	6.42	15.22	0.19	0.24	14.46	7.15
	Cardboard	10.06	4.36	10.33	0.66	0.82	15.08	7.45
	Subtotal	17.90	10.78	25.55	0.85	1.06	29.53	14.60
Plastics	Film	3.38	0.97	2.30	0.47	0.58	4.81	2.38
	Bottle & Others	2.73	0.79	1.88	0.08	0.10	3.60	1.78
	PET	0.72	0.34	0.82	0.01	0.01	1.08	0.53
	Subtotal	6.83	2.11	5.00	0.55	0.69	9.49	4.69
Rubber & Leather	0.84	0.30	0.72	0.02	0.03	1.17	0.58	
Textiles	2.36	0.28	0.66	0.01	0.01	2.65	1.31	
Yard Waste	8.60	2.71	6.42	0.17	0.21	11.48	5.68	
Wood	2.54	5.77	13.68	15.55	19.37	23.86	11.80	
Other Org. Waste	8.08	0.83	1.97	0.11	0.14	9.03	4.46	
<b>Organic Waste Total</b>	<b>62.50</b>	<b>31.28</b>	<b>74.11</b>	<b>17.26</b>	<b>21.51</b>	<b>111.04</b>	<b>54.89</b>	
<b>In-organic Waste</b>								
Glass	Broken Glass	0.33	0.10	0.23	0.00	0.00	0.42	0.21
	Bottle	1.36	0.47	1.11	0.01	0.01	1.84	0.91
	Subtotal	1.69	0.57	1.34	0.01	0.01	2.26	1.12
	Tin Cans (Steel Cans)	2.25	0.61	1.46	0.19	0.24	3.06	1.51
Aluminum cans	0.44	0.18	0.42	0.01	0.01	0.63	0.31	
Other Metals	1.04	1.65	3.92	0.26	0.32	2.95	1.46	
Dirt, Ash, Sand	11.68	1.47	3.48	62.39	77.72	75.54	37.35	
<b>In-organic Waste Total</b>	<b>17.10</b>	<b>4.48</b>	<b>10.62</b>	<b>62.86</b>	<b>78.30</b>	<b>84.44</b>	<b>41.74</b>	
<b>Hazardous Waste</b>								
Hazardous Waste (Batteries)	Hazardous Waste (Batteries)	0.15	0.07	0.16	0.00	0.00	0.22	0.11
	Other Hazardous Waste	0.07	0.05	0.11	0.15	0.18	0.26	0.13
<b>Hazardous Waste Total</b>	<b>0.21</b>	<b>0.11</b>	<b>0.27</b>	<b>0.15</b>	<b>0.18</b>	<b>0.47</b>	<b>0.23</b>	
Home Industry (Others)		5.27	12.49			5.27	2.61	
School		0.10	0.24			0.10	0.05	
Hospital & Clinics		0.96	2.27			0.96	0.47	
<b>Total Weight (kg)</b>	<b>79.81</b>	<b>42.20</b>	<b>100.00</b>	<b>80.27</b>	<b>100.00</b>	<b>202.28</b>	<b>100.00</b>	
<b>Total Waste Volume (cu. m)</b>	<b>378</b>	<b>265</b>		<b>72.71</b>		<b>716.03</b>		
<b>Bulk Density (ton/cu m)</b>	<b>0.211</b>	<b>0.159</b>		<b>1.104</b>		<b>0.283</b>		

d. **Waste Amount Survey in Thilafushi Disposal Site**

Thirty (30) days' survey was conducted from 8 July to 9 August in the Thilafushi to check the amount and types of the wastes transported directly from the resort islands. There were 31 resort islands, 2 nearby inhabited islands and Hulhule transporting wastes to the Thilafushi. The results are summarised and indicated in Table 1-11. During the 32 days, 302 dhoni and barges carried waste about 454 tons to the disposal site. The waste amount transported by the dhoni ranges from about 3.6 tons to 32 tons per day by the numbers of 3 to 15 boats. In average, nine(9) boats arrive daily to bring-in about 14.2 tons of wastes. The boat anchor about 35 minutes for unloading 1.5 tons of waste in average.

**Table 1-11 Summary of Waste Amount Survey in Thilafushi**

No.	Date			Nos. of Boat Arrival (boat)	Unloading Time (min.)	Estimated Weight (ton/day)	No.	Date			Nos. of Boat Arrival (boat)	Unloading Time (min.)	Estimated Weight (ton/day)
	Day	Month	Day of the Week					Day	Month	Day of the Week			
1	8	7	Wed	14	43	25.13	17	25	7	Sat	11	35	23.44
2	9	7	Thu	6	26	8.35	18	26	7	Sun	10	20	11.39
3	10	7	Fri	7	34	9.84	19	27	7	Mon	7	32	18.73
4	11	7	Sat	9	50	32.00	20	28	7	Tue	10	27	18.05
5	12	7	Sun	7	44	13.42	21	29	7	Wed	7	43	8.94
6	13	7	Mon	7	53	8.10	22	30	7	Thu	13	27	10.94
7	14	7	Tue	3	26	3.56	23	31	7	Fri	9	27	9.43
8	15	7	Wed	8	47	15.77	24	2	8	Sun	9	28	8.91
9	16	7	Thu	13	41	15.68	25	3	8	Mon	15	36	16.79
10	17	7	Fri	5	50	5.70	26	4	8	Tue	13	29	11.71
11	18	7	Sat	8	39	17.16	27	5	8	Wed	12	34	12.59
12	19	7	Sun	8	28	8.33	28	6	8	Thu	13	34	14.78
13	20	7	Mon	11	45	24.10	29	8	8	Sat	12	26	11.76
14	21	7	Tue	9	29	16.00	30	9	8	Sun	10	32	18.11
15	22	7	Wed	9	49	22.85	31	10	8	Mon	9	39	10.90
16	23	7	Thu	5	32	7.11	32	11	8	Tue	13	30	14.00
Total											302	1,135	453.57
Maximum											15	53	32.00
Average											9	35	14.17
Minimum											3	20	3.56
Average Loading Weight (ton/boat)													1.50

In parallel with the Waste Amount Survey at the Thilafushi, questionnaires were distributed to 74 resort islands through co-operation of the Ministry of Tourism to collect data and information of SWM activities in each resort island. Table 1-12 indicate the information from 45 respondents. Thirty one (31) resort islands out of 45 respondents are using the Thilafushi for the final disposal site. Each resort island spend 1,238 Rfs per trip or 77,500 Rfs in a year in average for the cost of transportation and unloading.

**Table 1-12 Summary of Waste Disposal Survey for Resort Islands**

Items	Transport & Unload Cost per Trip (Rfs)	Annual Transport Cost (Rfs)	Annual Hotel Guest in 1997 (bed-night)	Nos. of Staff on Season (person)	Nos. of Staff off-season (person)	Nos of Hotel Rooms (room)
Effective Count	33	32	41	44	44	45
Total	40,839	2,480,400	2,247,967	7,503	7,320	3,962
Average	1,238	77,512	54,828	171	166	88

## 1.2 Recovery/Recycling of Solid Waste

### 1.2.1 Recycling Activity in Operation

As a whole, recycling of solid waste is inactive here in the Maldives. However, small scale recycling market exist in Male'. For example, about 15 to 20 scavengers pick up recyclable materials at the Transfer Station to earn their livings. Recovered materials are sold to the buyers and/or exporters to reuse and materials recycling in the markets in Male and India. Some kind of recovered reusable materials are sold at the second hand market located at the open space next to the fruits market in Male. The surveys conducted to interview with the person engaged in recycling activities and to weigh the amount of recovered materials at the Transfer Station as summarised in the following subsections.

#### (1) Recycling Market in Male

##### a. Scavengers

About 15 to 20 person are working to pick up recyclable materials at the Transfer Station. Among them, 3 to 4 person are working at the break of dawn to around 7 to 8 a.m. for picking up the waste discharged from midnight to early morning. The other group of about 10 to 15 people are working daytime until 5 p.m.

The major materials recovered from the Transfer Station are coconut shells, electric wire (copper), broken electric appliances and machines, 5 gallon steel cans, glass bottles, sacks, clothes and toys.

Their earnings amount to 200 to 300 Rfs in average and sometimes it rise to 500 Rfs depending of the picked up items. Selling price of the major materials recovered by them are;

Coconut Shells (Firewood)	15 Rfs per sack about 20 kg.
Copper	10 Rfs per kg
Bottle	25 Rfs per 100 bottles
Brass	10 -15 Rfs per kg
Steel	About 10 Rfs per kg
Woven sacks	50 Rfs per 400 sacks
Others	Depend on negotiation

**b. Buyers of Recovered Materials**

Four(4) buyers are identified at the Transfer Station. The first man is working for scavenging materials at the Transfer Station and buy coconut shells from other scavengers at the rate 15 Rfs per sack and sell it to hotels specially for use as firewood to bake "Bokiba".

The other buyer buy bottles about 1,500 bottles per month to sell at 1 Rfs per bottle after washing.

Two buyers are working with two assistant men to collect brass, zinc and ferrous metal. One buyer dealt 2 tons of brass in a month to sell at the price 15,000 Rfs per ton.

**c. Exporter of Recovered Materials**

Three(3) exporters were identified during the survey period. Two men are working together with 4 to 6 men to deal with iron scraps but their activities are irregular. One exporter or merchant visit Maldives every week by air together with 2 to 3 accompanies to bring fruits and vegetable to the Male market. On his return trip to India, he takes copper and zinc collected from the buyers. Copper is sold at 13,000 Rfs per ton.

**d. Reusable Goods Bazaar**

Reusable goods bazaar is open at schools in the term of school holiday organised by PTA. The bazaar is opened for 5 days to sell many types of second hand reusable items including books, clothes, toys, etc. brought in by the PTA to sell it to the public. The bazaar is opened once in a year at 4 primary schools and the bazaar is crowded with many interesting residents. In other activities, the Society for Health and Education open stalls once in a year e to sell old books in the period of festival.

**(2) Amount of Recyclable Materials**

The survey was conducted for 15 days to measure weight of the recovered materials of the daytime scavengers working at the Transfer Station. The result of the survey was summarised in Table 1-13. During the survey period, the total weight of recovered materials amounted to 2,848 kg by about 10 to 15 scavengers collected everyday. In an average, the scavengers collect the reusable and recyclable materials amounted to about 190 kgs daily or about 0.1 % counted from the solid waste amount carried-in to the Transfer Station. Recovery of coconut shells is the most active work among the scavengers collecting about 110 kg or 58 % of the total weight every day followed by bottles, textile, waste electric appliance, and electric wire.

**Table 1-13 Amount of Materials Recovery by Scavengers**  
 Survey Period : 22 August - 7 September, 1998

Recovered Materials	Weight (kg)	Average per day (kg/d)	Ratio (%)
Coconut Shells	1,656	110	58.13
Electric Wire	126	8	4.42
Electric Appliances	193	13	6.78
5 Gals. Steel Cans	52	3	1.83
Other Metals	69	5	2.42
Bottles	454	30	15.92
Textiles	222	15	7.79
Others	77	5	2.72
<b>Total (kg)</b>	<b>2,848</b>	<b>190</b>	<b>100.00</b>

### 1.2.2 Materials Flow Related to Waste Generation

The Study Team collected the records of import goods in 1995 from the Customs. The aim of collection of this data is a try to make a material flow of the goods until the goods are consumed to estimate broadly the generation amount of solid waste in Male. However, due to difficulties to convert all the goods into weight or because of no records of out-going flow of the goods to resort islands and/or to the local inhabited islands, the trial have abandoned but the import records have shown in Table 1-14 (1/3) to (3/3) for a reference.

Table 1-14 (1/3) Imports of Maldives, 1995

Code	Description	Unit	Quantity	CIF (Rf.)
1	Live animals	No.	4,227	126,614
2	Meat and edible meat offal	kg	2,296,729	62,131,439
3	Fish & crustaceans, molluscs & other aquatic invertebrates	kg	111,745	11,045,259
4	Dairy produce, birds' eggs, natural honey, edible products of animal origin not elsewhere specified or included	kg	2,362,302	105,832,457
5	Products of animal origin not elsewhere specified or included	kg	1,749	27,138
6	Live trees & other plants, bulb, root and the like, cut flowers and ornamental foliage	kg	13,609	2,380,546
7	Edible vegetables and certain roots and tubers	kg	8,639,512	70,766,407
8	Edible fruit and nuts, peel of citrus fruit or melon	kg	4,349,716	52,973,831
9	Coffee, tea, mate and spices	kg	862,785	22,678,038
10	Cereals	kg	11,622,233	45,223,902
11	Products of the milling industry, malt, starches, insulin, wheat gluten	kg	12,576,429	39,312,489
12	Oil seeds, oleaginous fruit, miscellaneous grains, seeds & fruit, industrial or medicinal plants, straw & fodder	kg	36,165	967,468
13	Lac, gums, resins & other vegetable saps & extracts	kg	5,360	626,188
14	Vegetable plaiting materials, vegetable products not elsewhere specified or included	kg	25,112	328,180
15	Animal or vegetable fats & oils & their cleavage products, prepared edible fats, animal or vegetable waxes	ltr	3,953,298	33,576,477
16	Preparations of meat, of fish or of crustaceans, molluscs or other aquatic invertebrates	kg	199,888	5,970,135
17	Sugars and sugar confectionery	kg	10,654,175	62,197,024
18	Cocoa and cocoa preparations	kg	337,660	12,976,389
19	Preparations of cereal, flour, starch or milk, pastrycooks' products	kg	813,815	39,286,742
20	Preparations of vegetables, fruit, nuts or other parts of plants	kg	2,538,235	39,586,862
21	Miscellaneous edible preparations	kg	721,416	15,864,240
22	Beverages, spirits and vinegar	ltr	6,510,696	82,809,199
23	Residues & waste from food industries, prepared animal fodder	kg	2,017	63,002
24	Tobacco and manufactured tobacco substitutes	No.	235,240,017	52,544,393
25	Salt, sulphur, earth & stone, plastering materials, lime & cement	kg	178,283,772	117,745,652
26	Ores, slag and ash	kg	72,000	113,762
27	Mineral fuels, mineral oils & products of their distillation, bituminous substances, mineral waxes	kg	200,172,844	358,904,140
28	Inorganic chemicals, organic or inorganic compounds of precious metals, rare-earth metals of radioactive elements or of isotopes	kg	355,155	4,889,837
29	Organic chemicals	kg	73,608	1,673,511
30	Pharmaceutical products	kg	1,797,310	36,749,884
31	Fertilisers	kg	850,955	1,684,552
32	Tanning or dyeing extract, tanning & derivatives, dyes, pigments and other colouring matter, paints & varnishes, putty & other mastics, inks	kg	1,345,482	29,246,450
33	essential oils & resinoids, perfumery, cosmetic or toilet preparations	kg	397,801	37,859,020
34	Soap, organic surface-active agents, washing preparation, lubricating preparations, artificial waxes, prepared waxes polishing or scouring preparations, candle & similar articles, modelling pastes, "dental waxes" & dental preparation with a	kg	2,359,237	22,977,195

	basis of plaster			
35	Albuminoidal substances, modified starches, glues, enzymes	kg	111,191	5,023,880
36	Explosives, pyrotechnic products, matches, pyroporich alloys, certain combustible preparations	kg	227,386	1,045,167
37	photographic or cinematographic goods	No.	60,046	4,815,514
38	Miscellaneous chemical products	kg	1,452,587	10,348,747
39	Plastics and articles thereof	kg	4,485,559	64,284,069

Table 1-14 (2/3) Imports of Maldives, 1995

Code	Description	Unit	Quantity	CIF (Rf.)
40	Rubber and articles thereof	No.	2,735,700	11,069,029
41	Raw hides and skins (other than furskins) and leather	No.	345	36,845
42	Articles of leather, saddlery/harness, travel goods, hand bags and similar containers, articles of animal gut (other than silk-worm gut)	No.	501,884	6,692,876
44	Wood and articles of wood, wood charcoal	kg	28,908,024	103,774,809
45	Cork and articles of cork	No.	281,433	1,646,323
46	Manufactures of straw of esparto or of other plaiting materials, basketware and wickerwork	No.	35,790	1,519,099
48	Paper and paperboard, articles of paper pulp, of paper or of paperboard	kg	3,009,915	50,877,662
49	Printed books, newspapers, pictures & other products of the printing industry, manuscripts, typescripts and plans	No.	8,826,876	22,026,671
50	Silk	No.	15,112	32,913
51	Wool, fine or coarse animal hair, horsehair yarn & woven fabric	No.	130,414	368,409
52	Cotton	m <sup>2</sup>	8,653,161	109,281,289
53	Other vegetable textile fibres, paper yarn & woven fabrics of paper yarn	kg	341,460	505,808
54	Man-made filaments	kg	1,144,667	17,820,541
56	Wadding, felt & nonwovens, special yarns, twine, cordage, ropes & cables and articles thereof	kg	330,872	3,374,359
57	Carpets and other textile floor coverings	m <sup>2</sup>	16,665	1,861,381
58	Special woven fabrics, tufted textile fabrics, lace, tapestries, trimmings, embroidery	No.	55,665,890	9,714,277
59	Impregnated, coated, covered or laminated textile fabrics, textile articles of a kind suitable for industrial use	m <sup>2</sup>	275,451	2,768,623
61	Articles of apparel & clothing accessories, knitted or crocheted	No.	3,418,999	38,396,263
62	Articles of apparel & clothing accessories, not knitted or crocheted	No.	1,480,902	15,516,184
63	Other made up textile articles, sets, worn clothing & worn textile articles, rags	No.	6,351,251	19,972,495
64	Footwear, gaiters and the like, parts of such articles	pair	1,020,970	15,002,809
65	Headgear and parts thereof	No.	170,077	1,067,320
66	Umbrellas, sun umbrellas, walking sticks, seat-sticks, whips, riding crops and parts thereof	No.	58,716	1,308,461
67	Prepared feathers & down & articles made of feathers or of down, artificial flowers, articles of human hair	No.	58,412	212,192
68	Articles of stone, plaster, cement, asbestos, mica or similar materials	m <sup>2</sup>	2,115,162	26,526,011
69	Ceramic products	m <sup>2</sup>	1,797,161	26,308,381
70	Glass and glassware	No.	2,254,677	11,722,083
71	Natural or cultured pearls, precious or semi precious stones, precious metals, metals clad with precious metal and articles thereof, imitation jewellery coin	g	20,775	3,381,282



72	Iron and steel	kg	13,825,411	89,969,268
73	Articles of iron and steel	kg	3,252,506	52,777,761
74	Copper and articles thereof	kg	821,728	11,302,064
75	Nickel and articles thereof	kg	772	80,142
76	Aluminium and articles thereof	kg	729,007	21,261,416
78	Lead and articles thereof	kg	22,983	209,573
79	Zinc and articles thereof	kg	542,761	780,137
80	Tin and articles thereof	kg	3,543	381,128
81	Other base metals, cermets, and articles thereof	No.	2,003	7,795
82	Tools, implements, cutlery, spoons & forks, of base metal, parts thereof	No.	3,290,569	13,342,674
83	Miscellaneous base metal	kg	566,404	16,415,850
84	Nuclear reactors, boilers, machinery & mechanical appliances, parts thereof	No.	722,823	311,474,822

Table 1-14 (3/3) Imports of Maldives, 1995

Code	Description	Unit	Quantity	CFI (Rf.)
85	Electrical machinery & equipment & parts thereof, sound recorders & reproducers, television image & sound recorders & reproducers, & parts & accessories of such articles	No.	8,503,708	360,929,545
86	Railway or tramway locomotives, rolling-stock & parts thereof, railway or tramway track fixtures & fittings & parts thereof, mechanical (including electro-mechanical) traffic signalling equipment of all kinds	No.	137	2,902,814
87	Vehicles other than railway or tramway rolling-stock, and parts & accessories thereof	No.	691,554	55,560,393
88	Aircraft, spacecraft, and parts thereof	No.	64,824	22,386,743
89	Ships, boats and floating structures	No.	6,629	78,305,241
90	Optical, photographic, cinematographic, measuring, checking, precision, medical or surgical instruments & apparatus, parts & accessories thereof	No.	1,483,060	37,823,041
91	Diagnostic scanner parts	No.	141,165	11,671,225
92	Musical instruments, parts and accessories of such articles	No.	7,476	1,722,810
93	Arms and ammunition, parts and accessories thereof	No.	202	1,667
94	Furniture, bedding, mattress, mattress supports, cushions & similar stuffed furnishings, lamps & lighting fittings, not elsewhere specified or included, illuminated signs, illuminated name-plates & the like, prefabricated buildings	No.	867,902	63,794,306
95	Toys, games & sports requisites, parts & accessories thereof	No.	6,259,251	21,807,328
96	Miscellaneous manufactured articles	No.	16,000,983	18,656,784
97	Works of arts, collectors' pieces and antiques	No.	909,839	329,041
	<b>Total</b>		<b>970,516,693</b>	<b>3,153,334,292</b>

- Note: 1) The numbers under the "Code" column signify official Chapter Numbers.  
2) The unit under a certain Chapter Number is a representative unit in the said Chapter Number.  
3) The total quantity in kg, 970,516,693 is estimated from the relation between the quantity in kg and its corresponding amount in CFI.

### **1.3 Treatment of Special Wastes**

The major industrial activities here in the Maldives are construction work and commercial activities in Male' and beverage, fish canning and garment factories in the local islands. Followings are the brief report to present the current activities related with treatment and disposal of special types of wastes, most of them are generally categorised as industrial wastes observed typically at Transfer Station, Thilafushi and in municipal area in Male'.

#### **1.3.1 Current Operation and Considerations**

##### **(1) Construction Waste**

Solid wastes originated from construction work consist of concrete debris, excess sand, demolition and waste woods, waste sand bags, leftover of pipe, fittings and steel bars. Generation amount of construction waste is huge at present comparing with general municipal wastes discharged from daily livelihood. Normally, the construction waste is transported to the Transfer Station by the contractors and by individual person. Sometimes the contractors of large scale construction works request co-operation to MCPW to designate the site for disposal of concrete debris and excess soil. Most of the case, the reclaimed area in the north-east of the island, Nasandhula, is designated by MCPW for temporary disposal site until transported to Thilafushi. However, most of the construction waste is carried to the Thilafushi through Transfer Station. Daily generation amount of construction waste fluctuate owing to the progress of the construction work and the amount is estimated at approximately 80 tons per day in average.

##### **(2) Commercial Waste**

Packaging wastes consist of cartonbox and bamboo basket are the major waste from distribution and consumption of commodities. Carton box is not recovered in Male' at present and transported to the Transfer Station for disposal at Thilafushi.

##### **(3) Saw Dust from Carpentry**

Twenty two (22) carpentry factory are operated in Male. Waste wood and saw dust are carried-in to the Transfer Station by means of their private vehicles. Saw dust is retained separately at the Transfer and at the Thilafushi disposal site to make use as a organic matters for landscaping. Test composting is set to work soon to use food waste from hotels and restaurants to mix with saw dust for adjustment of moisture and nutrient elements. Generation amount of saw dust is estimated about 4 to 5 tons per day.

**(4) Waste Oil**

There are two sources of waste oil generation. The first source is from automobiles and the second source is from boats. Waste oil, lubricants, is stored at the Transfer Station in drum cans until the numbers of drum cans obstacle for loading operation at the Transfer Station. Waste oil was burnt before mixed with general waste and saw dust. In January, 1998, 2,400 litres of waste oil was transported to Thilafushi. Sixteen drum cans were stored at the Transfer Station in August, 1998.

**(5) Waste from Markets**

**a. Fish Market**

Currently in Male', waste from fish market is stored in plastic containers until evening and carried-out to off shore of Male' for disposal in the sea and the fish waste is not carried into the SWM system operated by the Municipality and MCPW. Amount of fish waste from the market recorded by the Municipality amount to 3 tons per day in average with the fluctuation ranging between 1 and 6 tons per day. Environmental pollution occurs sometimes caused by floating back of fish waste on to the shore. A study is being conducted by FAO to develop fish industries and for recycling of fish waste. The final proposal will be made to make use of the waste in Male' fish market by the end of 1998. Whatever the contents of the proposal is, the fish waste from the market will not be considered to treat or dispose of in SWM system of Male'.

**b. Fruits Market**

Waste from fruits market is collected by the Municipality together with dust bins placed on main streets. One tractor is operated for collection work in early morning to load about 300 to 500 kgs every day. Composition of the waste is a mixture of refuse normally observed in municipal wastes and packaging wastes.

**(6) Medical Waste**

Generation sources of medical waste in Male' are categorised by the sources from 2 hospitals and 27 clinics. IGMH treat infectious medical waste by incinerator installed in the compound of the hospital. Other medical waste of IGMH is transported to the Transfer Station in black plastic bags to burn it in drum cans. ADK hospital plan to install two types of incinerators. One type is designed for high heat furnace and the other type is low heat furnace. MCPW receive medical waste from ADK and clinics on request and carry it to Thilafushi for burning in drum cans. Currently, the amount of medical waste is estimated at more or less 1 ton per day.

## **(7) Hazardous Waste**

Hazardous waste such as batteries, insecticides, pesticides, waste chemicals are not collected separately and commingled with general municipal waste. Accordingly, there is no practical measures are taken to prevent it from causing of possible environmental pollution. Although the hazardous materials in municipal wastes is not a crucial problem at this moment, however, it will be better to take some practical measures before causing of the environmental pollution.

### **1.3.2 Considerations for Treatment of Special Wastes in Future**

Among the special wastes, there are certain types of wastes which will be a possible cause of environmental pollution and it will be preferable to treat prior to disposal at the Thilafushi as long as the treatment cost will not be a big burden to the financial capacity for carrying out the cleansing services. Considerations are made for those special wastes which is preferably pre-treated as described in the following paragraphs.

The amount of waste oil is not a large at this moment but it is evident that the amount will increase and be discharged periodically in future. Due to burning of waste oil in open area practised sometimes in the Thilafushi, smoke and odour spread over the neighbouring sea area caused of claims from the boats passing nearby. Installation of small size oil incinerator will be helpful for proper treatment of waste oil.

The medical waste shall be pre-treated properly before discharged by the waste generators because of the infectious nature of the wastes. The medical wastes from two hospitals will not have a problem since the incineration facilities are installed or planed to replace the existing facilities at IGMH or ADK hospitals. Problems will be the medical wastes discharged from more than 20 clinics and it will not an effective plan to install incinerator in each clinic. It will be preferable to find the solution for treatment of clinic waste together with the hospital wastes by charging the cost of treatment to the clinics.

Separate collection of waste batteries would not be so difficult in the small communities like Male' where the residents' co-operation for public services can be expected. Accordingly, if collection of waste batteries can be made through co-operation of the communities with the minimum cost burden to the municipality, it is better not only just store the waste batteries separately in drum cans but also to treat the waste batteries by cementing before disposal.

## **2. Waste Reduction, Recovery/Recycling and Treatment Plan**

### **2.1 Prediction of Solid Waste Amount and Composition in Future**

#### **2.1.1 Target Year**

##### **(1) Master Plan**

The target year of the Master Plan will be set at the year in 2010. The plan shall be phased with short term, middle/long terms development plans.

##### **(2) Priority Project**

Priority Project to be formulated in the Feasibility Study will be selected from the plans and programs proposed in the Master Plan and formulated for the year 2003.

#### **2.1.2 Population**

Future population of the Master Plan will be adopted the second assumption data which was predicted by Ministry of Planning, Human Resource Environment (MPHRE). Population in 2003 was estimated from the growth rate between 2000 and 2005 by means of the exponential model. The population in 1995, 2000, 2003, 2005 and 2010 are presented in Table 2-1 for Male' and for inhabited islands by atolls. The estimated population in Male' including Villingili reach at 80,684 in 2003 and 97,928 in 2010. Meanwhile, the population in Villingili alone will be 3,632 and 9,106 in 2003 and 2010 respectively.

In addition, the annual population from 1998 to 2010 was estimated for Male' and Villingili and indicated in Table 2-2. The estimation was made as well as the method adopted for estimating the population in 2003 by the exponential model obtaining the population growth rate between each 5 years period.

Table 2-1 Estimated Future Population by Atoll for 2000, 2003, 2005 and 2010

Year	1995	2000	2003*	2005	2010
Locality	Population	Population	Population	Population	Population
Republic	244,814	289,117	315,945	335,199	383,471
Male'	62,519	73,833	80,684	85,601	97,928
Atolls	182,295	215,284	235,261	249,598	285,543
North Thiladhunmathi	13,676	16,151	17,650	18,725	21,422
South Thiladhunmathi	15,365	18,146	19,830	21,038	24,067
North Miladhunmadhulu	10,462	12,355	13,502	14,325	16,387
South Miladhunmadhulu	10,103	11,931	13,038	13,833	15,825
North Maalhosmadhulu	12,953	15,297	16,716	17,735	20,289
South Maalhosmadhulu	8,712	10,289	11,243	11,928	13,646
Faadhippolhu	8,038	9,493	10,374	11,006	12,591
Male' Atoll	11,675	13,788	15,067	15,985	18,287
South Ari Atoll	6,695	7,907	8,641	9,167	10,487
North Ari Atoll	5,260	6,212	6,788	7,202	8,239
Felidhu Atoll	1,678	1,982	2,166	2,298	2,628
Mulakatholu	4,859	5,738	6,271	6,653	7,611
North Nilandhe Atoll	3,165	3,738	4,085	4,334	4,958
South Nilandhe Atoll	4,793	5,660	6,186	6,563	7,508
Kolhumadulu	9,545	11,272	12,318	13,069	14,951
Hadhunmathi	10,156	11,994	13,107	13,906	15,908
North Huvadhu Atoll	8,121	9,591	10,481	11,119	12,721
South Huvadhu Atoll	12,031	14,208	15,527	16,473	18,845
Fovahmulah	7,004	8,271	9,039	9,590	10,971
Addu Atoll	18,004	21,262	23,235	24,651	28,201

The year, 2003\* indicate that the figure was estimated by JICA Study Team based on the following equation.

$$P = p * \text{EXP}(\text{LOG}(P/p) * (\text{period} (P - p) * \text{LOG}(\text{EXP}(1)))) * n$$

Note:

Assumption 2

1. Proportion of Census 1995 - Place of enumeration (de facto) is taken as constant up to 2010
2. Migration effect is not accounted for in the future years
3. 2003 is calculated by JICA study team

Source: Ministry of Planning, Human Resources and environment, Population Housing Census of Maldives 1995.

Table 2-2 Future Population in Male', Villingili &amp; Atolls (1998 - 2010)

Year	Male' Island		Villingili Island		Atolls (Whole Country except Male' & Villingili)	
	Population	Growth Ratio	Population	Growth Ratio	Population	Growth Ratio
1998	67,236	-	1,844	-	201,427	-
1999	69,311	3.085%	2,106	14.234%	208,241	3.383%
2000	71,427	3.053%	2,406	14.234%	215,284	3.382%
2001	73,301	2.624%	2,749	14.234%	221,747	3.002%
2002	75,192	2.581%	3,140	14.234%	228,404	3.002%
2003	77,097	2.533%	3,587	14.234%	235,261	3.002%
2004	79,008	2.479%	4,098	14.234%	242,324	3.002%
2005	80,920	2.419%	4,681	14.234%	249,598	3.002%
2006	82,588	2.062%	5,347	14.234%	256,406	2.727%
2007	84,225	1.982%	6,109	14.234%	263,399	2.727%
2008	85,819	1.893%	6,978	14.234%	270,582	2.727%
2009	87,357	1.792%	7,971	14.234%	277,962	2.727%
2010	88,822	1.677%	9,106	14.234%	285,543	2.727%

### 2.1.3 Planning Area

Under the formulation of the Master Plan, the planning area will be determined within the area in Male'. However, the waste disposal plan will be dealt with the solid waste amount generated in Villingili, Hulhule(Airport), resort islands, and some neighbouring inhabited islands transporting waste directly to the Thilafushi.

### 2.1.4 Hulumale Project

The future development schedule of the Hulumale Project is not clear at present and difficult to estimate the future settlement population of the project within the time frame of the current SWM planning concerned. However, it is assumed that the population as well as the waste generation amount in the target year 2010 will be almost negligible to give influence to the SWM plan for Male'. Accordingly, waste collection and transportation plan for the Hulhumale will not be dealt in the planning of SWM plan for Male'. In future, it is preferable to consider to dispose at the Thilafushi for the wastes generated from the Hulmale Project area in respect of removing wastes far from the municipal area to the remote area.

### 2.1.5 Solid Waste Amount and Composition in Future

#### (1) Solid Waste Generation Amount in Future

Solid waste generation amount will be estimated for Male', Villingili, inhabited islands and resort islands based on the key elements shown in the followings.

- Trends of the past waste generation amount GDP growth,
- Current waste generation rate obtained from analysis of the data of the Waste Amount Survey,
- Correlations between waste generation rate and GDP per capita,
- Estimation of future waste generation rate per capita or per unit,
- Estimation of future population and the number of tourist arrivals,
- Estimation of growth rate of GDP per capita,
- Future trend of development in the project area.

One of the key factor for predicting the waste amount is determination of the waste generation rate per capita per day. The generation rate of the major wastes are shown in the followings for the unit generation rate for prediction of the solid waste amount in future.

Type and Sources of Wastes	Waste Generation Rate per capita per day (g/c/d)
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	1998	2010
Domestic Waste in Male'	714	1,020
Commercial Waste in Male'	303	433
Industrial Wastes	105 ton/day	150ton/day
Domestic Waste in Villingili	621	876
Resort Islands	7,320	7,320

The detail method and procedures for prediction of waste generation amount was compiled in Appendix-1 and the result was summarised in Table 2-3. According to the prediction, the total waste amount generated in Male' including Villingili reach at 287 tons per day in 2010. The waste amount generated in inhabited islands other than Male and Villingili and resort islands reach at 271 tons per day and 151 tons per day respectively. Accordingly, the total waste amount generated in whole country will reach at 708 tons per day or 258,000 tons per year in 2010.

Table 2-3 Summary of Waste Generation Amount in Future

Year	Domestic Waste	Commercial Waste	Business & Industrial Waste	Construction Waste	Subtotal Waste Generation Amount in Male'	Domestic Waste in Villingili	Total Waste Generation Amount in Male & Villingili	Waste Generation Amount in Inhabited Island	Waste Generation Amount in Resort Islands	Total Waste Generation Amount in the Maldives	Total Waste Generation Amount in the Maldives
	(ton/d)	(ton/d)	(ton/d)	(ton/d)	(ton/d)	(ton/d)	(ton/d)	(ton/d)	(ton/d)	(ton/d)	(ton/d)
1998	48.0	20.4	36.2	68.8	173.4	1.1	174.5	136.9	70.7	382.1	139,463
1999	51	21.6	37.3	70.9	180.8	1.3	182.1	145.6	76.0	403.7	147,337
2000	54	23.0	38.4	73.1	188.7	1.6	190.2	155.0	81.5	426.7	155,760
2001	57	24.4	39.7	75.4	196.9	1.8	198.7	164.6	87.3	450.6	164,486
2002	61	25.8	41.0	77.9	205.5	2.2	207.6	174.8	93.3	475.8	173,660
2003	64	27.3	42.3	80.4	214.3	2.6	216.9	185.6	99.6	502.0	183,230
2004	68	28.9	43.6	82.9	223.3	3.0	226.3	196.7	106.1	529.1	193,129
2005	72	30.4	44.9	85.4	232.4	3.6	236.0	208.3	112.8	557.1	203,355
2006	75	32.0	46.2	87.9	241.4	4.2	245.6	219.9	119.9	585.3	213,651
2007	79	33.6	47.6	90.4	250.6	4.9	255.5	231.8	127.2	614.6	224,313
2008	83	35.2	48.9	93.0	260.0	5.8	265.7	244.3	134.7	644.8	235,340
2009	87	36.8	50.3	95.6	269.4	6.8	276.2	257.3	142.5	676.0	246,727
2010	91	38.4	51.7	98.2	278.9	8.0	286.9	270.7	150.6	708.1	258,468

## (2) Solid Waste Disposal Amount in Thilafushi

Currently, the Thilafushi disposal site receive municipal solid wastes from Male' and Villingili, wastes from resort islands, wastes from Hulhule and wastes from several inhabited islands located nearby. Prediction of the waste disposal amount in future was conducted based on the islands transporting wastes currently to the



Thilafushi by estimating the future increase amount from each island. In prediction of waste disposal amount in future, the following condition and factors were given.

- All wastes from Male' and Villingili are disposed at Thilafushi
- Waste amount of the resort islands currently transporting wastes to the Thilafushi will increase in proportion to the increase of the waste generation amount in the resort islands,
- Wastes from Hulhule (Airport) increase in proportion to increase of the numbers of tourist arrival, which is the same ratio adopted for that of the resort islands,
- Wastes from the neighboring inhabited islands will increase in proportion to the increase ratio in other atoll islands

The detail procedures for prediction of waste disposal amount was compiled in Appendix-1 and the results were summarised in Table 2-4. According to the prediction, the total waste amount required for disposal at the Thilafushi reach at 332 tons per day or approximately 121,000 tons per year in 2010.

Table 2-4 Estimated Waste Disposal Amount in Thilafushi

Year	Resort Islands	Airport	Nearby Inhabited Islands	Waste Disposal Amount except for Male'	Waste Disposal Amount of Male' + Villingili	Daily Total Waste Disposal Amount	Annual Waste Disposal Amount	Accumulated Waste Disposal Amount
	(ton/day)	(ton/day)	(ton/day)	(ton/day)	(ton/day)	(ton/day)	(ton/year)	(ton)
1998	19.2	2.8	0.2	22.3	174.5	196.8	71,843	71,843
1999	19.8	3.0	0.3	23.1	182.1	205.2	74,887	146,731
2000	21.0	3.3	0.3	24.6	190.2	214.8	78,410	225,141
2001	22.5	3.5	0.3	26.3	198.7	225.1	82,148	307,288
2002	24.1	3.7	0.3	28.1	207.6	235.8	86,061	393,349
2003	25.7	4.0	0.3	30.0	216.9	246.9	90,118	483,467
2004	27.4	4.3	0.4	32.0	226.3	258.3	94,281	577,748
2005	29.1	4.5	0.4	34.0	236.0	270.0	98,547	676,294
2006	30.9	4.8	0.4	36.1	245.6	281.8	102,842	779,137
2007	32.8	5.1	0.4	38.3	255.5	293.9	107,266	886,403
2008	34.8	5.4	0.4	40.6	265.7	306.3	111,818	998,220
2009	36.8	5.7	0.5	43.0	276.2	319.2	116,494	1,114,714
2010	38.9	6.0	0.5	45.4	286.9	332.3	121,291	1,236,005

### (3) Waste Composition in Future

Prior to estimation of waste composition in future, analysis was made for the data obtained from the Waste Composition Survey and set up the following conditions.

- Future waste composition is basically the same with the present composition

- Changes of waste composition is estimated for increase of the ration of the portion of organic wastes rather than the ratio of in-organic wastes,
- Inorganic wastes especially sand commingled with yard wastes and demolition wastes shall be separated well and removed at the sites
- Dry batteries shall be separated and collected separately in future
- The role of waste management for environmental conservation will be realized by the waste generators in reduction and recycling of wastes at generation sources.

Considering the requirements for overall SWM planning, estimation of future waste composition was conducted for 18 components and bulk density of the waste categorised by the following 5 types.

- Domestic and Commercial Wastes in Male'
- Business and Industrial Wastes in Male'
- Construction and Demolition Wastes in Male''
- Domestic Wastes in Inhabited Islands
- Wastes Generated in Resort Islands

In estimation of the waste composition, the requisite condition was set for the ratio of organic, inorganic and hazardous wastes for 5 types of wastes as indicated below.

Categories of Waste	Organic Wastes	Inorganic Wastes	Hazardous Wastes
Domestic and Commercial Wastes in Male'	80%	19.8%	0.2%
Business and Industrial Wastes in Male'	90%	9.8%	0.2%
Construction and Demolition Wastes in Male'	19.8%	80%	0.2%
Domestic Wastes in Inhabited Islands	75%	24.8%	0.2%
Wastes Generated in Resort Islands	80%	19.8%	0.2%

The results of estimation was indicated in Table 2-5 and 2-6 and also the references are available in Appendix-1.

Table 2-5 Waste Amount and Composition in Male &amp; Villingili (2010)

Type of Waste	Domestic & Commercial Wastes		Business & Industrial Wastes		Construction Waste		Total		
Total Weight	137.0		51.7		98.2		286.9		
Sampling Weight & Composition Ratio	Weight (ton)	Ratio (%)	Weight (ton)	Ratio (%)	Weight (ton)	Ratio (%)	Weight (ton)	Ratio (%)	
<b>Organic Waste</b>									
Food Waste	26.85	19.60	12.62	24.43	0.00	0.00	39.47	13.76	
Paper	Paper	13.77	10.05	9.55	18.48	0.21	0.22	23.53	8.20
	Cardboard	17.67	12.90	6.48	12.54	0.74	0.76	24.90	8.68
	Subtotal	31.44	22.95	16.03	31.03	0.96	0.97	48.43	16.88
Plastics	Film	5.92	4.32	1.45	2.80	0.52	0.53	7.89	2.75
	Bottle & Others	4.79	3.50	1.18	2.28	0.09	0.09	6.06	2.11
	PET	1.27	0.93	0.51	0.99	0.01	0.01	1.79	0.62
	Subtotal	11.99	8.75	3.14	6.07	0.62	0.63	15.75	5.49
Rubber & Leather	1.47	1.08	0.45	0.87	0.03	0.03	1.95	0.68	
Textiles	4.15	3.03	0.42	0.80	0.01	0.01	4.57	1.59	
Yard Waste	15.09	11.01	4.03	7.80	0.19	0.20	19.31	6.73	
Wood	4.46	3.26	8.58	16.61	17.52	17.83	30.56	10.65	
Other Org. Waste	14.16	10.33	1.23	2.39	0.13	0.13	15.52	5.41	
<b>Organic Waste Total</b>	<b>109.62</b>	<b>80.00</b>	<b>46.49</b>	<b>90.00</b>	<b>19.45</b>	<b>19.80</b>	<b>175.57</b>	<b>61.19</b>	
<b>In-organic Waste</b>									
Glass	Broken Glass	0.52	0.38	0.11	0.22	0.00	0.00	0.63	0.22
	Bottle	2.16	1.58	0.53	1.03	0.01	0.01	2.70	0.94
	Subtotal	2.68	1.95	0.64	1.24	0.01	0.01	3.33	1.16
Tin Cans (Steel Cans)	3.57	2.61	0.69	1.34	0.24	0.25	4.51	1.57	
Aluminum cans	0.70	0.51	0.20	0.39	0.01	0.01	0.91	0.32	
Other Metals	1.65	1.20	1.87	3.62	0.32	0.32	3.83	1.34	
Dirt, Ash, Sand	18.54	13.53	1.66	3.21	78.01	79.41	98.20	34.23	
<b>In-organic Waste Total</b>	<b>27.13</b>	<b>19.80</b>	<b>5.06</b>	<b>9.80</b>	<b>78.59</b>	<b>80.00</b>	<b>110.78</b>	<b>38.61</b>	
<b>Hazardous Waste</b>									
Hazardous Waste(Batteries)	0.14	0.10	0.05	0.10	0.00	0.00	0.19	0.07	
Other Hazardous Waste	0.14	0.10	0.05	0.10	0.20	0.20	0.39	0.13	
<b>Hazardous Waste Total</b>	<b>0.27</b>	<b>0.20</b>	<b>0.10</b>	<b>0.20</b>	<b>0.20</b>	<b>0.20</b>	<b>0.57</b>	<b>0.20</b>	
<b>Total Weight (ton)</b>	<b>137</b>	<b>100.00</b>	<b>52</b>	<b>100.00</b>	<b>98</b>	<b>100.00</b>	<b>287</b>	<b>100.00</b>	
<b>Total Waste Volume (m<sup>3</sup>)</b>	<b>646</b>		<b>325</b>		<b>89</b>		<b>1,060</b>		
<b>Bulk Density (ton/m<sup>3</sup>)</b>	<b>0.212</b>		<b>0.159</b>		<b>1.104</b>		<b>0.271</b>		

**Table 2-6 Waste Amount and Composition in Inhabited and Resort Islands (2010)**

Type of Waste	Waste Amount and Composition in 2010 in Inhabited Islands except for Male'			Waste Amount and Composition in 2010 in whole Resort Islands			
	Estimated Waste Composition (%)	Daily Waste Amount (t/d)	Annual Waste Amount (t/yr)	Estimated Waste Composition (%)	Daily Waste Amount (t/d)	Annual Waste Amount (t/yr)	
<b>Organic Waste</b>							
Food Waste	31.35	84.8	30,968	33.44	50.3	8,629	
Paper	Paper	1.80	4.9	1,777	1.92	2.9	495
	Cardboard	2.87	7.8	2,839	3.07	4.6	791
	Total	4.67	12.6	4,616	4.98	7.5	1,286
Plastics	Film	0.37	1.0	362	0.39	0.6	101
	Bottle & Others	0.46	1.3	456	0.49	0.7	127
	PET	0.36	1.0	360	0.39	0.6	100
	Total	1.19	3.2	1,178	1.27	1.9	328
Rubber & Leather	0.11	0.3	112	0.12	0.2	31	
Textiles	0.26	0.7	254	0.27	0.4	71	
Yard Waste	33.88	91.7	33,468	36.14	54.4	9,326	
Wood	0.61	1.7	607	0.66	1.0	169	
Other Org. Waste	2.92	7.9	2,888	3.12	4.7	805	
<b>Total (Organic Wastes)</b>	<b>75.00</b>	<b>203.0</b>	<b>74,091</b>	<b>80.00</b>	<b>120.4</b>	<b>20,645</b>	
<b>In-organic Waste</b>							
Glass	Broken Glass	0.13	0.4	131	0.11	0.2	27
	Bottle	3.30	8.9	3,261	2.65	4.0	684
	Total	3.43	9.3	3,392	2.75	4.1	711
Tin Cans (Steel Cans)	1.00	2.7	988	0.80	1.2	207	
Aluminum cans	0.19	0.5	186	0.15	0.2	39	
Other Metals	0.21	0.6	208	0.17	0.3	44	
Dirt, Ash, Sand	19.97	54.0	19,725	16.02	24.1	4,135	
<b>Total (Inorganic Wastes)</b>	<b>24.80</b>	<b>67.1</b>	<b>24,499</b>	<b>19.90</b>	<b>30.0</b>	<b>5,135</b>	
<b>Hazardous Waste</b>							
Batteries	0.15	0.4	148	0.05	0.1	13	
Other Hazardous Waste	0.05	0.1	49	0.05	0.1	13	
<b>Total (Hazardous Waste)</b>	<b>0.2</b>	<b>0.5</b>	<b>198</b>	<b>0.10</b>	<b>0.2</b>	<b>26</b>	
<b>Total Weight (ton)</b>	<b>100.00</b>	<b>270.7</b>	<b>98,788</b>	<b>100.00</b>	<b>150.6</b>	<b>25,806</b>	
<b>Total Waste Volume (m<sup>3</sup>)</b>	-	<b>972</b>	<b>354,790</b>	-	-	-	
<b>Bulk Density (ton/m<sup>3</sup>)</b>	-	<b>0.278</b>	<b>0.278</b>	-	-	-	

## 2.2 Treatment of Special Wastes

The most part of the mixed wastes carried into the Thilafushi shall be disposed by landfill although the concrete debris and sand generated from construction work will be reusable as a material for embankment of the landfill site and/or the material for covering soil for landfill operation. Some sort of wastes are proposed to have treatment or recycling in respect of the properties of the wastes and for the benefit to avoid probable secondary pollution, recovery of materials for recycling, conservation of the environment, and reduction of the final disposal amount to prolong the life of the landfill site. The method of treatment and recycling of these wastes are proposed as in the following paragraphs.

### 2.2.1 Food Wastes from Hotels & Restaurants : Composting

The Waste Amount Survey shows that the waste from hotels and restaurants in Male' reach at 4 tons per day approximately and the Waste Composition Survey shows that the food waste ratio commingled in the hotel & restaurants wastes amount to 83 % by weight. Soil in the Maldives mostly consist of coral sand require organic matters for growing plant. The food waste to be collected separately from other wastes will be a good raw materials for composting. The final products of compost will be useful for the "Planting Two Million Trees Project", small scale farming in local islands and also useful for gardening in resort islands and by the Male' citizen.

Development of the compost plan shall be formulated by the following steps. Firstly, the system for waste separation, collection and transportation must be established by the waste generators, hotels and restaurants, supported by Male' Municipality and MCPW. Special containers must be provided at the transfer station to receive the food wastes carried by the hotels and restaurants. Secondly, the pilot scale composting yard shall be constructed in the Thilafushi. Thirdly, distribution system of the final products shall be established. Operation of the works in these 3 steps shall be carried out by the direction of the Special Task Team organised under SWMS of MCPW.

The pilot compost yard shall be developed by 3 lots consisting of reception and separation area, composting and turning area and maturation, storage and shipping area. Composting will be carried out by the Windrow type composting, turning and watering by hand. The minimum requirement of the composting facilities are concrete floor, roofing, storage and shipping yards and water tank to store rain water for watering as required. The pilot facilities will be developed initially at the capacity to receive about 2 to 3 tons of raw material twice in a week. Food waste - saw dust composting will require 6 to 8 weeks by the Windrow system. The

composting capacity and/or the processes may be developed further in future as required.

### **2.2.2 Saw Dust from Carpentry : Moisture Adjustment for Composting**

Twenty two (22) carpentry factories operated in Male produce about 5 tons of saw dust and cuttings of lumbers. Saw dust can be recycled to mix with the food waste for composting. Saw dust will be useful to adjust the quality of compost in terms of moisture and C/N ratio. Because of higher water content of food waste about 70 %, saw dust is useful to reduce the water content of the raw material up to 50 to 55 %. In order to enrich the nutrients elements in the final products of compost, the C/N ratio of raw material have to be kept between 25 to 30 to control the heat higher than 45 but not higher than 75 degree Celsius at least for 3 days by watering and turning properly. Mixing the food waste containing more nitrogen with the saw dust containing more carbon will be good for moisture adjustment but saw dust need more period for composting. The ratio of food waste and compost have to be studied initially through test operation of the pilot plant and test application of the compost at the trial farm.

### **2.2.3 Waste Oil : Incineration at Thilafushi disposal site**

Increase of vehicles bring about increase of waste oil naturally. At present, waste oil, most of them are lubricants from automobiles is transported to Thilafushi and burnt at site without proper procedures. Generation amount of waste oil is not clear yet but the small incinerator of the capacity from 20 to 30 kg/hr will be useful for incineration treatment.

### **2.2.4 Fish Waste : Treatment by the FAO supported Project**

About 3 tons of fish waste generated at the Fish Market in Male' is expected to be recycled by the project supported by FAO. Accordingly, the SWM plan do not deal the fish waste in SWM plan. However, if the project will not be implemented, a part of the fish waste can be used for raw material of compost by mixing together with food waste and saw dust. Also, the dried fish waste will be recyclable for a feed for chicken breeding at Thilafushi.

### **2.2.5 Medical Waste : Incineration at IGMH and/or ADK Hospitals**

There are two options for treatment of medical wastes. The first option is to have incineration treatment at the two hospitals, IGMH and ADK. The other option is to install the medical waste incinerator at the Thilafushi. IGMH has equipped with incinerator although the system has some problems with exhausting gases. ADK is planning to install two types of incinerators for high heat and low heat combustion. After improvement and installation of the incinerators in two

hospitals, all the medical waste generated in Male will be treated except for the medical wastes from 27 clinics.

For the practical point of view, it will be better to ask co-operation of the two hospitals to treat medical wastes of the clinics at the hospital incineration facilities. The total capacity of the incineration plants must be larger than 1 ton per day or about 200 kg per hour.

### **2.2.6 Batteries : Collection and Cementing at Thilafushi**

Waste Composition Survey conducted in Male' shows that the hazardous waste such as batteries, insecticides, pesticides, waste chemicals commingled with general municipal waste by the ratio of 0.2 % in weight. About a half of the hazardous waste is composed of waste dry batteries.

It is important to establish the collection system for planning disposal of waste dry batteries. Considering the social conditions in Male', schools and mosques are the most convenient places for the resident to bring waste batteries and for periodical collection by the Municipality. The battery recovery boxes will be placed at the entrance of 6 primary schools, 9 secondary schools and mosques to enable easy access to the students and the residents for discharging the waste batteries at anytime in daytime. Collection work may be conducted by the Municipality once in a month divided into 4 Wards.

The waste batteries will be stored temporally at the Transfer Station and transported to Thilafushi once in a month for storing and treatment by cementing in the concrete boxes fabricated for the purpose of disposal of waste batteries.

## **2.3 Waste Reduction and Recovery/Recycling Plan**

### **2.3.1 Trend of SWM Plan**

Plans and programs formulated in the SWM Master Plan is focused on implementation of the long term plan as a basis and the urgent project(s) required immediate implementation for improving the facing problems.

The conventional SWM plan formulates waste collection, intermediate treatment and final disposal plan on the technical side and minimising the cost on the economic side. However 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. Nevertheless, the waste recycling have not been adopted until the recent years even in the developed countries because of the complexity to involve the society, awareness of the residents, recycling industries,

market price of the recovered materials and recycled products, initial cost investment, etc.

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 successful execution of the integrated SWM plan.

For the purpose to establish the integrated SWM system in future in Male', it will be required essentially to encompass the initiation of waste reduction and recycling systems together with formation of effective and efficient waste collection, waste transfer and transportation and disposal systems.

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. Also, it shall be noted that the issues implicated in the current situation need immediate improvement of the existing system under the financial weakness are the important elements for planning of the required minimum system to bring in the maximum performance for waste reduction and waste recovery/reduction plans to be proposed as in the following sections.

### **2.3.2 The Role of Each Party Concerned**

#### **(1) The Role of Each Party Concerned for SWM**

Because of involvement of the party concerned with SWM for some relation or other, the role of each party shall be defined clearly prior to formulation of waste reduction and 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 SWMS 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 SWMS are the most important to establish an efficient municipal solid waste management system for Male' as defined in the following section.

**(2) The Role of Male' Municipality and SWMS in Operation of Waste Reduction and Recycling Systems**

Solid waste is generated as a consequence of human activities and cause public nuisance unless integrated solid waste management system is operated properly in participation of all the parties concerned including the Government, local government, residents, enterprises, and institutions. The role and responsibility of each party shall be clarified by the legislative measures to establish the effective solid waste management system for Male'.

In this respect, the Male Municipality is responsible for public campaign and education, encouragement, assistance, co-ordination to form a link between the community base 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. In order to organise the activities through the community based groups, the Male Municipality shall have responsibilities to collect specific wastes, distribute and publicise database and pamphlets on waste reduction and recycling procedures, list of community based groups, list of recycling groups & companies, trading sites of the recovered materials (buy-back centres), etc., and control/ co-ordinate with the standard price for maintaining a stable market for the recovered materials.

MCPW is responsible for 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.

By obtaining co-operation from other governmental agencies concerned, the MCPW is responsible for implementation of overall waste reduction and recycling plans as one of the national plan 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. Responsibilities and obligations should not be fragmented or overlapping among the institutions. Linkages and co-ordination arrangements between the different institutions should be efficient and effective.

For practical operation of the systems, SWMS shall be responsible to provide the storage areas for each type of the recovered materials at the Transfer Station and the Thifafushi disposal site. In addition, SWMS have to construct, operate and

maintain the facilities for small scale food waste-saw dust composting and marketing of the final products as well.

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.

### **2.3.3 Objective, Planning Policy and Strategy**

#### **(1) Objective**

The objective of the Waste Reduction Plan is to lighten the cost burden to Male Municipality and SWMS through the reduced solid waste amount for collection and disposal and contribute to minimise the pollution loading to the environment.

The objective of the Recycling Plan is to save finite resources and energy through reuse, recovery and recycling materials to minimise the landfill space as a result. In addition, recovery of resources through the food waste - saw dust composting is implemented to have the objective for growing more trees and plants in the Maldives.

#### **(2) Planning Policy**

- ① The Waste Reduction Plan shall be implemented under the condition to perform the role of each party, i.e., the role of the Government, MCPW, Male Municipality, the beneficiaries/ polluters, importers, and overseas manufacturers; and
- ② The Waste Recycling Plan shall be implemented by means of active promotion, encouragement and assistance to the community groups, interesting parties and the recycling industries to enable formation of the system in the domestic and/or the overseas markets to the maximum extent.

#### **(3) Planning Strategy**

- ① Male Municipality shall have the primary responsibilities for the Waste Reduction Plan for operation, promotion, guidance and education to all the waste generators including residents, shops, business establishments, institutions, etc. for implementation of the plan through participation of the public;
- ② SWMS shall have the primary responsibilities for promotion, encouragement, guidance and assistance to the community based 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 by the waste generators to the Transfer Station through storing separately, transporting and storing at the Thilafushi disposal site until selling to the buyer(s);
- ⑤ Special Task Team shall carry out the study for introduction of applicable recycling technologies and marketing of the recycled products;
- ⑥ Composting derived from food waste and saw dust shall be formulated by means of the appropriate technology in the Maldives and the scale of the facilities so as not to cause a financial burden to SWMS

#### **2.3.4 Waste Reduction and Recovery/Recycling Plans**

From the side of administrator, the program for waste reduction, recycling and recovery of resources at generation sources is the most desired system although it will be a time consuming activities requiring support from the society. To implement the trying programs so called the waste generation source management, the more practical and promising methods are proposed briefly in the sections, a. Generation Source Control, b. Waste Discharge Control, and c. Recovery/Recycling of Materials by means of the plans and programs presented in the section d. Implementation of Plan and Programs presented below.

##### **(1) 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.

##### **(2) 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.

##### **(3) Recovery/Recycling of Materials**

Recovery of resources and recycling in the initial stage shall be conducted to store separately the recyclable materials transported directly to the Transfer Station by the waste generators. Raising awareness and participation of the society is important to sustain the recycling and recovery of resources. For practical operation, recovery of reusable materials will be made through encouragement of the reusable goods bazars at schools and the junk dealers. Pilot plant for food waste-saw dust composting and initiating the study for introduction of Recycling Centre will be

also effective after securing the sales routes. The pilot composting plant shall be expanded when the scheme will have been supported by the society in future.

#### (4) 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 2-1.

#### 2.3.5 Establishment of the Special Task Team

A Special Task Team shall be organised in Male' Municipality by recruiting the member of SWMS and Male Municipality. A total of 8 staff shall be appointed comprised of a manager, an engineer, secretary and four officials, one each for four Wards. The Special Task Team shall have assignment for Waste Reduction and Recycling Plans in co-operation with the operation staff of Male' Municipality and SWMS to study, develop, organise, assist, and implement the plan to enable the Waste Reduction and Recovery/Recycling systems will be operated properly as intended within the time frame.

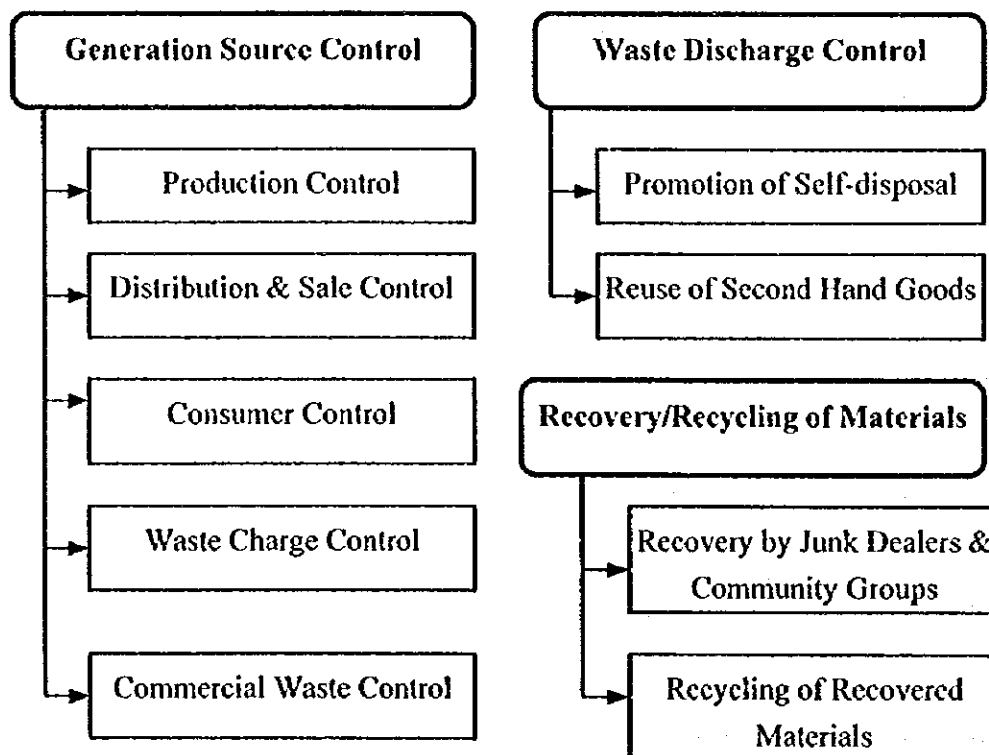


Figure 2-1 Operation Flow of Waste Reduction and Recycling Plans

### **2.3.6 Proposed Target Levels and Prospects**

#### **(1) Proposed Target Level**

Implementation of the waste recycling plan shall be initiated with accumulation of the database including the amount of recyclable materials, recycling activities, investors for recycling industries, domestic and overseas markets of recovered materials and recycle products, etc. In addition the study shall be made for the type and scale of the facilities installed in Male' and confirm whether implementation of the plan is a needs of the society. These data and information shall collected and studied by 2003 when implementation of the improved solid waste management services will be started in accordance with the priority projects proposed in the Master Plan. However, the Waste Reduction Plan at generation sources shall be started immediately through public campaign to ask co-operation of the residents.

The expectable target level of waste reduction at sources is proposed to realise the ratio at 5 % by 2005 and 10 % by 2010 in terms of the ration 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 include the amount of concrete debris and sand recovered for disposal operation at Thilafushi and the ratio is counted from the weight after waste reduction at generation sources.

#### **(2) 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. In total, about 90.2 tons per day will be reduced from the amount of final disposal 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 2-7 shows the details of the expectable amount of the Waste Reduction Recovery and Recycling Plans.

**Table 2 - 7 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 (%)
<b>1) Waste Generation Amount</b>								
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 <sup>3</sup> )	646.3		324.6		89.0		1,059.8	
Bulk Density (ton/m <sup>3</sup> )	0.212		0.159		1.104		0.271	
<b>2) Waste Reduction Amount</b>	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
<b>3) Waste Discharge Amount</b>								
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 <sup>3</sup> )	582		292		89.0		963	
Bulk Density (ton/m <sup>3</sup> )	0.212		0.159		1.104		0.278	
<b>4) Waste Recovery Amount</b>	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
<b>5) Waste Disposal Amount (Male' &amp; Villingili)</b>								
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
Total Hazardous Waste	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 <sup>3</sup> )	553		278		89		919	
Bulk Density (ton/m <sup>3</sup> )	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.

### **2.3.7 Implementation of Waste Reduction and Recovery/Recycling Plans**

#### **(1) Action Plan and Programs for Waste Reduction**

##### **a. Short Term Plan**

- ① Special Task Team shall be organised staffing from SWMS/ MCPW and Male Municipality comprised of 8 staff 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" at the generation sources through public campaign and education,
- ③ The Generation Source Control shall be commenced with two measures i.e. "Distribution & Sale Control" and "Consumer Control" in accordance with the improved SWM system proposed in the Master Plan,
- ④ Waste amount reduction under the program of Waste Discharge Control shall be realised through self-disposal, repair and reuse of broken appliances/instruments, and exchange/sale of second hand goods carried out by the resident obtaining supports from Male Municipality,
- ⑤ Male Municipality shall commence the public campaign and education to encourage the residents to change the previous habits on generation, discharge of waste and reuse of second hand goods,

##### **b. 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 to reduce waste generation amount from industrial products itself, shops, markets, offices, institutional buildings, etc.

#### **(2) Action Plan and Programs for Waste Recovery/Recycling**

##### **a. 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' including appropriate reuse, recycling and marketing of recovered materials,
- ② Recovery/Recycling of materials shall have started with the programs of "Recovery by Junk Dealers". After the improved SWM introduced, the scavengers are not be allowed to pick up the recyclables at new Transfer Station. Instead, Male' Municipality organise, encourage, assist, and control them to be the junk dealers allowed to go around the town to

collect the recyclables from houses, shops and other places for their daily income.

- 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 SWMS, where any individuals can bring back recyclable materials in exchange for money,
- ④ Recovery of materials at the Transfer Station shall be made to receive and store separately the wastes carried into the station. These recoverable materials include food waste from hotels and restaurants, saw dust from carpentry's, concrete debris and sand from construction wastes. Finally, the recovered materials shall be transported periodically to the Thilafushi disposal site for storing.
- ⑤ SWMS 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. SWMS shall store the separated materials properly at the disposal site,
- ⑦ Special Task Team in co-operation with SWMS shall initiate a pilot scale food waste - saw dust composting at Thilafushi and test application of the compost to study the ratio and effects of compost for different type of plants,
- 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 SWMS,
- 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,

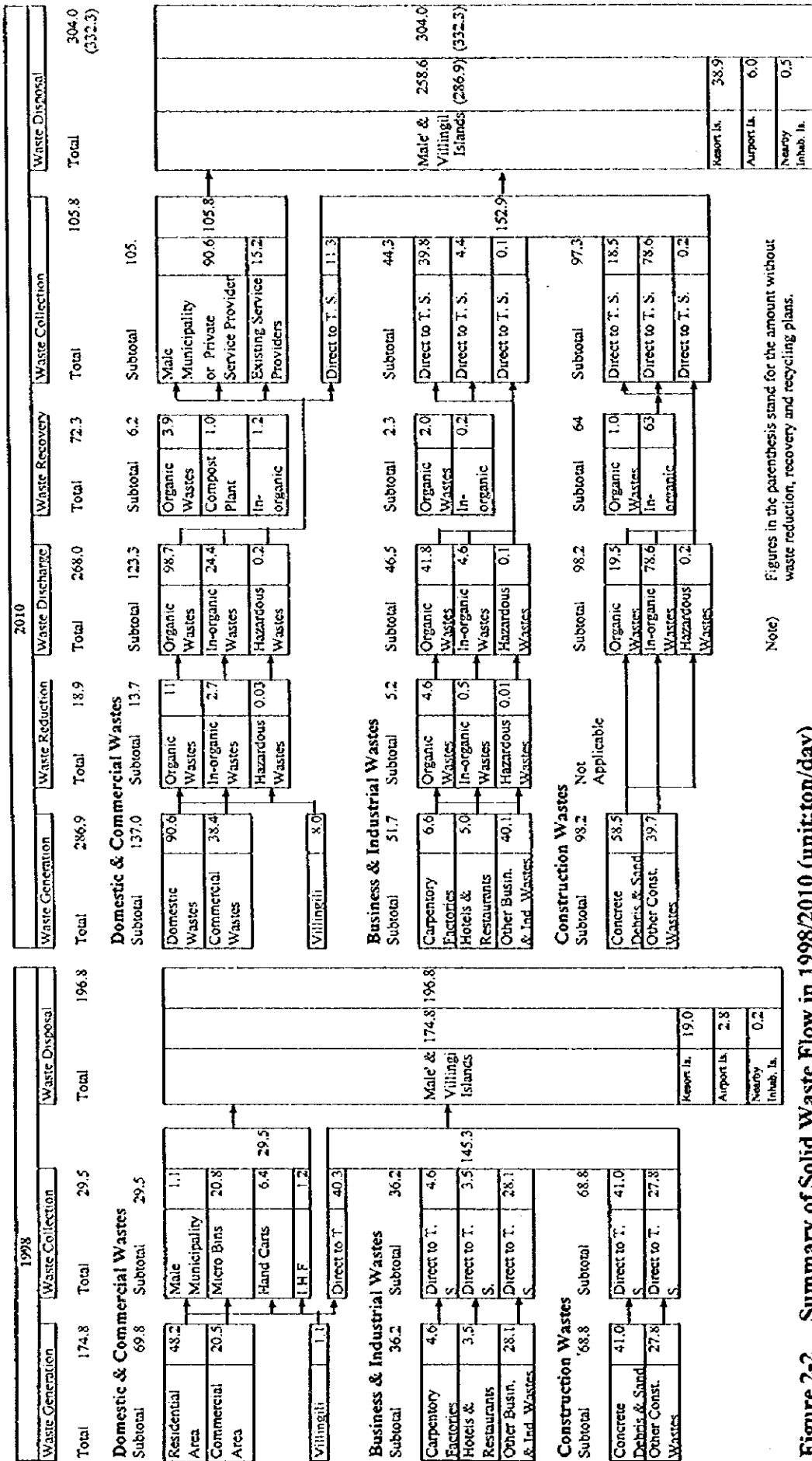
**b. Middle/Long Term Plan**

- 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 by co-ordination and assistance by MCPW,
- ③ Special Task Team shall promote and assist the investor(s) to develop the Recycling Centre and secure the sale routes of the recycled products in domestic and overseas markets through involvement of the dealers and exporters,



- 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 2-2 summarize the whole processes of the SWM from waste generation to disposal.



Note) Figures in the parenthesis stand for the amount without waste reduction, recovery and recycling plans.

Figure 2-2 Summary of Solid Waste Flow in 1998/2010 (unit:ton/day)

### **3. Priority Project of Waste Reduction, Recovery/Recycling**

The priority project(s) is selected and developed for the urgent project(s) required to commence in 2003.

#### **3.1 Target Waste to be Recycled**

Waste recovery shall be carried out with the target recyclable wastes commingled in the domestic waste, commercial waste, business & industrial wastes and construction wastes in Male' Island. Before recovery of materials from the wastes, the solid waste reduction programs shall be carried out at the waste generation sources to cut the waste discharge amount by 5 % by 2005 and 10 % by 2010. The types of wastes to be recovered were studied based on the results of the Waste Composition Survey, Recycling Market Survey and Resource Recovery Survey conducted at the existing Transfer Station and proposed as shown in the following items.

##### **3.1.1 Target Wastes Recovered at Generation Sources**

###### **Domestic wastes**

clothes, books, coconut shells, glass bins, toys, 5 gallons steel cans, electric appliances, electric wire, etc.

###### **Commercial wastes**

same as above

##### **3.1.2 Target Wastes Recovered at Transfer Station and Thilafushi**

###### **Business & industrial wastes**

food wastes from hotels and restaurants, saw dust from carpentry factories, metal & non-metals, electric wire

###### **Construction wastes**

concrete debris and sand, metal & non-metals, electric wire, sacks

###### **Wastes from resort islands and Airport Island**

live bottle bins, tins & cans, aluminium cans, PET bottles, Plastic bottles, etc.

### 3.1.3 Target Amount of Waste Reduction and Recovery/Recycling

Amount of waste reduction, recovery/recycling is estimated based on the waste flow from waste generation to disposal and the target ratio of 5 % and 2.5 % by 2005 for waste reduction and recovery/recycling respectively and indicated in Table 3-1. Estimated waste reduction amount reach at 7.4 tons per day in 2005. Waste recovery/recycling amount is estimated at 62.4 tons in total including the amount of concrete debris & sand at 54.6 tons and 7.8 tons from domestic, commercial, business & industrial wastes and other construction wastes in 2005.

**Table 3-1 Expected Amount of Waste Reduction and Recycling (2005)**

Waste Categories	Domestic & Commercial Wastes		Business & Industrial Wastes		Construction Waste		Total	
	Weight (t)	Ratio (%)	Weight (t)	Ratio (%)	Weight (t)	Ratio (%)	Weight (t)	Ratio (%)
<b>1) Waste Generation Amount</b>								
Total Organic Waste	81.7	80.0	40.4	90.0	16.9	19.8	139.0	61.8
Total In-organic Waste	20.2	19.8	4.4	9.8	68.3	80.0	92.9	38.0
Total Hazardous Waste	0.2	0.2	0.1	0.2	0.2	0.2	0.6	0.2
Total Weight (ton)	102.2	100.0	44.9	100.0	85.4	100.0	232.5	100
Total Waste Volume (m <sup>3</sup> )	693.7		324.6		89.0		1,107.3	
Bulk Density (ton/m <sup>3</sup> )	0.212		0.159		1.104		0.210	
<b>2) Waste Reduction Amount</b>	Target	5%	Target	5%	Not applicable for construction wastes			
Total Organic Waste	4.1	80.0	2.0	90.0			6.1	83.1
Total In-organic Waste	1.0	19.8	0.2	9.8			1.2	16.7
Total Hazardous Waste	0.01	0.2	0.00	0.2			0.01	0.2
Total Weight (ton)	5.1	100.0	2.2	100.0			7.4	100.0
<b>3) Waste Discharge Amount</b>								
Total Organic Waste	77.6	80.0	38.4	90.0	16.9	19.8	132.9	59.1
Total In-organic Waste	19.2	19.8	4.2	9.8	68.3	80	91.7	40.7
Total Hazardous Waste	0.2	0.2	0.1	0.2	0.2	0.2	0.5	0.2
Total Weight (ton)	97.0	100.0	42.6	100.0	85.4	100.0	225.1	100.0
Total Waste Volume (m <sup>3</sup> )	458		268		89.0		815	
Bulk Density (ton/m <sup>3</sup> )	0.212		0.159		1.104		0.276	
<b>4) Waste Recovery Amount</b>	Target	2.5%	Target	2.5%	Target 2.5%			
Total Organic Waste	3.9	80.2	1.9	90.2	0.8	1.5	6.6	10.6
Total In-organic Waste	1.0	19.8	0.2	9.8	54.6	98.5	55.8	89.4
Total Hazardous Waste	0	0	0	0	0	0	0	0
Total Weight (ton)	4.8	100.0	2.1	100.0	55.5	100.0	62.4	100.0
<b>5) Waste Disposal Amount (Male' &amp; Villingili)</b>								
Total Organic Waste	73.8	80.0	36.5	90.0	16.1	53.7	126.3	56.1
Total In-organic Waste	18.3	19.8	4.0	9.8	13.7	45.7	35.9	15.9
Total Hazardous Waste	0.2	0.2	0.1	0.2	0.2	0.6	0.5	0.2
Total Weight (ton)	92.2	100.0	40.5	100.0	29.9	100.0	162.6	72.3
Total Waste Volume (m <sup>3</sup> )	435		255		89		778	
Bulk Density (ton/m <sup>3</sup> )	0.212		0.159		1.104		0.209	

Remarks : Due to utilisation of recovered concrete debris & sand for covering material or temporary dike for landfill operation, the total waste amount carried in to the Thilafushi amount to 217.2 tons (162.6 + 54.6) in 2005.

### **3.2 Development of Waste Reduction and Recovery/Recycling Plans**

#### **3.2.1 Waste Reduction and Materials Recovery Plans**

Eight(8) staff of The Special Task Team(STT) established in Male Municipality shall initiate the waste reduction and recovery/recycling programs by obtaining the supports from the government and the society and through linking with community groups. The configuration of the major activities to implement the programs are proposed in the following sections.

##### **(1) Action Plans for Waste Reduction and Recovery/Recycling**

The waste reduction and recovery/recycling shall be carried out in combination of the plan and programs indicated in Table 3-2 and as summarised in the followings.

##### **Generation Source Control**

- Production Control \*
- Distribution and Sale Control
- Consumer Control
- Waste Charge Control \*
- Commercial Waste Control \*

##### **Waste Discharge Control**

- Promotion of Self-disposal
- Reuse of second Hand Goods

##### **Recovery/Recycling of Materials**

- Recovery by Junk Dealers & Community Groups
- Recycling of Recovered Materials

(Note : The programs marked by \* shall be implemented after 2003 in response to the progress of the activities in the initial stage.)

**Table 3-2 Action Programs for Waste Reduction and Recovery/Recycling**

<b>Generation Source Control</b>		
<p><b>Production Control</b> Planning Purposes</p> <ul style="list-style-type: none"> <li>* Use of returnable bottles</li> <li>* Use of eco-friendly goods</li> </ul>	<p><b>Actions by Male Municipality &amp; SWMSAICPW</b></p> <ul style="list-style-type: none"> <li>* Encouragement/Assistance to makers</li> <li>* Encouragement/Assistance to makers</li> </ul>	<p><b>Actions by the Communities</b></p> <ul style="list-style-type: none"> <li>* Development/Production of returnable bottle goods</li> <li>* Development/Production of eco-friendly goods</li> </ul>
<p><b>Distribution &amp; Sale Control</b></p> <ul style="list-style-type: none"> <li>* Marketing of returnable bottle goods</li> <li>* Reduction of packaging wastes</li> </ul>	<ul style="list-style-type: none"> <li>* Control of non-returnable bottle goods</li> <li>* Control of over-packaging import goods</li> </ul>	<ul style="list-style-type: none"> <li>* Establishment of bottle deposit system</li> <li>* Sale/Purchase of simple packaging goods</li> </ul>
<p><b>Consumer Control</b></p> <ul style="list-style-type: none"> <li>* Reduction of domestic waste generation</li> <li>* Reduction of waste shopping bags</li> </ul>	<ul style="list-style-type: none"> <li>* Public education on SWM</li> <li>* Campaign for reduction of waste plastics</li> </ul>	<ul style="list-style-type: none"> <li>* Previous habit change in discharging wastes</li> <li>* Participation to use own shopping bag</li> </ul>
<p><b>Waste Charge Control</b></p> <ul style="list-style-type: none"> <li>* Application of progressive waste charge rates</li> <li>* Penalty to unpaid bills</li> </ul>	<ul style="list-style-type: none"> <li>* Establishment of fair waste charge rates</li> <li>* Billing and monitoring of unpaid bills</li> </ul>	<ul style="list-style-type: none"> <li>* Payment for the extra waste charge by the large amount waste generators</li> <li>* Payment of the unpaid bills</li> </ul>
<p><b>Commercial Waste Control</b></p> <ul style="list-style-type: none"> <li>* Reduction of commercial waste generation rate</li> <li>* Application of progressive rates to commercial wastes</li> </ul>	<ul style="list-style-type: none"> <li>* Public campaign/monitoring/control</li> <li>* Survey/Establishment of commercial waste charge rates</li> </ul>	<ul style="list-style-type: none"> <li>* Participation to the SWM services</li> <li>* Payment by the large amount waste generators</li> </ul>
<b>Waste Discharge Control</b>		
<p><b>Promotion of Self-disposal</b> Planning Purposes</p> <ul style="list-style-type: none"> <li>* Reduction of discharge amount at generation sources</li> <li>* Reduction of wastes from broken appliances/instruments</li> <li>* Exchange/Sale of second hand goods</li> </ul>	<p><b>Actions by Male Municipality &amp; SWMSAICPW</b></p> <ul style="list-style-type: none"> <li>* Campaign for reduction of waste discharge amount</li> <li>* Encouragement/Training/Introduction of repair technology</li> <li>* Encouragement/Assistance for reusable goods bazaar</li> </ul>	<p><b>Actions by the Communities</b></p> <ul style="list-style-type: none"> <li>* Participation to SWM services</li> <li>* Repair of Broken Appliances/Devices and sales at bazaar</li> <li>* Organization of reusable goods bazaars at schools, mosques, etc.</li> </ul>
<b>Recovery/Recycling of Materials</b>		
<p><b>Recovery by Junk Dealers &amp; Community</b> Planning Purposes</p> <ul style="list-style-type: none"> <li>* Establishment of the resource saving</li> <li>* Securing the sales routes of recovered materials</li> </ul>	<p><b>Actions by Male Municipality &amp; SWMSAICPW</b></p> <ul style="list-style-type: none"> <li>* Campaign for saving the resources</li> <li>* Establishment/Operation of buy-back center at Transfer Station</li> </ul>	<p><b>Actions by the Communities</b></p> <ul style="list-style-type: none"> <li>* Participation to the activities</li> <li>* Recovery of reusable materials by junk dealers</li> </ul>
<p><b>Recycling of Recovered Materials</b></p> <ul style="list-style-type: none"> <li>* Stable supply of recyclable materials</li> <li>* Reuse of concrete debris and sand for waste disposal operation</li> <li>* Recovery of recyclables in the wastes from resort islands</li> <li>* Production of compost derived from wastes</li> <li>* Promotion of recycling industries</li> <li>* Securing regular market for recovered materials</li> </ul>	<ul style="list-style-type: none"> <li>* Recovery/Storage of recyclable materials at Transfer Station/Thilafushi</li> <li>* Storage and transportation of concrete debris and sand to Thilafushi</li> <li>* Recovery of bottles, PET, tins &amp; cans from the resort islands wastes</li> <li>* Construction/Operation of pilot scale compost plant in Thilafushi</li> <li>* Study of recycling technology, encouragement, assistance to recycling industries</li> <li>* Linkage/Encouragement with buyers / exporters</li> </ul>	<ul style="list-style-type: none"> <li>* Participation to recovery of recyclable materials</li> <li>* Unloading of concrete debris and sand at the designated storage area</li> <li>* Separation and transportation of recyclable wastes to Thilafushi by resort</li> <li>* Use of compost, separation of food waste and saw dust by hotels, restaurants and carpentry</li> <li>* Investment to recycling center, development of recycling technology, use of recycled goods</li> <li>* Development of sale routes with domestic and overseas dealers</li> </ul>

**(2) Implementation of Waste Reduction and Materials Recovery Plans**

The action plan of waste reduction and materials recovery shall be implemented in accordance with the configurations of the major activities proposed in the following sections.

**a. Raising Awareness of the Society for Waste Reduction Programs**

Firstly, the action plan of waste reduction shall be commenced with raising awareness of the people by means of public campaign and education through mass media, school education, non-formal education and/or co-operation by the mosques. The details of public campaign and the texts for education shall be prepared by the Special Task Team (STT) in collaboration with Department of Planning, Ministry of Planning and National Development, Non-formal Education Centre, Ministry of Education.

**b. Division of Waste Recovery/Recycling Districts**

In order to facilitate implementation of the action plans, the Male' Municipality area shall be divided into 22 districts based on the location of the poll stations as shown in Figure 3-1. The STT shall organise and maintain a link with at least one volunteer group in each waste recovery/recycling district through the community groups, i. e. neighbouring house groups, school PTA groups, etc. The poll station in each district shall be utilised as a centre for the meeting place of the volunteers supporting the programs and temporary stock area of recovered materials on the operation day to function as the District Waste Recovery Center.

**c. Reusable Goods Bazaars and Buy-back Centres**

Reusable Goods Bazaars mainly dealing with second hand clothes and old books shall be opened every other month by rotation of 6 primary schools in Male'. In addition, permanent Buy-back Centre shall be set up within the compound of the Transfer Station. The second hand goods and recovered materials shall be taken to the Reusable Goods Bazaars for sale and/or to the Buy-back Centre for exchange of money by the standard rate set by the STT. The exchange rate will vary periodically depending on the market price of the recyclable materials.

**d. Encouragement of Scavengers and Junk Dealers**

Most of the case in developing countries, scavengers are refused from the society due to their involvement of criminal act. However, the scavengers in the island society like Male' are different from the common idea of the

scavengers and they are given a position to compose the communities as the community member make living on materials recovery at the existing Transfer Station. Utilisation of their function will be effective to improve and activate resource recovery activities in the future. STT have to study the current activities regarding the flow of the recovered materials for the purpose to take it into one of the process to realise a regulated and enhanced resource recovery programs for Male' Municipality.

**e. Co-operation by Residents and Enterprises for Waste Separation**

Recyclable materials must be set aside from the general waste at generation sources until collection is made by the community groups and/or the junk dealers or take it to the poll station to be function as a centre for the District Waste Recovery Centre. Separation of the recyclable materials and hand to the collectors by the waste generators are the key factors to structure the effective and efficient system for waste recovery and the system will not exist without co-operation of the residents and enterprises in the area.

Co-ordination, guidance and instruction for asking co-operation of the people by STT staff is important to have smooth recovery operation from resident houses, shops and offices carried out by the community groups or the junk dealers from time to time.



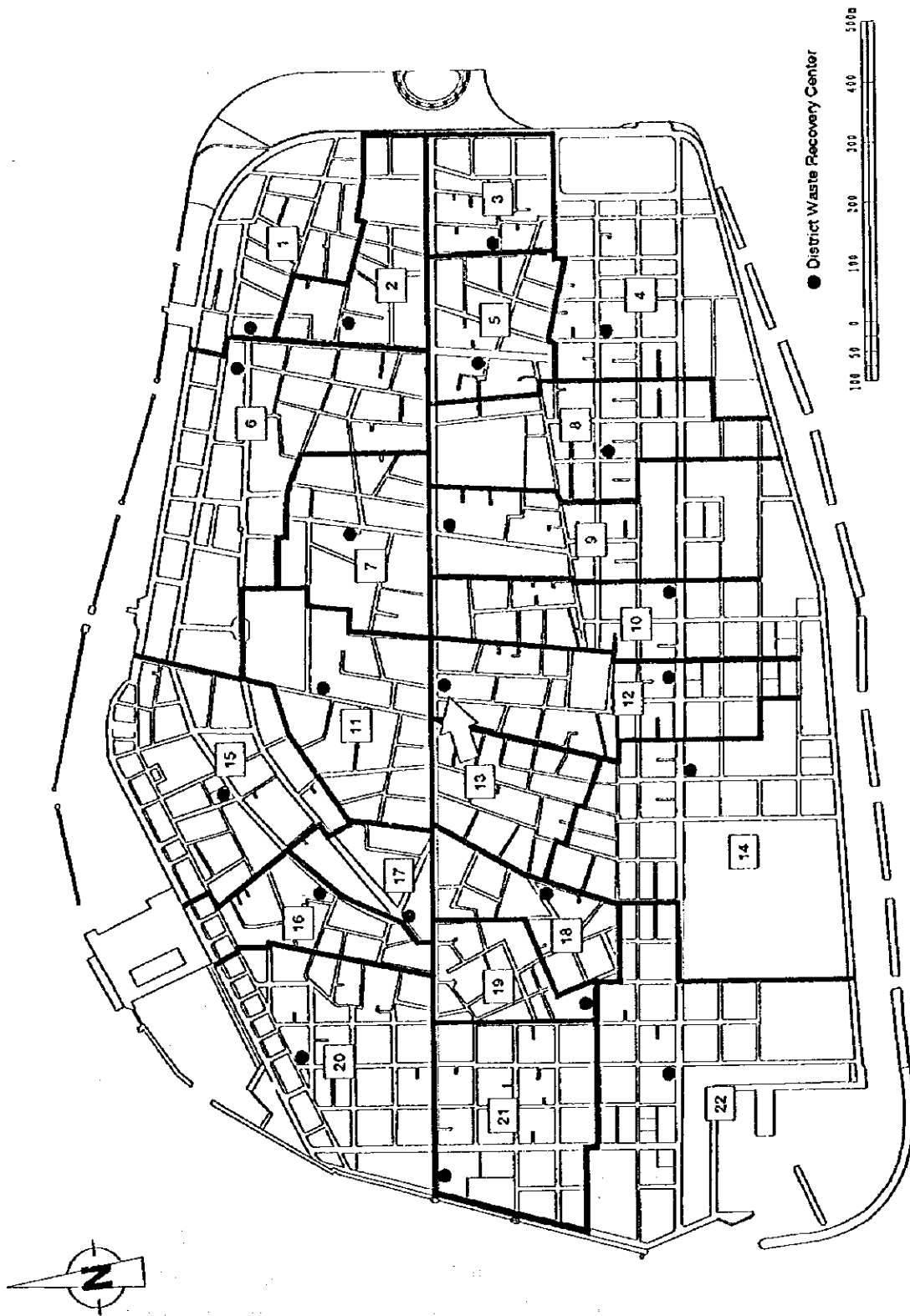


Figure 3-1 Division of Waste Recovery / Recycling Districts

### **3.2.2 Waste Recycling Plan**

#### **(1) Overview**

The types of materials for recovery under the waste recovery/recycling scheme are categorised into two types. The first type is wash and reuse type to recover the materials such as coconut shells, live glass bins, sacks, clothes, 5 gallon cans, etc. and reuse, which are simple and commonly practised currently in Male'. The other type need conversion of the recovered materials through biological, chemical and/or manufacturing processes for reuse. Due to no recycling industries operated in the Maldives, the recovered materials of the second type must be exported to the foreign countries. The following proposals specify the key issues tackled by STT and the agencies concerned to cope with the recovered materials need conversion for recycling.

#### **(2) Implementation of Waste Recycling Plan**

##### **a. Storage of Recyclable Materials at Transfer Station and Thilafushi**

All the wastes from business and industrial sources are proposed to collect and transported to the Transfer Station by the waste generators. Recyclable materials shall be unloaded at the storage area designated by the operator of the Transfer Station. Those wastes separated from general wastes include food wastes from hotels and restaurants, saw dust from carpentry factories, metal & non-metals, concrete debris and sand. As the storage yard filled up, the recyclable wastes shall be transported to the Thilafushi for storage longer period until the materials are reused or sold.

Recyclable materials commingled in the wastes from resort islands and the Airport Islands shall be separated at the generation sources and transported directly by the waste generators. Recyclable materials shall be unloaded separately at the garbage Dhoni unloading jetty. The recyclable materials are collected and stored properly by the operators in the disposal site together with the recovered materials from the Male'.

##### **b. Link with Buyers and Recycling Industries**

Due to long distance from the consumption centre of the recovered materials such as the countries like India, Indonesia or Singapore, selling and distribution of the stored materials will be the control factor for performing the materials recovery and recycling programs successfully. Sale of the recyclable materials shall be made by spot deal depending on the pricing of the recycle markets in the neighbouring countries.

Firstly, collection of market information must be made through maintaining close relation with the buyers and recycling industries in foreign countries. Secondary, on the contrary, the information of the recovered materials such as an amount and type of the recovered materials in Male' must be circulated among the interesting buyers and the recycling industries. In order to make a close link with the buyers and the recycling industries and collection of information, market research shall be conducted in the recycle markets in India, Indonesia and Singapore by the staff of STT prior to launch on the materials recovery programs in 2003.

**e. Food Wastes and Saw Dust Composting**

Composting of solid waste through biological conversion is effective considerably here in the Maldives. Coral sand need nutrients for gardening in Male' and resort islands. In addition, the nation wide project which is called "Planting Two Million Trees Projects" implemented by the Ministry of Fisheries, Agriculture and Marine Resources and supported by the people and the Government need post application of organic matters for growing trees in about 1,200 islands in the Maldives for contribution to the programs against the global warming.

Approximately 4 tons of wastes are discharged from hotels and restaurants and 5 tons are discharged from carpentry factories every day estimated from the waste amount and composition surveys conducted by JICA Study Team from August to September in 1998. Most of these wastes are available for raw materials for composting.

Pilot study for composting is proposed to carry out at the Thilafushi to make use of food waste, saw dust and othe organic wastes. The composting yard of Windrow type composting shall have a capacity to receive raw materials about 2 to 3 tons twice in a week. The facilities shall have the functions for sorting, the composting process consist of fermentation, turning, moisture adjustment for 8 weeks in two rows and for maturation and storage. The composting yard shall have concrete slabs, roofing , rain water tanks, pre-treatment area and sieving area for final products as shown in Figure 3-2.

Composting will be carried out by manual operation to process the compost piles in accordance with the procedures prescribed in the Manuals for Small Scale Composting attached in the Supporting Report E.

The final products of the pilot compost will be able to distributed easily due to the limited amount. At first, the compost shall be used at the test farm prepared in the Thilafushi to study the effects of the final products. After proved at the test farm, the final products shall be packed and shipped by the

return trip of the garbage Dhoni from the resort islands for further test application by the interesting resort islands.

Composting yard shall be expanded or replaced by the mechanical type composting facilities to enlarge the production capacity subject to the successful results of the pilot composting facilities.

### **3.3 Priority Projects of Waste Reduction, Recovery/Recycling Plans**

Physical facilities, equipment or materials required for waste reduction and recovery /recycling plan and programs are listed in the followings. These tools for implementation include stock yard of recovered materials, pilot compost facilities, public campaign and education materials, cost for accumulating information of recycle markets as shown in the following sections.

#### **3.3.1 Construction of Facilities**

##### **(1) Stock Yard in the Transfer Station**

- Included in the Transfer Station design

##### **(2) Stock Yard in the Thilafushi**

- Included in the design of Thilafushi new disposal site

#### **3.3.2 Procurement of Equipment and Marketing Study**

##### **(1) Public Campaign Materials**

- Education Video Programs for Adult, 20 minutes video tape in Dhivehi, consist of 1 master tape and 20 copy tapes
- Education Video Programs for Children, 20 minutes video tape in Dhivehi consist of 1 master tape and 20 copy tapes
- Campaign Posters, 1,000 sheets, A2 size color poster

##### **(2) Public Education Materials for Adult**

- Text for Non-formal Education, 7,000 sets pamphlets

##### **(3) School Education Materials for Children**

- Text for School Education 10,000 sets for the primary school children age 9-10 years old, and 10,000 sets for the secondary school children 14-15 years old

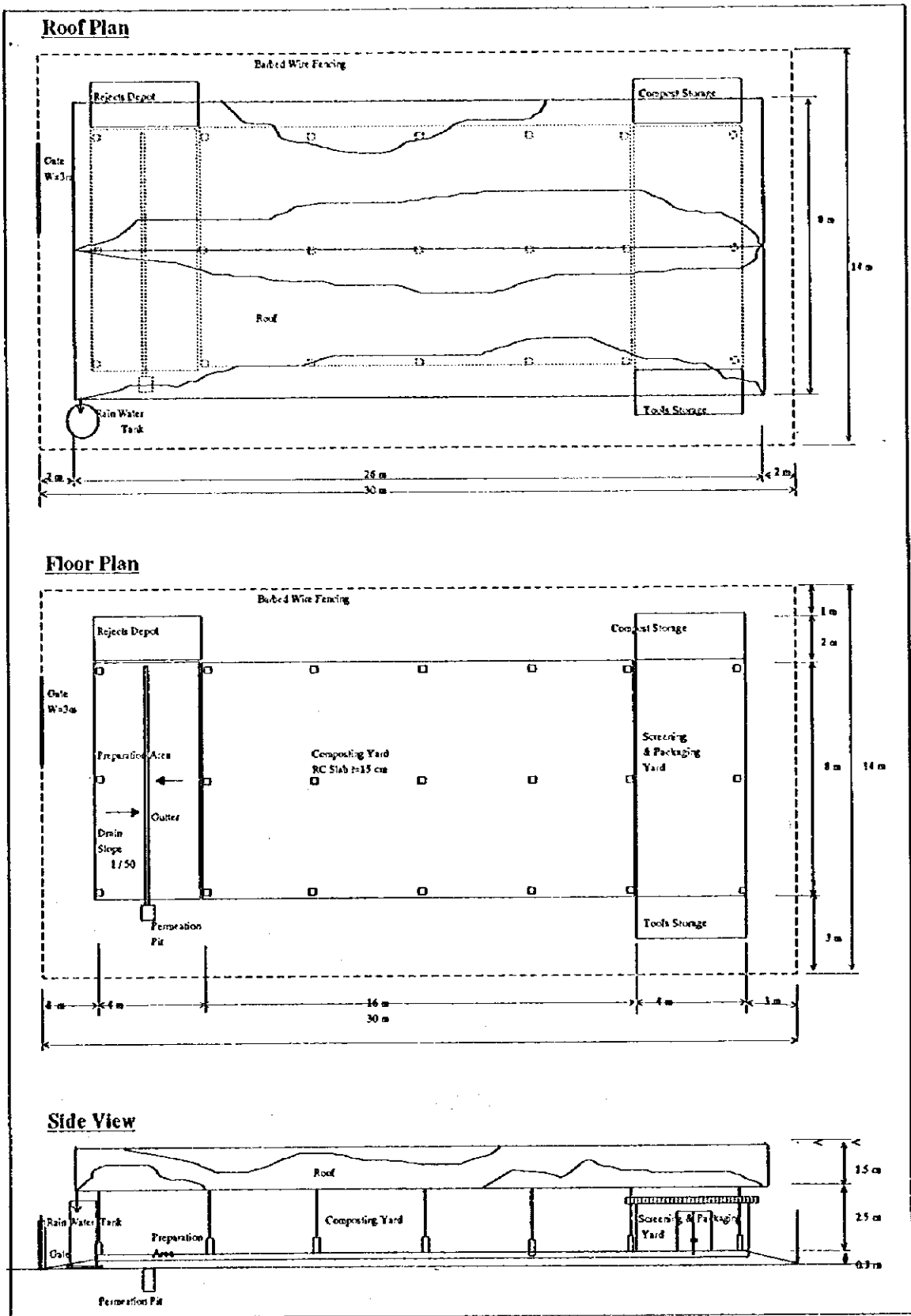


Figure 3.2 Conceptual Design of Pilot Composting Yard in Thilafushi

**(4) Promotion of Recycling Industries**

- Visiting Recycle Markets in India, Indonesia and Singapore to make a link with buyer and recycling industries, 3 person for 7 days each in each country

**(5) Study for Recycling Technologies**

- Accumulation of technical data, information and study on appropriate technology for the Maldives by STT staff

**3.3.3 Required Personnel**

Waste reduction and recover/recycling programs must be implemented under the involvement of various types of people and agencies in the society, the programs must be implemented by the social movement in other words. In the centre of the activities, Special Task Team(STT) established in Male Municipality shall have responsibilities to play a leading role of the activities in collaboration with and supports from the Government agencies, residents and enterprises.

The STT shall be organised with 8 staff member comprised of one(1) Assistant Director to manage the STT, two(2) engineer to study an appropriate method for implementation, one(1) secretary or clerk to maintain smooth office work and four(4) staff to make a link with ward office and community groups.

**3.4 Cost Estimates**

Most of the activities of waste reduction and recovery/recycling programs are conducted through participation of the volunteers of the community groups, enterprises and the facilities are constructed as one of the function of the Transfer Station and the Disposal Site. Accordingly, the cost estimation made for the waste reduction and recovery/recycling plans consist mostly of expenses of public education materials. The total investment cost was estimated at 1,324,000 Rfs. for the cost to be disbursed in 2001. Operation cost was estimated for the salary of the Special Task Team(STT). The total annual personnel cost of STT amount to 294,000 Rfs in and after 2003 .

### 3.4.1 Investment Cost

Construction/ Equipment	Contents/ Quantity	Cost (Rfs)
<b>Cost in 2001</b>		
Stock Yard in the Transfer Station	Included in the Transfer Station design	--
Stock Yard in the Thilafushi	Included in the design of Thilafushi new disposal site	--
Preparation of Education Video	Education Video Programs for Adult and Children 20 minutes 2 maste tapes and 40 copy tapes	240,000
Preparation of Posters	Color Posters, 1,000 sheets, A2 size	200,000
Education Text for Adult	Text for Non-formal Education, 7,000 sets Phamphlets	140,000
Education Text for Children	Text for School Education 10,000 sets	400,000
<b>Subtotal Const in 2001</b>		<b>980,000</b>
<b>Cost in 2002</b>		
Promotion of Recycling Industries	Visiting Recycle Markets, travelling and accomodation for 3 person, 7 days, 3 places	144,000
Study for Recycling Technologies	Accumulation of technical data and study	200,000
<b>Subtotal Cost in 2002</b>		<b>344,400</b>
<b>Total Investment Cost</b>		<b>1,324,000</b>

### 3.4.2 Operation Cost

#### (1) Personnel Cost

Staff	Quantity (person)	Salary per month per person (Rfs.)	Annual Cost (Rfs.)
Assistant Director	1	5,000	60,000
Engineer	2	3,500	84,000
Secretary/Clerk	1	2,500	30,000
Staff Member	4	2,500	120,000
<b>Total</b>			<b>294,000</b>