I.2.2 Forecast of ISW Generation

a. Method applied

aa. Indicators for the forecast of future ISW generation

Based on the estimated amount of present ISW generation, a forecast of future ISW generation in 2010 was conducted by applying the Standard Unit Method (SUM) which required the estimation of the following indicators.

aaa. Population figure for the forecast: Number of Employees

Concerning the population figure for forecasting ISW generation, there are three major indicators, i.e. annual production, annual sales of products, and the number of employees. Since the data available to be required for the forecast is very limited regarding yearly production and annual sales, the number of employees was used as the population for the forecast. However, industrial production will increase by the modernization of production system etc. even though there is no increase in number of employees. Therefore, annual production or annual sales of products should be used as the population figure for forecasting ISW generation when such data is available in the future. The details of the method and result of the forecast is described in the previous section ; i.e. forecast of future socio-economic conditions.

aab. Generation ratio

The generation ratio of ISW fluctuates in accordance with various factors. In the Study, the following two factors were examined for the forecast of future ISW generation.

i. Variation with the introduction of cleaner production technology (CPT).
ii. Difference with the installation rate of the following pollution control facilities (PCF):

- Water pollution control facility: Installation rate (SISS) and sewage treatment plan (EMOS)
- Air pollution control facility: Installation rate (PROCEFF)

ab. Variation factors of ISW generation ratio

aba. Variation of ISW generation ratio with the introduction of Cleaner Production Technology (CPT)

To estimate the fluctuation of unit ISW generation by introducing CPT, a more detailed factory survey is needed to identify the representative production system for each of the 36 or more specific sub-sector of the manufacturing industry. Based on such survey, it may be possible to assume variation rate by CPT introduction. However, due to the time limit and availability of statistics and information, it was impossible to estimate the variation rate. Instead, as mentioned above, the Study assumed and incorporated the labor productivity factor in the forecast of the future number of employees. Since many of the CPT were developed at a time of increasing productivity, during the period of high economic growth in Japan, the factor of minimizing unit ISW generation by CPT introduction is somehow automatically incorporated in the process of forecasting the number of employees.

abb. Variation rate by installation of PCF

The installation rates of pollution control facilities (PCF) for air and water pollution were determined as the target of the Master Plan respectively as shown in Table I.2.2a below.

Table I.2.2a Installation Rate of Pollution Control Facilities

Year / Types of PCF	Installation Rate (%)		
	Unit	1995	2010
Air PCF	Installation Rate (%)	48.9*1	100
On-site Water PCF	Installation Rate (%)	2.1*2	100
Public Sewage Treatment	Installation Rate (%)	2.0	100

Note: *1: Percentage of gas effluent quantity through the "filter" over total gas effluent quantity in the MR (source: SESMA-PROCEFF data)
*2: Source; information of SISS, MOP

ac. Transition of Dust and Sludge Generation Rate

It is estimated that, at present, 51.1% of "Dust and APC (Air Pollution Control) Products" and 98% of "Sludge" are discharged into the air and public water course

without any treatment. Whereas, it is assumed that 100% of waste water and gas effluent shall be treated by the year 2010; quantities of dust and sludge as ISW are estimated in the next section.

ad. Forecast

The forecast of ISW generation in 2010 was based principally upon data obtained from the Team's factory survey and EWI's RISNOR study except for sludge and dust. Hence, the ISW generation in the year 2010 is the product of "generation rate in 1995" and "forecasted employee number in 2010" for 36 respective industries' classification. The forecast of sludge and dust generation, on the other hand, is conducted by the respective methods described below.

b. Forecast of sludge generation

ba. Outline

Generally, sources of sludge generation in factories are:

- on-site waste water treatment facilities, and
- manufacturing processes of products.

Meanwhile, it was found, as the result of factory survey, that:

- Most of factories do not posses waste water treatment facilities, and
- Sludge generated from manufacturing processes, which shows a high water content and/or is unsuitable for reutilization in the factory, is discharged directly into the sewers.

Whereas, the present state of sewerage system in the MR is that:

- The sewer network is substantially completed, and
- Sewage treatment facilities are still under preparation and only about 2% of sewage in the MR is currently subject to treatment.

Since the sewer system in the MR is substantially completed, the rate of sewage treatment in the MR will be drastically improved as the treatment plants commence their operation. Consequently, a huge amount of sludge will be generated in future. The national norm (i.e. Nch2280) stipulates maximum limits for industrial liquid waste to be discharged into the public sewerage system (refer to Table I.2.2b), the newly

built factories should bear this in mind if they need to discharge their industrial waste water into sewage line.

Table I.2.2b Maximum Limits for Industrial Liquid Waste Water Discharge into Sewer Line

Item	unit	Maximum Limit
pH	-	5.5 to 9.0
Temperature	°C	<35
Suspended Solid	mg/l	300
Sedimentable Solids	mg/l	20
Oil and Greases	mg/l	150
Hydrocarbons	mg/l	20
BOD	mg/l	300
Arsenic (As)	mg/l	0.5
Cadmium (Cd)	mg/l	0.5
Cyanide (CN)	mg/l	1
Copper (Cu)	mg/l	3
Total Chromium (Cr)	mg/l	3.5
Hexavalent Chromium(Cr^{+6})	mg/l	0.5
Phosphorus (P)	mg/l	10
Mercury (Hg)	mg/l	0.02
Nickel (Ni)	mg/l	4
Nitrogen (N)	mg/l	80
Lead (Pb)	mg/l	1
Sulphate (dissolved) (SO_4)	mg/l	1000
Sulphide (S)	mg/l	5
Zinc (Zn)	mg/l	5
Detergents (SAAM)	mg/l	20
Trichloromethane	mg/l	0.5
Phenolic Compounds	mg/l	0.5

In this context, sludge attributable to waste water treatment are:

- sludge generated from on-site waste water treatment facilities (to comply with the maximum limits of Nch2280), and
- sludge generated from public waste water (contaminated with discharged industrial waste water with permissible limits) treatment facilities.

Hence the sludge generation amount is forecasted based on the above two factors.

bb. Sludge generated from on-site waste water treatment facilities

Since regulations of Nch2280 are not imposed on the majority of factories to date, sludge generation rates obtained through the Team's factory survey are a conservative estimate. In future, due to enforcement of Nch2280 regulations (i.e. the regulations will also be imposed to existing factories), the increase in sludge generation will be overwhelming.

Therefore, if a similar method, as applied in the forecast of other ISW generation in future (i.e. forecast based on increase of employees), is employed for the forecast of sludge generation in future, the estimated amount should be definitely undervalued.

In this context, since factories' waste water quantities in proportion to the amount of water they consume and waste water quality surveyed on individual industries (e.g. waste water quality for CIIU 3111: BOD 810 mg/l, SS 460 mg/l) was not available, the forecast was carried out by applying the methods below:

i. Firstly, "waste water rate (per employee) defined here as $\underline{a}$", which is proportional to "water-consumption rates (per employee)", of individual industries in the MR are calculated based on the Team's investigation. Although Japanese empirical data of "rationalization in water consumption" is not included in the calculation, a table for change of water-consumption rates between 1973 to 1984 per employee for individual industries in Japan is prepared for a reference material (see Table I.2.2c).

ii. Secondly, waste water (biochemical oxygen demand and suspended solid; hereafter BOD and SS respectively) concentration of respective group-wise industries in the MR are set out with reference to the data in Japan obtained through a survey done by the Ministry of Construction in Japan. (refer to Table I.2.2d)

iii. Thirdly, "waste water BOD/SS concentration obtained from ii. above" minus "maximum limits of BOD/SS concentration defined in Nch2280" give respective BOD/SS concentration to be removed on-site (hereinafter defined Br and Sr).

iv. In calculation of sludge amount to be generated in factories through on-site BOD/SS removal processes;

- Sludge generated from "oxidative decomposition process of BOD" (hereinafter Bg) ; and
- Sludge generated from SS removal process (hereinafter Sg)

should be considered. Generation ratio per employee (hereinafter Tg) is calculated as:

$$Tg = Bg + Sg$$

Bg and Sg are calculated based on following assumptions.

v. Bg is calculated by the following formula with an assumption that : BOD to be removed will be (oxidatively) decomposed 50% into carbon dioxide (CO_2) and 50% into sludge.

$$Bg = \alpha \times Br \times 0.5$$

vi. Sg is calculated by the following formula with an assumption that all SS removed is transformed into sludge.

$$Sg = \alpha \times Sr$$

vii. The sludge generated from the removal of dissolved inorganic substances through physical-chemical treatment is not projeceted in the estimation due to lack of available data for whole industries (available for some industries).

Accordingly, the sludge generation rates per employee are the values of on-site sludge (dry content) generation, assuming that all factories comply with the Nch2280 regulations in their on-site waste water treatment.

Accordingly, future sludge generation amount (dry content) is estimated from:

"Tg" above multiplied by estimated future employee numbers

Where sludge generation amount obtained from the above comprises:

i. amount of inorganic sludge (dry content), and
ii. amount of organic sludge (dry content).

The factory survey gives the estimated proportion of 'inorganic sludge" and "organic sludge" to being 32% and 68% respectively.

Meanwhile, water content of "inorganic sludge" and "organic sludge" are estimated 90% and 99% respectively with reference to visual observations at the factory survey

and to Japanese empirical data. The water content in the sludges should be reduced for the purpose of the transportation. It can be reached to a water content of 85% (i.e. the minimum requirement for transportation through a mechanical treatment. It can be reduced to lower than 85% through drying systems.

The sludge generation amount in 2010 based on the above assumptions is calculated, as shown in Tables I.2.2e and I.2.2f.

Table I.2.2c Change of Water Consumption Rates between 1973 to 1984 in Japan

Potential	CIIU Code	Industrial Category	Nos. of Employees		Water Consumption Amount (m3/day)		Water Consumption Amount (m3/day/employees)		Increase Rate
			1973	1984	1973	1984	1973	1984	1984/1973
Highly Potential Industries	351	Manufacture of industrial chemical products	190,486	128,748	76,197,048	27,982,399	400.014	217.342	0.54
	352	Manufacture of other chemical products	179,344	181,526	1,840,469	3,664,804	10.262	20.079	1.96
	354	Oil and coal products	37,262	29,969	4,704,042	6,087,501	126.242	203.127	1.61
	356	Other non-classified plastic products	48,117	40,611	10,817,588	10,600,953	224.818	261.036	1.16
	371	Iron and steel industries	465,603	333,612	27,198,380	36,933,183	58.415	110.707	1.90
	372	Basic metal industries	189,705	144,977	4,777,340	4,109,460	25.183	28.346	1.13
	381	Manufacture of metal products except machinery & equipment	434,969	343,742	850,840	538,233	1.956	1.566	0.80
		Sub-total	1,545,486	1,203,185	126,385,707	89,896,533	81.777	74.715	0.91
Potential Industries	3211	Textile processing and materials manufacturing	656,221	345,378	4,626,032	3,479,294	7.050	10.074	1.43
	3231	Leather tanning and finishing	4,991	2,984	29,555	22,286	5.922	7.468	1.26
	3232	Fur dressing, dyeing and other fur and skin articles	4,493	4,323	1,803	3,515	0.401	0.813	2.03
	3319	Other non-classified wooden products	11,219	6,500	5,099	6,125	0.454	0.942	2.07
	341	Paper, printing and publishing industries	216,852	171,559	14,466,313	15,651,832	66.711	91.233	1.37
	3420	Printing, photoengraving, publishing and the likes	264,983	257,707	222,578	222,792	0.840	0.865	1.03
	355	Manufacture of rubber products	128,442	110,363	750,550	985,877	5.843	8.933	1.53
	362	Glass and glass products	65,867	53,927	580,966	1,084,953	8.820	20.119	2.28
	3699	Other non-metallic mineral products	59,588	39,065	307,596	437,728	5.162	11.205	2.17
	382	Manufacture of machinery except electrical	850,541	733,385	1,052,470	1,628,493	1.237	2.221	1.80
	383	Manufacture of electrical machinery	1,177,936	1,499,108	1,525,402	3,783,776	1.295	2.524	1.95
	384	Manufacture of transport equipment	851,313	796,025	5,238,595	9,833,122	6.154	12.353	2.01
	385	Manufacture of science, measuring, controlling equipment(inc.lens)	197,525	193,480	160,605	219,860	0.813	1.136	1.40
	390	Other manufacturing industries	323,689	321,957	1,278,769	1,890,497	3.951	5.872	1.49
	625	Gasoline filling station	-	-	-	-	-	-	-
	952	Laundries and dry cleaners	-	-	-	-	-	-	-
		Sub-total	4,313,660	4,535,761	30,246,333	39,250,150	6.283	8.653	1.38
Less Potential Industries	311	Food manufacturing	469,536	461,965	2,761,710	2,830,437	5.882	6.127	1.04
	312	Other food manufacturing	97,144	159,116	1,233,032	1,981,361	12.693	12.452	0.98
	313	Beverage industries	74,956	58,093	1,009,392	787,601	13.466	13.558	1.01
	314	Cigarettes, cigars and tobacco	-	-	-	-	-	-	-
	3212-3219	Textile industries	57,422	53,453	19,646	18,310	0.342	0.343	1.00
	322	Garment industries	208,922	200,707	59,674	469,292	0.286	2.338	8.17
	3233	Leather products (exc.footwears)	4,874	3,844	1,066	956	0.219	0.249	1.14
	324	Leather footwears	18,951	17,102	11,319	6,407	0.597	0.375	0.63
	3311-3315	Wood and cork industry	179,746	75,482	144,876	100,767	0.806	1.335	1.66
	332	Furniture, fixture and the likes	133,065	90,035	76,494	46,633	0.575	0.518	0.90
	361	Potteries and ceramic products	67,458	56,191	69,292	77,201	1.027	1.374	1.34
	3691-3696	Manufacture of non-metallic mineral products	146,047	98,719	1,763,014	1,386,206	12.072	14.042	1.16
	410	Generation, transmission and distribution of electric energy	-	-	-	-	-	-	-
		Sub-total	1,458,121	1,274,707	7,149,515	7,705,171	4.903	6.045	1.23
		Total	7,817,267	7,013,653	163,781,555	136,851,854	20.951	19.512	0.93

Source: "Industrial Statistic Table for Land and Water Use in 1973 and 1984", by Research and Statistic Department, Ministry of International Trade and Industry in Japan.

Table I.2.2d Calculation of Loading Ratio

Potential	CIIU Code		Industrial Category	*Concentration of Waste Water(mg/l)		Discharge Conc.(mg/l)		**WCR	Loading Ratio(kg/y/emp)	
				BOD	SS	BOD	SS	(m3/y/emp	BOD	SS
Highly Potential Industries	351	3511	Organic and inorganic industrial chemicals	1,000	380	700	80	653.271	457.3	52.3
		3512	Fertilizers, Insecticides and the likes	360	160	60	-	202.727	12.2	-
		3513	Resins, plastics, and chemical fibbers	900	21,100	600	20,800	218.182	130.9	4,538.2
		3514	Manufactured chemical products	1,700	300	1,400	0	358.063	501.3	0.0
	352	3521	Paints, Varnishes, lacquers, enamels, and the likes	2,330	860	2,030	560	433.850	921.4	254.2
		3522	Medicines (Pharmaceutical products)	1,800	240	1,500	-	230.535	345.8	-
		3523	Soaps, detergents, shampoos, cosmetics, and the likes	90	50	-	-	63.311	-	-
		3529	Other non-classified chemical products	480	170	380	-	754.235	135.8	-
	354	3540	Oil and coal products	890	770	590	470	409.449	241.6	192.4
	356	3560	Other non-classified plastic products	490	120	190	-	130.613	24.8	-
	371	3710	Iron and steel industries	640	1,490	340	1,190	539.565	183.5	642.1
	372	3721	Basic copper industry	400	40	100	-	833.333	83.3	-
		3722	Copper products and alloys	90	210	-	-	248.259	-	-
		3729	Basic non-ferrous metal industries (exc. copper)	180	610	-	310	540.796	-	167.6
	381	3811	Metal cutlery, hand tools and other general hardware	340	350	40	50	64.583	2.6	3.2
		3812	Metal furniture and fixture	50	90	-	-	191.249	-	-
		3813	Metal structures, tanks, shandies, doors and windows	30	50	-	-	361.568	-	-
		3814	Metal packages, tools, and household utensils	110	80	-	-	88.450	-	-
		3815	Wires, non-isolated cables and by-products	90	100	-	-	201.170	-	-
		3819	Other metal products	2,300	340	2,000	40	240.417	480.8	9.6
Potential Industries	3211	3211	Textile processing and materials manufacturing	370	130	70	-	2,715.905	190.1	-
	3231	3231	Leather tanning and finishing	1,410	1,360	1,110	1,060	788.285	875.0	835.6
	3232	3232	Fur dressing, dyeing and other fur and skin articles	500	1,000	200	700	788.285	157.7	551.8
	3319	3319	Other non-classified wooden products	320	500	20	200	31.250	0.6	6.3
	341	3411	Paper and pulp	1,830	350	1,530	50	9,818.182	15,021.8	490.9
		3412	Paper containers and boxes	240	380	-	80	116.470	-	9.3
		3419	Other paper and pulp products	410	370	-	70	373.656	-	26.2
	3420	3420	Printing, photoengraving, publishing and the likes	190	120	-	-	90.409	-	-
	355	3551	Tires, tubes, rims and the likes	90	1,360	-	1,060	551.532	-	584.6
		3559	Other non-classified rubber products	170	70	-	-	46.825	-	-
	362	3620	Glass and glass products	1,430	1,360	1,110	1,060	293.697	326.0	311.3
	3699	3699	Other non-metallic mineral products	270	8,200	-	7,900	200.207	-	1,581.6
	382	3822	Agricultural machinery	90	100	-	-	166.906	-	-
		3823	Wood and metal working machinery	30	70	-	-	61.071	-	-
		3824	Other industrial machinery	370	370	70	70	166.906	11.7	11.7
		3825	Office machinery and equipment (inc computers)	130	130	-	-	166.906	-	-
		3829	Other non-classified machinery	160	160	-	-	272.740	-	-
	383	3831	Motors, generators, transformers and the likes	1,200	150	900	-	98.737	88.9	-
		3832	Radio, TV, X-ray related machinery and equipment	200	640	-	340	212.804	-	72.4
		3833	Electric heating machinery and equipment	160	130	-	-	212.804	-	-
		3839	Other electric machinery	50	260	-	-	326.870	-	-
	384	3841	Ship and boatyards, marine engines and their parts	130	620	-	320	38.848	-	12.4
		3842	Railroad machinery and equipment	80	80	-	-	38.848	-	-
		3843	Vehicle parts and engines	170	160	-	-	38.848	-	-
		3844	Motorcycles and bicycles	580	5,830	280	5,530	38.848	10.9	214.8
		3845	Airplanes and their components	140	110	-	-	38.848	-	-
		3849	Other transport equipment	180	80	-	-	38.848	-	-
	385	3851	Measurement, controlling and medical machinery	240	160	-	-	174.878	-	-
		3852	Optical and photochemical machinery (inc lens)	210	350	-	50	200.000	-	10.0
	390	3901	Jewelry and silverware	10	100	-	-	13.333	-	-
		3902	Musical instruments	30	140	-	-	13.333	-	-
		3903	Sporting, athletic and camping goods	180	260	-	-	13.333	-	-
		3909	Other non-classified manufacturing industries	670	1,360	320	1,060	13.333	4.3	14.1
	625	6233	Gasoline filling station	0	2,000	-	2,700	121.462	-	206.5
	932	9530	Laundries and dry cleaners	1,100	1,200	850	900	3,642.549	2,914.0	3,278.3
Less Potential Industries	311	3111	Livestock slaughtering and meat production	810	460	510	160	718.416	366.4	114.9
		3112	Dairy products	1,610	400	1,310	100	687.345	900.4	68.7
		3113	Fruits, vegetables, and their products	980	390	680	90	671.951	592.9	78.5
		3114	Fish and other marine foods	2,490	850	2,100	550	654.394	1,269.2	332.4
		3115	Animal and vegetable oils	1,780	550	1,480	250	604.394	894.5	139.0
		3116	Cereal foods	1,110	580	810	280	604.394	489.6	169.2
		3117	Bakery, biscuits, cakes, pastas and the likes	640	370	340	70	660.927	224.7	46.3
		3119	Cocoa and Chocolate powder and sugar confectioneries	320	3,610	10	3,210	83.333	0.8	255.8
	312	3121	Other non-classified food manufacturing	1,430	710	1,100	410	604.394	664.8	247.8
		3122	Animal feeds	2,050	2,920	1,750	2,620	604.394	1,057.7	1,625.8
	313	3131	Alcoholic distilling	1,120	620	820	320	3,065.467	2,454.5	981.7
		3132	Wine, ciders and other fermented beverages	450	100	150	-	3,065.467	450.8	-
		3133	Malt, beer and malt liquors	1,180	550	880	250	4,716.981	4,150.3	1,179.2
		3134	Non-alcoholic beverages	430	130	180	-	1,293.952	232.9	-
	314	3149	Cigarettes, cigars and tobacco	380	180	80	-	604.394	48.4	-
	3212 - 3215	3212	Cloth manufacturing and related processing	270	30	-	-	263.014	-	-
		3213	Socks, stocking and knit products	240	70	-	-	263.014	-	-
		3214	Carpets and rugs	210	110	-	-	263.014	-	-
		3215	Ropes, cables, cordage, nets and the likes	400	90	100	-	263.014	26.3	-
		3219	Other non-classified textile industries	170	30	-	-	263.014	-	-
	322	3220	Garment industries	380	250	80	-	74.717	6.0	-
	3233	3233	Leather products (exc footwear)	10	20	-	-	14.593	-	-
	324	3240	Leather footwear	10	20	-	-	14.593	-	-
	3311 - 3313	3311	Wood processing and wooden products manufacturing	140	150	-	-	14.593	-	-
		3312	Wooden and cane containers manufacturing	10	30	-	-	14.593	-	-
	332	3320	Furniture, fixture and the likes	10	40	-	-	14.593	-	-
	361	3610	Potteries and ceramic products	10	3,500	-	3,200	14.593	-	46.7
	3691 - 3696	3691	Bricks, Lattices, walls and refractory materials	410	5,000	110	4,700	295.620	32.5	1,389.4
		3692	Cements, lime, and plasters	1,110	270	810	-	295.620	239.5	-
		3693	Cement building materials	30	3,500	-	3,200	295.620	-	946.0
		3695	Fiber cement products	1,110	270	810	-	295.620	239.5	-
		3696	Plaster building materials	170	2,290	-	1,990	295.620	-	588.3
	410	4101	Generation, transmission and distribution of electric energy			-	-	0.000	-	-
	613	6138	Wholesale paper distributors	20	40	-	-	34.256	-	-

(Note) *Data from Guideline for Formulation of Sewerage Management Master Plan, 1992, Ministry of Construction Japan

**WCR: Water Consumption Rate

Table I.2.2e Calculation of Organic and Inorganic Sludge Generation

Forecast of Sludge Generation Amount

Rem-BOD= 200 Rem-SS= 300.0

Potential	CIIU Code		Industrial Category	No. of Employee 1995	No. of Employee 2010	Loading Ratio(kg/emp) BOD	Loading Ratio(kg/emp) SS	BOD (ton/year) 1995	BOD (ton/year) 2010	SS (ton/year) 1995	SS (ton/year) 2010	Total Dry Solid (ton/year) 1995	Total Dry Solid (ton/year) 2010	Organic Sludge (m³/year) 1995	Organic Sludge (m³/year) 2010	Inorganic Sludge (m³/year) 1995	Inorganic Sludge (m³/year) 2010
Highly Potential Industries	351	3511	Organic and inorganic industrial chemicals	1,237	1,652	457.3	52.3	565,680	755,460	64,695	86,400	347,535	464,130	23,632	31,560	1,112	1,483
		3512	Fertilizers, insecticides and the likes	163	218	12.2	-	1,989	2,660	0.000	0.000	0.995	1.330	67	90	3	4
		3513	Resins, plastics, and chemical fibres	332	443	130.9	4,338.2	43,459	57,989	1,504,682	2,010,423	1,528,412	2,039,418	103,932	138,680	4,890	6,526
		3514	Manufactured chemical products	730	307	501.3	0.0	115,299	153,899	0.000	0.000	57,650	76,950	3,920	5,232	184	246
	351	*Sub-total*		*1,962*	*2,620*			726,427	970,008	1,571,377	2,096,823	1,934,592	2,581,828	131,551	175,562	6,189	8,261
	352	3521	Paints, Varnishes, lacquers, enamels, and the likes	2,172	2,825	921.4	254.2	2,093,421	2,602,955	577,542	718,115	1,624,253	2,019,593	110,449	137,332	5,197	6,462
		3522	Medicines (Pharmaceutical products)	6,137	7,628	345.8	-	2,122,175	2,637,762	0.000	0.000	1,061,088	1,318,881	72,153	89,683	3,395	4,220
		3523	Soaps, detergents, shampoos, cosmetics, and the likes	4,734	5,880	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0
		3529	Other non-classified chemical products	3,369	6,673	133.8	-	729,110	906,193	0.000	0.000	364,555	453,097	24,789	30,810	1,166	1,449
	352	*Sub-total*		*18,512*	*23,009*			4,944,706	6,146,910	577,542	718,115	3,049,895	3,791,571	207,391	257,825	9,758	12,131
	354	3540	Oil and coal products	*1,360*	*1,731*	241.6	192.4	328,576	418,461	261,664	333,227	425,952	542,463	28,964	36,887	1,363	1,736
	356	3560	Other non-classified plastic products	*15,931*	*17,459*	24.8	-	395,089	442,903	0.000	0.000	197,545	221,452	13,433	15,058	632	708
	371	3710	Iron and steel industries	*4,106*	*4,951*	183.3	662.1	753,451	908,876	2,436,463	3,180,321	3,013,189	3,634,758	204,896	247,162	9,642	11,631
	372	3721	Basic copper industry	151	172	83.3	-	12,576	14,328	0.000	0.000	6,289	7,164	427	487	20	22
		3722	Copper products and alloys	2,068	2,363	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0
		3729	Basic non-ferrous metal industries (exc. copper)	136	153	-	167.6	0.000	0.000	22,794	25,978	22,794	25,978	1,549	1,766	73	83
	372	Sub-total		*2,355*	*2,690*			12,576	14,328	22,794	25,978	29,083	33,142	1,976	2,253	92	105
	381	3811	Metal cutlery, hand tools and other general hardware	1,789	2,233	2.6	3.2	4,651	5,811	5,723	7,152	8,031	10,038	547	683	25	32
		3812	Metal furniture and fixture	2,120	2,647	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0
		3813	Metal structures, tanks, shentes, doors and windows	7,490	9,353	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0
		3814	Metal packages, tools, and household utensils	7,983	9,969	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0
		3815	Wires, non-insulated cables and by-products	2,354	2,940	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0
		3819	Other metal products	4,866	6,076	480.8	9.6	2,339,573	2,921,341	46,714	58,330	1,216,501	1,519,001	92,722	103,292	3,892	4,860
	381	Sub-total		*26,603*	*33,220*			2,344,224	2,927,152	52,439	65,482	1,224,551	1,529,058	93,269	103,975	3,917	4,892
			Highly Potential Total	*70,828*	*86,083*			*9,505,051*	*11,824,628*	*5,122,279*	*6,419,956*	*9,874,805*	*12,334,270*	*671,480*	*836,723*	*31,593*	*39,463*
				0	0							0.000	0.000				
Potential Industries	3211	3211	Textile processing and textile manufacturing	*19,717*	*23,942*	190.1	-	3,748,202	4,513,354	0.000	0.000	1,874,101	2,256,677	127,458	153,454	5,997	7,221
	3231	3231	Leather tanning and finishing	*1,868*	*1,836*	875.0	835.6	1,634,500	1,606,500	1,560,991	1,534,162	2,378,151	2,337,412	161,716	158,966	7,610	7,479
	3232	3232	Fur dressing, dyeing and other fur and skin worker	*14*	*14*	157.7	551.8	2,208	2,208	7,725	7,725	8,929	8,929	600	600	28	28
	3319	3319	Other non-classified wooden products	770	975	0.6	6.3	0,462	0,464	4,851	4,870	5,682	5,102	345	348	16	16
	341	3411	Paper and pulp	2,154	2,926	15,021.8	490.9	33,561,317	43,953,787	1,555,579	1,436,375	18,836,238	23,413,267	1,280,864	1,592,102	60,275	74,922
		3412	Paper containers and boxes	3,401	4,228	-	9.3	0.000	0.000	31,629	39,320	31,629	39,320	2,150	2,673	101	125
		3419	Other paper and pulp products	3,900	4,847	-	26.2	0.000	0.000	102,180	126,991	102,180	126,991	6,948	8,633	326	406
	341	Sub-total		*9,455*	*12,001*			33,561,317	43,953,787	1,289,388	1,602,684	18,970,047	23,579,578	1,289,962	1,603,410	60,702	75,453
	3420	3420	Printing, photoengraving, publishing and the likes	*17,734*	*28,286*	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0
	355	3551	Tires, tubes, tyres and the likes	1,711	2,269	-	384.6	0.000	0.000	1,000,251	1,326,457	1,000,251	1,326,457	68,017	90,199	3,200	4,244
		3559	Other non-classified rubber products	3,040	4,031	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0
	355	Sub-total		*4,751*	*6,300*			0.000	0.000	1,000,251	1,326,457	1,000,251	1,326,457	68,017	90,199	3,200	4,244
	362	3620	Glass and glass products	*2,160*	*2,895*	326.0	311.3	705,139	943,770	673,342	901,214	1,025,911	1,373,099	69,761	93,370	3,282	4,393
	3699	3699	Other non-metallic mineral products	*1,211*	*1,603*	-	1,581.6	0.000	0.000	1,915,318	2,535,305	1,915,318	2,535,305	130,241	172,409	6,129	8,112
	382	3822	Agricultural machinery	413	611	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0
		3823	Wood and metal working machinery	779	1,154	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0
		3824	Other industrial machinery	831	1,230	11.7	11.7	9,723	14,391	9,723	14,391	14,585	21,587	991	1,467	46	69
		3825	Office machinery and equipment (inc.computers)	82	122	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0
		3829	Other non-classified machinery	8,372	12,392	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0
	382	Sub-total		*10,477*	*15,509*			9,723	14,391	9,723	14,391	14,585	21,587	991	1,467	46	69
	383	3831	Motors, generators, transformers and the likes	1,290	1,596	88.9	-	114,681	141,884	0.000	0.000	57,341	70,942	3,899	4,824	183	227
		3832	Radio, TV, X-ray related machinery and equipment	416	515	-	72.4	0.000	0.000	30,118	37,286	30,118	37,286	2,048	2,535	96	119
		3833	Electric heating machinery and equipment	543	672	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0
		3839	Other electric machinery	2,580	3,192	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0
	383	Sub-total		*4,829*	*5,975*			114,681	141,884	30,118	37,286	87,459	108,228	5,947	7,359	279	346
	384	3841	Ship and boatyards, marine engines and their parts	182	213	-	12.4	0.000	0.000	2,257	2,641	2,257	2,641	153	179	7	8
		3842	Railroad machinery and equipment	784	920	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0
		3843	Vehicle parts and engines	3,982	4,674	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0
		3844	Motorcycles and bicycles	592	694	10.9	214.8	6,453	7,565	127,162	149,071	130,389	152,854	8,866	10,394	417	489
		3845	Airplanes and their components	1,518	1,782	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0
		3849	Other transport equipment	344	403	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0
	384	Sub-total		*7,402*	*8,684*			6,453	7,565	129,419	151,712	132,646	155,495	9,019	10,573	424	497
	385	3851	Measurement, controlling and medical machinery	740	896	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0
		3852	Optical and photochemical machinery (inc.lens)	354	429	-	10.0	0.000	0.000	3,540	4,290	3,540	4,290	240	291	11	13
	385	Sub-total		*1,094*	*1,325*			0.000	0.000	3,540	4,290	3,540	4,290	240	291	11	13
	390	3901	Jewellery and silverware	262	316	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0
		3902	Musical instruments	104	91	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0
		3903	Sporting, athletic and camping goods	84	73	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0
		3909	Other non-classified manufacturing industries	2,048	1,790	4.9	14.1	10.035	8,771	28,877	25,239	33,895	29,625	2,304	2,014	108	94
	390	Sub-total		*2,498*	*2,270*			10.035	8,771	28,877	25,239	33,895	29,625	2,304	2,014	108	94
	625	6232	Gasoline filling station	*5,115*	*5,155*	-	206.5	0.000	0.000	1,056,248	1,064,508	1,056,248	1,064,508	71,824	72,386	3,379	3,406
	952	9320	Laundries and dry cleaners	*3,535*	*3,555*	2,916.0	3,278.3	7,286,990	7,445,270	9,310,491	8,375,057	12,003,986	12,098,692	816,271	822,711	38,412	38,715
			Potential Hazardous Total	*85,933*	*110,925*			48,979,709	58,637,964	16,020,192	17,585,900	40,510,047	46,904,882	2,754,674	3,189,524	129,623	150,086
			Hazardous Total	*156,761*	*197,008*			58,484,760	70,466,592	21,142,471	24,005,856	50,384,851	59,239,152	3,426,154	4,026,247	161,216	189,549

Low Potential Industries	311	3111	Livestock slaughtering and meat production	5,870	7,550	366.4	114.9	2,150,768	2,768,518	674,463	868,184	1,749,867	2,252,443	118,989	153,166	5,599	7,207
		3112	Dairy products	4,630	5,961	900.4	68.7	4,168,852	5,367,284	318,081	409,321	2,402,507	3,093,163	163,370	210,335	7,686	9,898
		3113	Fruits, vegetables, and their products	6,165	7,937	392.9	78.5	3,655,229	4,705,847	483,953	623,033	2,311,568	2,975,979	157,186	202,366	7,397	9,523
		3114	Fish and other marine foods	969	1,247	1,269.2	332.4	1,229,835	1,582,692	322,096	414,303	937,024	1,205,849	63,717	81,997	2,998	3,858
		3115	Animal and vegetable oils	2,305	2,967	894.5	139.0	2,061,823	2,653,982	320,395	412,413	1,351,307	1,739,404	91,888	118,279	4,324	5,566
		3116	Cereal foods	1,300	1,674	489.6	169.2	636,480	819,590	219,960	283,241	538,200	693,036	36,597	47,126	1,722	2,217
		3117	Bakery, biscuits, cakes, pastry and the likes	17,273	22,235	224.7	46.3	3,881,243	4,996,205	799,740	1,029,481	2,740,362	3,527,584	186,344	239,875	8,769	11,288
		3119	Cocoa and Chocolate powder and sugar confectionaries	2,845	3,663	9.8	275.8	2,274	2,930	784,651	1,010,255	785,789	1,011,720	53,433	68,796	2,514	3,237
	311	Sub-total		41,357	53,240			17,786,526	22,897,048	3,923,339	5,050,453	12,816,602	16,499,177	871,524	1,121,940	41,011	52,794
	312	3121	Other non-classified food manufacturing	3,621	4,661	664.8	247.8	2,407,241	3,098,633	897,284	1,154,996	2,100,905	2,704,313	142,861	183,893	4,722	6,653
		3122	Animal feeds	974	1,253	1,057.7	1,625.8	1,030,200	1,325,298	1,583,529	2,037,127	2,098,629	2,699,776	142,706	183,584	6,715	8,639
	312	Sub-total		4,595	5,914			3,437,441	4,423,931	2,480,813	3,192,123	4,199,534	5,404,089	285,567	367,477	13,437	17,292
	313	3131	Alcoholic distilling	554	689	2,604.5	961.7	1,343,333	1,698,041	332,782	662,611	1,215,449	1,511,632	42,650	102,700	3,689	4,837
		3132	Wine, cidre and other fermented beverages	3,623	4,509	430.8	-	1,634,150	2,032,657	0.000	0.000	817,075	1,016,329	35,561	69,110	2,614	3,252
		3133	Malt, beer and malt liquors	1,194	1,486	4,150.9	1,179.2	4,956,173	6,168,237	1,407,965	1,752,291	3,896,053	4,846,410	264,231	328,875	12,435	15,476
		3134	Non-alcoholic beverages	2,323	2,890	232.9	-	541,027	673,081	0.000	0.000	270,514	336,541	18,394	22,884	863	1,074
	313	Sub-total		7,694	9,574			8,496,685	10,572,016	1,940,747	2,414,902	6,189,090	7,700,910	420,836	523,659	19,603	24,641
	314	3140	Cigarettes, cigars and tobacco	167	207	48.4	-	8,083	9,777	0.000	0.000	4,042	4,889	0	0	0	0
	3212 - 3219	3212	Cloth manufacturing and related processing	1,774	2,136	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0
		3213	Socks, stocking and knit products	10,236	12,330	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0
		3214	Carpets and rugs	806	970	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0
		3215	Ropes, cables, cordage, nets and the likes	147	177	263	-	3,866	4,655	0.000	0.000	1,933	2,328	131	158	6	7
		3219	Other non-classified textile industries	238	286	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0
	3212-3219	Sub-total		13,211	15,919			3,866	4,655	0.000	0.000	1,933	2,328	131	158	6	7
	322	3220	Garment industries	25,525	32,364	6.0	-	(53,156)	194,184	0.000	0.000	76,575	97,092	5,207	4,692	245	316
	323	3233	Leather products (exc. footwear)	1,158	1,139	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0
	324	3240	Leather footwear	14,785	14,935	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0
	3311 - 3315	3311	Wood processing and wooden products manufacturing	3,655	3,669	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0
		3312	Wooden and cane containers manufacturing	90	90	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0
	3311-3315	Sub-total		3,745	3,759			0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0
	332	3320	Furniture, fixture and the likes	5,975	10,447	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0
	361	3610	Pottories and ceramic products	3,391	4,404	-	44.7	0.000	0.000	147,700	205,647	147,700	205,647	11,493	13,965	534	658
	3691 - 3696	3691	Bricks, Lattices, walls and refractory materials	1,900	2,516	325	1,189.4	61,750	81,770	2,639,860	3,495,720	2,670,753	3,536,615	181,609	240,489	8,446	11,317
		3692	Cements, lime, and plasters	715	947	239.5	-	171,243	226,807	0.000	0.000	85,622	113,404	5,872	7,711	273	362
		3693	Cement building materials	2,793	3,700	-	946.0	0.000	0.000	2,644,070	3,500,200	2,644,070	3,500,200	179,796	238,013	8,461	11,200
		3695	Fibre cement products	1,067	1,413	239.5	-	255,547	338,414	0.000	0.000	127,774	169,207	8,688	11,506	408	541
		3696	Plaster building materials	485	642	-	588.3	0.000	0.000	285,326	377,689	285,326	377,689	19,402	25,682	915	1,208
	3691-3696	Sub-total		6,962	9,218			488,540	646,991	5,569,256	7,373,619	5,813,526	7,697,115	395,317	523,401	18,601	24,628
	410	4101	Generation, transmission and distribution of electric energy	75	75	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0
			Low Potential Total	128,852	183,190			30,374,291	38,748,602	14,081,856	18,234,944	29,249,002	37,611,267	1,990,005	2,557,222	93,439	120,330
			Total	285,613	362,198			88,859,051	109,215,194	35,224,326	42,742,820	79,653,853	96,850,419	5,416,159	6,585,469	254,855	309,879

Table I.2.2f Forecast of Sludge Generation Amount in 2010

Unit : ton/year

Potential	CIIU Code		Industrial Category	C - 3	C - 4
Highly Potential Industries	351		Manufacture of industrial chemical products	8,261	175,562
	352		Manufacture of other chemical products	12,131	257,825
	354	3540	Oil and coal products	1,735	36,887
	356	3560	Other non-classified plastic products	708	15,058
	371	3710	Iron and steel industries	11,631	247,163
	372		Basic metal industries	105	2,253
	381		Manufacture of metal products except machinery & equipment	4,892	103,975
Potential Industries	3211	3211	Textile processing and materials manufacturing	7,221	153,454
	3231	3231	Leather tanning and finishing	7,479	158,944
	3232	3232	Fur dressing, dyeing and other fur and skin articles	28	600
	3319	3319	Other non-classified wooden products	16	346
	341		Paper, printing and publishing industries	75,453	1,603,410
	3420	3420	Printing, photoengraving, publishing and the likes	0	0
	355		Manufacture of rubber products	4,244	90,199
	362	3620	Glass and glass products	4,393	93,370
	3699	3699	Other non-metallic mineral products	8,112	172,400
	382		Manufacture of machinery except electrical	69	1,467
	383		Manufacture of electrical machinery	346	7,359
	384		Manufacture of transport equipment	497	10,573
	385		Manufacture of science, measuring, controlling equipment	13	291
	390		Other manufacturing industries	94	2,014
	625	6253	Gasoline filling station	3,406	72,386
	952	9520	Laundries and dry cleaners	38,715	822,711
Less Potential Industries	311		Food manufacturing	52,794	1,121,940
	312		Other food manufacturing	17,292	367,477
	313		Beverage industries	24,641	532,659
	314	3140	Cigarettes, cigars and tobacco	0	0
	3212-3219		Textile industries	7	158
	322	3220	Garment industries	310	6,602
	3233	3233	Leather products (exc. footwear)	0	0
	324	3240	Leather footwears	0	0
	3311-3315		Wood and cork industry	0	0
	332	3320	Furniture, fixture and the likes	0	0
	361	3610	Potteries and ceramic products	658	13,985
	3691-3696		Manufacture of non-metallic mineral products	24,628	523,401
	410	4101	Generation, transmission and distribution of electric energy	0	0
			Total	309,879	6,585,462

bc. Sludge generated from public sewage treatment plants

bca. Outline of public sewage treatment plan

EMOS has a long term programme of sewage treatment diffusion (in terms of rate of population served) as shown in the Table below.

Table I.2.2g Sewage Treatment Plan in Greater Santiago

Year	1992	1995	1999	2004	2009	2024
Sewage Treatment Plan	0%	2.0%	25.0%	27.5%	100%	100%

Source: EMOS

The amount of total suspended solid to be received in sewage treatment facilities are estimated as follows (refer to Table below).

Table I.2.2h Mass of Inlet Suspended Solid to Sewage Treatment Plants

Unit: kg/day

Year	1992	1995	1999	2004	2009	2024
Inlet Suspended Solid (dry content)	0	6,142	92,220	113,183	607,552	607,552

Source: EMOS

It is planned that 95% of suspended solid received shall be removed. The sludge treatment processes proposed for the programme are:

"Sludge Thickening" + "Digestion" + "Dehydration".

Meanwhile, it is planned that water content after dehydration shall be 75%.

Sludge generated after the processes are expected to be disposed at landfills. Although candidate locations of landfills are expressed in the plan, no specific action for localization of disposal site is underway.

In relation to the sewage treatment programme outlined above, amount of sludge generated from public sewage treatment plants to be disposed is calculated.

bcb. Estimation of sludge to be disposed

i. Assumptions

The estimation of sludge amount is based on the assumptions expressed below.

- All suspended solid removed by the sewage treatment plants converted to sludge.
- Empirical data obtained at the Santiago Poniente Plant of EMOS (Planta de Tratamiento de Agua Servidas Santiago Poniente) suggest the proportion of "inorganic matter" and "organic matter", in treated sludge, to be 50% each.
- According to the empirical data in Japan, 50% of organic matter in sludge is decomposed to water and methane gas by sludge digestion.
- The water content of dehydrated sludge cake is 75% as mentioned in the EMOS's plan.

ii. Outcome of the estimation

The outcome of the estimation based on the assumptions above are shown in the table below.

Table I.2.2i Forecast of Sludge Generated at Sewage Treatment Plants

Year	1992	1995	1999	2004	2009	2024
Inlet suspended solid (DS kg/day)	0	6,142	92,220	113,183	607,552	607,552
Removed SS at sewage treatment plants (DS kg/day)	0	5,835	87,609	107,524	577,174	577,174
SS after digestion (DS kg/day)	0	4,376	65,707	80,643	432,881	432,881
Dehydrated cake (moisture content 75%, m^3/day=ton/day)	0	17.5	262,8	322.6	1,731.5	1,731.5
Final disposal amount (moisture content 75%, ton/year)	0	6,388	95,922	117,749	631,998	631,998

Note: DS: Dry Solid

bd. Conclusions

Table below shows "Forecast for Total Sludge Generation Amount" as a summary of the above estimation.

Table I.2.2j Forecast for Total Sludge Generation Amount

Sludge Generation Source	Type	Moisture content	1995 (ton/year)	2010 (ton/year)
Factories	In-organic	90%	47,035	309,879
	Organic	99%	43,518	6,585,469
Sewage Treatment Plants	Organic	75%	6,388	631,998
Total	In-organic	-	47,035	309,879
	Organic	-	49,906	7,217,467
	Total	-	96,941	7,527,346

c. Forecast of dust generation in 2010

Dust generation rations obtained by the factory survey amount to less than half of categories of industries as shown in Table I.2.2k. Forecasted amount of dust generation in 2010 shall be a conservative estimate if the forecast is conducted without generation ratios for industries which are unaccounted for at present. In order to get the generation ratios of several industries for which ratios were not obtained by the Team's survey, generation ratios surveyed in Japan by the Ministry of International Trade and Industry (MITI) were examined and tabulated in Table I.2.2l.

However, as clearly understood by the table, there are large differences between the ratios obtained by the Team's survey and MITI. In addition, it is hard to get correlation of them. This is due to differences of production processes, raw materials, fuels, flue gas treatment facilities, emission standards, etc.. Thus generation ratios of similar categories of industries, which were obtained by the Team's survey, are applied to dust generation in 2010.

On the other hand, the installation rate of facilities emitting exhaust fumes is 82% according to the Team's Factory Survey (although the SESMA-PROCEFF data base has the installation rate in the MR, it does not provide the rate in accordance with the CIIU code). Consequently, dust generation amount in 2010 is presented in Table I.2.2m.

Table I.2.2k Dust Generation Ratios Obtained by the Factory Survey and Applied to Estimation

Potential	CIIU Code		Industrial Category	Nos. Empl	Generation Ratio Obtained tn/month	Generation Ratio Obtained (Gr/year/empl.)	Generation Ratio Applied (kg/year/empL)
Highly Potential Industries	351		Manufacture of industrial chemical products	24	0.02	7.50	
	352		Manufacture of other chemical products	1,200	0.30	3.00	
	3541	3540	Oil and coal products				47.83
	356	3560	Other non-classified plastic products				7.50
	371	3710	Iron and steel industries	992	11.92	144.18	
	372		Basic metal industries	267	10.00	449.44	
	381		Manufacture of metal products except machinery & equipment	1,845	11.29	73.44	
Potential Industries	3211	3211	Textile processing and materials manufacturing	1,000	0.24	2.91	
	3231	3231	Leather tanning and finishing	33	0.20	72.73	
	3232	3232	Fur dressing, dyeing and other fur and skin articles				2.91
	3319	3319	Other non-classified wooden products				704.79
	341		Paper, printing and publishing industries	647	38.00	704.79	
	3420	3420	Printing, photoengraving, publishing and the likes				
	355		Manufacture of rubber products				2.91
	362	3620	Glass and glass products	700	90.00	1,542.86	
	3699	3699	Other non-metallic mineral products	138	0.55	47.83	
	382		Manufacture of machinery except electrical	730	7.50	123.29	
	383		Manufacture of electrical machinery				73.44
	384		Manufacture of transport equipment	1,300	0.20	1.85	
	385		Manufacture of science, measuring, controlling equipment(inc.lens)				73.44
	390		Other manufacturing industries				73.44
	625	6253	Gasoline filling station				
	952	9520	Laundries and dry cleaners	193	4.00	248.70	
Less Potential Industries	311		Food manufacturing	748	5.76	92.45	
	312		Other food manufacturing				92.45
	313		Beverage industries				92.45
	314	3140	Cigarettes, cigars and tobacco				92.45
	3212-3219		Textile industries				2.91
	322	3220	Garment industries				2.91
	3233	3233	Leather products (exc.footwears)				2.91
	324	3240	Leather footwears				2.91
	3311-3315		Wood and cork industry				73.44
	332	3320	Furniture, fixture and the likes				73.44
	361	3610	Potteries and ceramic products				1,542.86
	3691-3696		Manufacture of non-metallic mineral products				1,542.86
	410	4101	Generation, transmission and distribution of electric energy	95	12.50	1,578.95	
			Total	9,912	192.48	233.03	

Table I.2.21 Dust Generation Ratios Surveyed by MITI in Japan

Unit : kg/year/employee

Potential	CIIU Code		Industrial Category	Generation Ratio obtained by MITI	Generation Ratio obtained JICA's Survey
Highly Potential Industries	351		Manufacture of industrial chemical products	2,807.8	7.5
	352		Manufacture of other chemical products	2,807.8	3.0
	354	3540	Oil and coal products	6,632.1	-
	356	3560	Other non-classified plastic products	2,807.8	-
	371	3710	Iron and steel industries	34,229.6	144.2
	372		Basic metal industries	62.6	449.4
	381		Manufacture of metal products except machinery & equipment	12.9	73.4
Potential Industries	3211	3211	Textile processing and materials manufacturing	27.5	2.9
	3231	3231	Leather tanning and finishing	27.5	72.7
	3232	3232	Fur dressing, dyeing and other fur and skin articles	27.5	-
	3319	3319	Other non-classified wooden products	69.0	-
	341		Paper, printing and publishing industries	628.2	704.8
	3420	3420	Printing, photoengraving, publishing and the likes	628.2	-
	355		Manufacture of rubber products	2,807.8	-
	362	3620	Glass and glass products	415.7	1,542.9
	3699	3699	Other non-metallic mineral products	415.7	47.8
	382		Manufacture of machinery except electrical	37.3	123.3
	383		Manufacture of electrical machinery	37.3	-
	384		Manufacture of transport equipment	52.7	1.9
	385		Manufacture of science, measuring, controlling equipment(inc.lens)	52.7	-
	390		Other manufacturing industries	52.7	-
	625	6253	Gasoline filling station	-	-
	952	9520	Laundries and dry cleaners	-	248.7
Less Potential Industries	311		Food manufacturing	39.2	92.5
	312		Other food manufacturing	39.2	-
	313		Beverage industries	39.2	-
	314	3140	Cigarettes, cigars and tobacco	39.2	-
	3212-3219		Textile industries	27.5	-
	322	3220	Garment industries	27.5	-
	3233	3233	Leather products (exc.footwears)	27.5	-
	324	3240	Leather footwears	27.5	-
	3311-3315		Wood and cork industry	69.0	-
	332	3320	Furniture, fixture and the likes	69.0	-
	361	3610	Potteries and ceramic products	415.7	-
	3691-3696		Manufacture of non-metallic mineral products	415.7	-
	410	4101	Generation, transmission and distribution of electric energy	238,756.4	1,579.0

(source) Study on Establishment of Database for ISW, March 1995, MITI (Ministry of International Trade and Industry)

Table I.2.2m Forecast of Dust Generation Amount in 2010

Potential	CIIU Code		Industrial Category	Nos. of Employee 2010	Total ton/year
Highly Potential Industries	351		Manufacture of industrial chemical products	2,620	16.11
	352		Manufacture of other chemical products	23,009	56.60
	354	3540	Oil and coal products	1,732	67.93
	356	3560	Other non-classified plastic products	17,859	109.83
	371	3710	Iron and steel industries	4,953	585.59
	372		Basic metal industries	2,690	991.37
	381		Manufacture of metal products except machinery & equipment	33,220	2,000.46
Potential Industries	3211	3211	Textile processing and materials manufacturing	23,742	56.65
	3231	3231	Leather tanning and finishing	1,836	109.49
	3232	3232	Fur dressing, dyeing and other fur and skin articles	14	0.03
	3319	3319	Other non-classified wooden products	773	446.74
	341		Paper, printing and publishing industries	12,001	6,935.72
	3420	3420	Printing, photoengraving, publishing and the likes	20,286	-
	355		Manufacture of rubber products	6,300	15.03
	362	3620	Glass and glass products	2,895	3,662.59
	3699	3699	Other non-metallic mineral products	1,603	62.87
	382		Manufacture of machinery except electrical	15,509	1,567.90
	383		Manufacture of electrical machinery	5,975	359.82
	384		Manufacture of transport equipment	8,686	13.15
	385		Manufacture of science, measuring, controlling equipment(inc.lens)	1,325	79.79
	390		Other manufacturing industries	2,270	136.70
	625	6253	Gasoline filling station	5,155	-
	952	9520	Laundries and dry cleaners	2,555	521.06
Less Potential Industries	311		Food manufacturing	53,240	4,036.27
	312		Other food manufacturing	5,914	448.33
	313		Beverage industries	9,574	725.80
	314	3140	Cigarettes, cigars and tobacco	202	15.31
	3212-3219		Textile industries	15,919	37.99
	322	3220	Garment industries	32,364	77.23
	3233	3233	Leather products (exc.footwears)	1,139	2.72
	324	3240	Leather footwears	18,935	45.18
	3311-3315		Wood and cork industry	3,759	226.37
	332	3320	Furniture, fixture and the likes	10,447	629.13
	361	3610	Potteries and ceramic products	4,404	5,571.70
	3691-3696		Manufacture of non-metallic mineral products	9,218	11,662.11
	410	4101	Generation, transmission and distribution of electric energy	75	97.11
			Total	362,198	41,370.68

d. Forecast of ISW generation in 2010

ISW generation in 2010 is forecasted and the summary of the forecast is presented in Table I.2.2n. Detailed forecast is shown in Table I.2.2o.

Table I.2.2n Summary of ISW Generation in 2010

nit: ton/year

ISW Category		1995	1997	2000	2005	2010	Increase rate (2010/1995)
C-1	Ash including from incinerator	10,973	11,295	11,795	12,611	13,437	1.22
C-2	Dust and APC products	5,078	9,917	17,176	29,273	41,371	8.15
C-3	Inorganic sludge	47,035	82,081	134,650	222,264	309,879	6.59
C-4	Organic sludge	43,518	915,778	2,224,169	4,404,819	6,585,469	151.33
C-5	Asbestos	299	312	331	363	395	1.33
C-6	Acids	16,911	17,479	18,332	19,762	21,178	1.25
C-7	Alkalis	2,435	2,518	2,641	2,849	3,055	1.25
C-8	Solvents	485	511	550	615	679	1.40
C-9	Oily waste	3,824	3,863	3,924	4,020	4,118	1.08
C-10	Inorganic chemical residues	24,479	25,273	26,464	28,430	30,392	1.24
C-11	Organic chemical residues	7,927	8,175	8,549	9,171	9,786	1.23
C-12	Other liquid waste	4,044	4,209	4,449	4,859	5,268	1.30
C-13	Waste from food production	219,911	227,530	239,327	258,741	277,927	1.26
C-14	Glass and ceramics	129,240	133,153	139,128	149,087	159,047	1.23
C-15	Metal and scrap	55,028	56,871	59,644	64,235	68,817	1.25
C-16	Paper and cardboard	90,602	96,492	105,269	119,921	134,543	1.49
C-17	Plastics	24,858	25,758	27,117	29,374	31,626	1.27
C-18	Rubber	14,306	14,949	15,886	17,466	19,049	1.33
C-19	Textile and leather	10,158	10,321	10,573	10,993	11,418	1.12
C-20	Waste similar to domestic waste	47,984	49,664	52,221	56,455	60,675	1.26
C-21	Wood	117,359	119,799	123,274	129,204	135,182	1.15
C-22	Slag form melting	10,898	11,221	11,704	12,504	13,310	1.22
C-23	Construction Waste	6,577	6,845	7,249	7,922	8,600	1.31
C-24	Other solid waste	45,209	47,265	50,350	55,484	60,668	1.34
Grand Total		939,139	1,881,278	3,294,771	5,650,420	8,005,888	8.52

Note: The table does not include the sludge generated from sewage treatment plants since EMOS has plans for appropriate treatment and final disposal of said sludge.

Table I.2.2o Detail Forecast of ISW Generation Amount in 2010

Unit: m³/year

Potential	CIIU Code		No. of Employee	CLS																								
				C-1	C-2	C-3	C-4	C-5	C-6	C-7	C-8	C-9	C-10	C-11	C-12	C-13	C-14	C-15	C-16	C-17	C-18	C-19	C-20	C-21	C-22	C-23	C-24	TOTAL
Highly	351		3,420	-	16.11	8,261.00	179,262.00	-	428.19	799.64	-	27.75	-	-	3,498.93	-	-	247.79	177.82	492.81	-	18.63	212.90	-	-	515.41	-	189,848.99
Potential	352		23,099	-	56.40	12,151.00	257,823.00	-	13,266.07	1,864.36	210.74	33.69	0.72	285.59	1,774.22	-	48.47	1,070.41	2,308.43	1,464.68	-	49.50	2,644.80	692.29	1,142.20	23.61	-	296,794.50
Industries	354	3560	1,732	-	67.93	1,775.00	36,887.00	-	-	-	-	-	-	-	-	-	-	76.46	729.26	-	-	24.07	160.44	21.88	-	-	-	39,642.04
	356	3560	17,859	-	109.93	708.00	13,058.00	-	1.13	-	3.46	38.19	-	-	-	-	-	1,360.00	1,643.60	3,317.17	-	20.31	2,061.22	72.01	-	-	0.58	24,399.71
	371	3710	6,953	-	585.59	11,631.00	247,163.00	-	-	-	-	5.14	3,903.13	0.04	-	17.35	14,545.77	2,477.97	71.99	8.67	-	36.38	7,307.74	58.55	7,700.01	117.42	14.73	293,648.48
	372		2,680	13.94	993.37	103.00	2,253.00	-	33.87	-	-	3.99	3.57	-	-	-	540.72	32.74	36.17	435.56	-	-	132.97	39.83	1,394.81	-	-	6,681.54
	381		33,279	337.14	7,000.46	4,892.00	107,975.00	6.53	3,419.40	178.98	156.77	616.51	17,919.09	90.62	-	-	5,273.73	42,231.03	1,460.06	3,470.35	-	74.38	4,717.49	821.32	1,343.96	1.96	26.30	193,213.81
Potential	3231	3231	23,742	8,373.41	56.65	7,221.00	153,654.00	-	38.92	-	-	114.04	-	123.32	-	10.11	-	127.39	278.92	102.31	-	2,219.79	1,723.66	-	-	-	0.81	174,042.13
Industries	3251	3251	1,834	-	109.49	7,479.00	158,844.00	-	-	-	-	-	-	267.67	-	2,606.48	44.64	981.93	7.37	5.98	-	4,392.79	109.16	-	-	-	0.65	175,229.17
	3252	3252	14	-	0.03	28.00	600.00	-	-	-	-	-	-	2.04	-	20.49	0.34	7.49	0.06	0.05	-	33.02	0.83	-	-	-	0.08	694.35
	3319	3319	773	-	444.74	16.00	346.00	-	-	-	-	-	-	-	-	-	-	13.94	-	-	-	0.20	51.60	4,792.53	-	5.07	2.43	5,614.62
	341		12,891	1,095.20	6,973.72	75,437.00	1,607,610.00	-	-	-	0.31	32.01	-	1,542.92	-	-	-	899.91	32,766.91	4,879.03	12.86	6.11	9,517.03	2,586.04	-	23.71	-	1,734,159.13
	3420	3420	26,286	-	-	-	-	-	3.70	0.17	263.66	2.80	-	-	-	72.85	-	631.61	77,352.93	2,947.91	425.89	6.72	2,113.16	22.42	-	-	8.41	93,852.24
	355		6,300	-	13.03	4,244.00	90,199.00	-	-	-	-	0.57	-	-	-	-	-	210.01	1,007.39	71.56	18,063.47	0.07	2,271.76	22.16	-	-	1.42	116,113.93
	362	3620	2,895	22.06	3,662.59	4,393.00	93,370.00	-	-	-	-	16.73	-	-	-	-	4,048.65	914.21	1,374.58	1,851.28	-	0.63	143.01	1,162.76	1,469.27	981.56	-	113,299.74
	3699	3699	1,685	-	62.87	8,112.00	172,400.00	287.30	-	-	-	-	-	-	-	-	-	0.39	180.87	-	-	-	103.47	-	-	-	129.10	181,376.19
	382		15,509	172.40	1,367.90	69.00	1,467.00	0.69	-	-	28.75	57.49	4.32	-	-	-	914.15	3,848.63	120.74	239.66	-	-	699.12	594.30	57.49	-	-	10,273.75
	383		5,975	-	359.82	344.00	7,329.00	-	93.06	9.54	-	13.30	-	-	-	-	11,779.06	9,195.96	341.88	140.87	-	-	1,531.13	145.62	-	-	-	31,337.22
	384		8,186	-	13.15	497.00	10,573.00	-	-	-	-	0.46	-	-	-	-	-	2,594.74	39.41	1.32	2.77	0.23	461.00	222.43	-	-	0.92	14,306.63
	385		1,329	-	79.79	13.00	291.00	-	-	-	-	11.52	-	-	-	-	1,852.12	316.85	292.80	257.17	-	-	295.35	57,873.70	-	-	-	61,384.69
	390		2,270	-	134.70	94.00	2,014.00	-	-	-	-	0.10	-	-	-	1.16	-	0.38	218.50	4.24	0.39	2.79	63.05	592.93	0.19	-	3.66	3,132.17
	625	6253	5,158	-	-	3,406.00	72,386.00	-	-	-	-	2,775.77	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	78,567.77
	957	9570	2,955	-	521.06	28,715.00	872,711.00	-	-	-	11.12	-	-	-	-	-	-	-	234.18	127.09	-	-	9.75	-	-	-	-	902,309.99
Low	311		83,240	2,911.00	4,036.27	52,794.00	1,121,940.00	-	3,225.08	-	4.16	92.15	-	-	-	145,741.60	2,104.03	875.17	7,330.74	4,275.86	-	203.06	16,322.90	588.49	-	-	-	1,342,446.50
Potential	312		5,914	31.15	448.33	17,292.06	367,477.00	-	-	-	-	127.87	-	102.30	4.48	5,660.18	-	5.75	246.79	138.30	-	139.38	1,859.87	70.33	-	-	-	393,643.75
Industries	313		9,576	-	725.80	34,641.00	523,639.00	-	-	594.19	-	121.34	8,372.04	7,292.33	-	122,329.56	4,466.35	415.26	2,981.08	4,527.32	-	145.17	2,706.94	1,209.92	-	-	-	705,237.69
	314	3140	282	0.67	15.31	-	-	-	-	6.27	-	3.47	87.79	78.68	0.08	1,387.17	47.12	4.48	35.66	50.46	-	3.91	70.87	13.02	-	-	-	1,887.36
	3212-3219		15,919	-	37.99	7.00	138.00	-	-	-	-	3.66	149.09	-	-	0.53	-	-	65.20	1,903.32	-	113.92	135.30	-	-	-	-	2,594.22
	322	3220	32,366	-	77.25	310.00	6,602.00	0.01	545.57	-	-	-	-	-	-	-	-	-	2,113.43	201.32	-	2,061.47	1,100.40	72.04	-	-	-	13,034.50
	3233	3233	1,139	-	2.72	-	-	0.03	19.20	-	-	-	-	-	-	-	-	-	76.38	7.09	-	72.35	38.73	0.78	-	-	-	215.06
	324	3240	38,355	-	45.18	-	-	-	-	-	-	-	-	-	-	-	-	33.92	542.78	474.93	542.78	1,916.42	400.98	6.78	-	-	-	3,573.79
	3311-3315		3,799	-	226.37	-	-	-	-	-	-	-	-	1.79	-	-	-	83.38	0.98	3.57	-	-	267.03	49,937.23	-	-	10.14	50,532.29
	332	3320	10,447	-	629.13	-	-	-	-	-	-	-	-	0.84	-	-	-	12.62	25.24	1.26	-	46.28	503.24	13,737.80	-	-	7,363.48	17,723.89
	341	3410	6,464	-	5,571.70	438.00	13,943.00	-	-	-	-	-	-	-	-	-	113,250.43	-	229.13	9.44	-	-	397.87	-	-	1,721.20	-	135,472.77
	3691-3696		9,218	-	11,662.11	24,628.00	523,401.00	-	-	-	-	-	-	-	-	-	108.98	217.94	252.84	72.69	-	-	497.50	63.39	-	5,712.04	57,106.19	623,684.78
	410	4101	75	226.84	97.11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	323.95
			347,196	13,434.98	41,370.69	309,979.06	6,505,469.00	395.34	21,178.11	3,056.15	679.37	6,119.34	36,391.68	9,795.95	5,267.70	277,927.40	159,846.76	68,817.04	134,543.99	31,625.50	19,048.54	11,417.93	60,674.63	135,781.67	13,389.94	8,600.18	68,468.41	8,807,888.30

I.3 Present and Future Medical Solid Waste Generation

This section outlines the present and the future generation of Medical Solid Waste. Basic prerequisites for this work are classification of Medical SW, hereunder identification of potentially infectious waste types and identification of the potential producers of Medical SW. In terms of Medical SWM, the quantity of infectious waste types is the main basic data to be investigated as infectious waste types require special attention and a separate handling system.

Radioactive waste is another waste type requiring special attention, however, radioactive waste is not included in the scope of work of the Study.

The quantity of chemicals and other general hazardous waste types generated in the medical institutions is rather small compared to the generation in the industrial sector. Thus, chemicals and other general hazardous waste types generated in the medical institutions should be included in the management system proposed for industries etc.

In relation to the determination of the quantity of infectious waste it is deemed important briefly to discuss the actual and perceived risks connected to handling of Medical SW.

I.3.1 Classification of Medical Solid Waste

Medical (solid) waste is defined as follows in the context of the present Master Plan study:

(Solid) waste generated in the diagnosis, treatment or immunization of human beings or animals, in related research, or in the production or testing of biological agents.

Solid is put in a clause as in terms of medical waste, a number of liquid waste types such as biological agents and blood are regarded infectious and, thus, being included in the same handling system as solid waste types. Thus, there is not the same distinction between solid and liquid waste as known in Municipal Waste.

There are several classification systems for medical SW. They all originates in the philosophy that a part of the waste being similar to municipal solid waste (and may be collected and treated as such) and a part being either of infectious (and unaesthetic) nature or general hazardous wastes.

The following waste classification system for medical SW is proposed (see table I.3.1a at next page for the detailed definition). The proposal combines the classification recommended by WHO and definition of waste types applied by US-EPA:

- Pathological waste *,
- Human blood and blood products *,
- Cultures and stocks *,
- Sharps *,
- Infectious waste *,
- Animal waste *,
- Chemical waste,
- Radioactive waste,
- General (non-hazardous) waste.

The waste types marked with an asterisk are potentially *infectious types.*

a. Producers of Medical Solid Waste

Hospitals and clinics are the main generator of medical SW, but also some minor sources should be considered in the long term development of the medical SW management system.

Table I.3.1b presents a list of sources of medical SW grouped according to the likely size of waste generation. The list is representative rather than the precise picture in Santiago. It should be added that even very developed medical SW systems may not include all the listed small size producers as the collection system will be relatively costly.

Table I.3.1a The Proposed Classification of Medical Solid Waste

Waste type	Description
Pathological waste	Tissues, organs, body parts, human fetuses and other human parts (recognizable and unrecognizable).
Human blood and blood products	Liquid human blood and products of blood; items saturated with human blood (including caked blood), including serum, plasma and other blood components and their containers.
Cultures and stocks	Cultures and stocks of infectious agents and associated biologicals, including cultures from medical and pathological laboratories; cultures and stocks of infectious agents from research and industrial laboratories; waste from the production of biologicals; discarded live and attenuated vaccines; and culture dishes and devices used to transfer, inoculate, and mix cultures.
Sharps	Sharps that have been used in animal or human patient care or treatment or in medical research, or industrial laboratories, including hypodermic needles, syringes, Pasteur pipettes, scalpel blades, blood vials, needles with attached tubing, and culture dishes (regardless of presence of infectious agents). Broken or unbroken glassware that were in contact with infectious agents, such as used slides and coverslips. Hypodermic needles, suture needles, syringes, scalpel blades and other unused, but discarded sharp items.
Infectious waste	Biological waste and discarded materials contaminated with blood, excrement, exudates, or secretion from humans who are isolated to protect others from certainly highly communicable diseases, or isolated animals known to be infected with highly communicable diseases.
Animal waste	Contaminated animal carcasses, body parts, and bedding of animals known to have been exposed to infectious agents during clinical trials.
Chemical waste	Discarded solid, liquid and gaseous chemicals, for example from diagnostic and experimental works, disinfecting procedures, preservation purposes, and cleaning. Hazardous chemicals includes waste that is toxic, corrosive, flammable, reactive and cytotoxic.
Radioactive waste	Includes solid, liquid and gaseous waste contaminated with radio nuclides generated from analysis of body tissues and fluids, body organ imaging and tumor localization, and therapeutic procedures.
General non-hazardous waste	Domestic-type waste, including packaging materials, kitchen waste, non-infectious waste from wards and other substances that do not pose a special handling problem or hazard to human health or the environment.

Table I.3.1b Producers of Medical Solid Waste

Large size producers
University hospitals and clinics General hospitals Maternity hospitals and clinics
Medium size producers
Medical centers Medical laboratories Out-patient clinics Medical research facilities Mortuary/pathology facilities veterinary clinics Farm and equine centers Blood bank and transfusion centers Hospices Emergency services Abortion clinics
Small size producers
General medical practitioners Convalescent homes Sanatoria Nursing and remedial homes Home-based health care Medical consulting rooms Dental practitioners Pharmacies Animal boarding and hunt kennels Cosmetic piercesrs Tattooists Acupuncturists Opticians Chiropodists Funeral directors Embalmers Physical and mental handicapped homes/centers Psychiatrists Physiotherapists Animal and fur farms

b. The Risk of Medical Solid Waste

There is widespread concern over the safe management and disposal of medical SW due to its possible hazardous or infectious contents.

The risks arising from handling, treatment and disposal of medical SW may be placed into two categories; the medical (real) risk recognized by health professionals and the risk perceived by the public.

<u>The Real Risk</u>

There are in principle 4 ways for transmission of pathogenic micro organisms (bacteria, virus, fungi and parasites):

1: Through the skin; via lacerated skin or penetration by needle or other sharp or pointed object.

2: Through the surface of mucous membranes.

3: Through the respiratory passages via inhalation.

4: Through the gastrointestinal canal by consumption of infectious material.

The risk of transmission of pathogenic micro-organisms (in medical term) from medical SW is virtually considered at the same level as of municipal SW which is considered minimal. The particular concern is related to Hepatitis B and human immunodeficiency virus (HIV). These virus are primarily transmitted through the contact of body fluids and, thus, the risk of infection is closely associated with blood contaminated sharp objects such as needles and splintered bones.

Thus, provided sharps and pointed items are properly packed, the main risk arises during the generation of the waste. Through careful source separation and use of unbreakable packaging, the risk of infection during the subsequent waste handling is minimal. In fact, medical literature do not report on any case where a person has contracted an infection from medical waste except in case of a physical injury of the skin caused by sharp objects.

<u>The Risk Perceived by the Public</u>

In general, the public exaggerate the risks posed by medical SW. The rare incidents

involving medical SW have been disproportionately highlighted and much publicized by the media (HIV accidents with sharps, illegal dumping of medical SW, etc.). Thus, it is natural that the public perception of risk varies distinctly from the professional medical view.

Although it may be inappropriate to respond on the perceived risk (as this is not real), the public perception must be observed in the medical SWM system. Thus, it is adequate to require medical SW being kept in a *separate handling system* with proper treatment and disposal facilities for infectious waste types.

Finally, the public responds on the risk of being confronted with recognizable, unpleasant waste items such as human limbs, placentas, syringes etc.

Confrontation with these medical waste types may not constitute a particular risk of transfer of disease etc. However, it will certainly affect the person and provoke disgust and anger. This, what we may describe as an aesthetic based conflict, should be given considerable attention in choice of the handling system.

I.3.2 The Present Generation of Medical Solid Waste and the Waste Flow

a. The Present Generation of Medical Solid Waste

The registered waste generation is generally higher in ADIMARK's RESHOS Study than that observed by EWI's RESHOS Study. This is probably due to the survey methods and due to the fact that the ADIMARK Study includes all waste types, e.g. also liquid waste. Table I.3.2a presents waste generation data obtained from the two studies.

Table I.3.2a Waste Generation Data According to Studies Conducted by EWI and ADIMARK

Institution	Waste type	Unit	EWI [1]	Adimark [4]
Hospitals	Total waste generation	kg/bed/day	1.9187	5.3235
	Pathological waste	kg/bed/day	0.0624	0.2425
	Infectious waste	kg/bed/day	0.5937 [2]	1.4173
	Communal waste	kg/bed/day	1.2502	3.6327
	Hazardous waste	kg/bed/day	0.0124 (chemicals)	0.0149
	Radioactive waste	kg/bed/day	-	0.0076
	Animal waste	kg/bed/day	-	0.0084
Clinics	Total waste generation	kg/bed/day	-	5.8431
	Pathological waste	kg/bed/day	-	0.3304
	Infectious waste	kg/bed/day	-	1.7265
	Communal waste	kg/bed/day	-	3.7442
	Hazardous waste	kg/bed/day	-	0.0412
	Radioactive waste	kg/bed/day	-	0.0008
	Animal waste	kg/bed/day	-	0
Primary and secondary practitioners	Total waste generation	kg/consultation	0.0541	-
	Risk waste	kg/consultation	0.0023	-
Rural health clinics [3]	Total waste generation	kg/clinic/day	-	13.3927
	Pathological waste	kg/clinic/day	-	0.1416
	Infectious waste	kg/clinic/day	-	2.7352
	Communal waste	kg/clinic/day	-	8.6324
	Hazardous waste	kg/clinic/day	-	2.0228
Laboratories [3]	Total waste generation	kg/laboratory/day	-	14.8438
	Infectious waste	kg/laboratory/day	-	6.1425
	Common waste	kg/laboratory/day	-	6.7123
	Hazardous waste	kg/laboratory/day	-	1.9945

Note:
1) Average for public (4 types) and private hospitals.
2) EWI category risk waste exclusive of pathological waste.
3) Based on limited samples.
4) The generation ratio in this table is the survey results before the adjustment of 25% reduction.

Table I.3.2b compares waste generation data for various countries. It appears that data obtained by ADIMARK correspond to the international trend, however, somewhat in the higher end of the selected countries. The likely lesser use of disposable equipment in Chile compared to some other countries makes it reasonable not to expect the medical SW generation today to be in the high end. For the subsequent planning we propose to apply a 25% reduction of the figures obtained by Adimark. In Table 3.2c the total medical SW generation estimate for the Metropolitan Region of Santiago.

Table I.3.2b Generation of Medical Waste in Various Countries

Place	Total generation of medical waste	Generation of waste of infectious nature
Santiago, Chile [1]	1.9187 kg/bed/day = 1.82 kg/capita/year (EWI) 5.3235 kg/bed/day = 5.04 kg/capita/year (ADIMARK)	0.6561 kg/bed/day = 0.62 kg/capita/year (EWI) 1.6598 kg/bed/day = 1.57 kg/capita/year (ADIMARK)
Latin America [2]	3 kg/bed/day	20% of 3 kg =0.60 kg/bed/day
Belgium	11 kg/capita/year	1.4 kg/capita/year
Denmark		1.95 kg/capita/year 1.3 kg/bed/day
France	12.8 kg/capita/year	1.9 kg/capita/year
Germany	1.15 kg/capita/year	0.4 kg/capita/year
Ireland	6.1 kg/capita/year	2.6 kg/capita/year
Italy	2.6 kg/capita/year	1.0 kg/capita/year
Mexico City	2.4 kg/capita/year 4.73-5.38 kg/bed/day	0.24 kg/capita/year
Netherlands	10.8 kg/capita/year 2.3-6.5 kg/bed/day	0.6 kg/capita/year
Portugal	4.9 kg/capita/year	1.5 kg/capita/year
Spain	4.9 kg/capita/year 4-4.5 kg/bed/day	0.6 kg/capita/year 0.4-0.5 kg/bed/day
United Kingdom	5.5 kg/capita/year 2.5-3.3 kg/bed/day	5.5 kg/capita/year
USA	4.1-5.24 kg/bed/day	

Note:
1) The conversion from generation per bed to generation per capita is based on all 14,517 beds at hospitals and clinics and 5.6 millions inhabitants. Medical SW from other sources is not included.
2) Average assumed generation for Latin America according to *Organizacion Panamericana de la Salud* and *Organización Mundial de la Salud* (/NK3/).
3) Sources: /NK1/, /NK2/, /NK3/ and research made by RH&H Consult in Mexico City.

Table I.3.2c The Present Medical Solid Waste Generation, Santiago Metropolitan Region 1995

Source	Units	Total waste generation per unit	Annual total waste generation	Generation of infectious waste types per unit	Annual generation of infectious waste types
Hospitals	12,938 beds	0.75 • 5.32 = 3.99 kg/bed/day	18,800 tons	0.75 • 1.66 = 1.25 kg/bed/day	5,900 tons
Clinics	1,579 beds	0.75 • 5.84 = 4.38 kg/bed/day	2,500 tons	0.75 • 2.06 = 1.55 kg/bed/day	900 tons
Sub-total for hospitals and clinics	-	-	**21,300 tons**	-	**6,800 tons**
Rural health centers and rural/urban surgeries	164 units	15 kg/unit/day	900 tons	Approximately 20%	200 tons
Other sources	-	-	1,400 tons	Assumed 20%	300 tons
TOTAL	-	-	**23,600 tons**	-	**7,300 tons**

There is a disparity between the composition of special medical SW from hospitals and clinics in the two studies as seen from Table I.3.2d below.

Table I.3.2d Composition of Medical Solid Waste from Hospitals and Clinics According to Studies (Infectious Types only)

Waste type	EWI	ADIMARK
Pathological waste	9.5%	18.8%
Cultures/stocks and blood products	1.0%	23.2%
Sharps	4.8%	18.8%
(Other) infectious waste [1]	n.a.	39.2%
Surgical waste (dressing etc.)	76.1%	n.a.
Waste from isolation wards	8.6%	n.a.

Note: 1) Here, the term infectious waste should not be compared or mixed up with the term used in the classification.

EWI's study is the most reliable with respect to the waste composition as actual sorting and weighing were carried out. However, the percentage of cultures/stocks is underestimated in EWI's study, probably because of its contents of liquid waste, which to a large extent is disposed of in the sewer. In order to estimate the present waste flow, the composition in Table I.3.2e below is assumed for infectious types of medical SW from hospitals and clinics. This assumption is the *best estimate* assessed by the JICA Study Team.

Table I.3.2e Assumed Composition of Medical Solid Waste from Hospitals and Clinics (Infectious Types only)

Waste type	Composition	Quantity
Pathological waste	10%	680 tonne
Cultures/stocks and blood products	15%	1,020 tonne
Sharps	5%	340 tonne
Infectious waste	70%	4,760 tonne
TOTAL (hospitals and clinics)	100%	6,800 tonne

b. The Waste Flow

Table I.3.2f presents the assumed flow of waste of infectious nature from hospitals and clinics.

Table I.3.2f The Present Waste Flow for Medical Solid Waste from Hospitals and Clinics (Infectious Types only)

	Quantity (tonne)	Burial		Incinerator		Municipal landfill		Sterilization [3]		Sewer		Other	
		% [2]	tonne	% [2]	tonne	% [2]	tonne	% [2]	tonne	% [2]	tonne	% [2]	tonne
Pathological	680	34	230	35	240	3	20	13	90	3	20	12	80
Cultures/stocks and blood products	1,020	3	30	22	225	8	80	34	345	17	175	16	165
Sharps	340	5	20	28	95	18	60	34	115	0	0	15	50
Infectious waste	4,760	5	240	32	1,525	22	1,045	19	905	8	380	14	665
TOTAL	6,800 [1]	8	520	31	2,085	18	1,455	21	1,455	8	575	14	960

Note:
1) Note that only infectious type wastes from hospitals and clinics are included (6,800 tones in 1995 versus the total estimate of 7,300 tones).
2) Distribution on disposal methods is according to ADIMARK's RESHOS Study.
3) The indicated flow is the primary waste flow. Waste sterilized by autoclave will afterwards be disposed of by incineration, landfilling and via the sewer.

I.3.3 Forecast of Medical Solid Waste Generation

The forecast of medical SW generation for the period 1995 - 2010 is developed for waste of infectious nature, i.e. the first 6 categories of the classification in section I.3.1.

a. Forecast Method

The generation of waste of infectious nature depends on a number of factors such as the population, the general hygiene standard applied in society and at medical institutions, the development of preventative medicine and development of curative methods.

A number of the above-mentioned factors are not statistically quantifiable and, furthermore, they are uncertain in respect of the possible impact on the medical SW generation. Thus, for the Master Plan Study it is proposed to forecast the future medical SW generation based on the development of the population combined with an assumption of the possible impact of developed welfare of the individuals and the society.

The generation of medical SW is assumed to develop linear to the development of population of society. Increased welfare is likely to improve hospital hygiene, which normally means increased use of disposable equipment and, consequently, increased waste production. However, modern hospital SW management includes attention to possible methods for reduction of the waste quantities, e.g. through resource minded and environmental conscious purchasing of equipment and consumables.

There are no available historical information for quantification of the possible impact of the above-mentioned factors. For this study, an annual increase of 1% is assumed.

b. Forecast

Table I.3.3a shows the population projection 1995-2010 for the Santiago Metropolitan Region and the projection of medical SW generation (infectious waste types only).

Table I.3.3a Projection of Medical Solid Waste Generation 1995-2010 (Waste of Infectious Nature Only)

Year	Projection of population		Effect of improved hospital hygiene	Projected generation of medical solid waste of infectious nature (tons)
	Total	Index		
1995	5,642,000	100.00	100.00	7,300
1996	5,738,000	101.70	101.00	7,500
1997	5,831,000	103.35	102.01	7,700
1998	5,923,000	104.98	103.03	7,900
1999	6,013,000	106.58	104.06	8,100
2000	6,102,000	108.15	105.10	8,300
2001	6,190,000	109.71	106.15	8,500
2002	6,276,000	111.24	107.21	8,700
2003	6,361,000	112.74	108.29	8,900
2004	6,445,000	114.23	109.37	9,100
2005	6,528,000	115.70	110.46	9,300
2006	6,610,000	117.16	111.57	9,500
2007	6,690,000	118.57	112.68	9,800
2008	6,770,000	119.99	113.81	10,000
2009	6,850,000	121.41	114.95	10,200
2010	6,931,000	122.85	116.10	10,400

ANNEX J

INVESTIGATION AND INITIAL ENVIRONMENTAL EVALUATION OF CANDIDATE SITES FOR HAZARDOUS WASTE DISPOSAL

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ANNEX J INVESTIGATION AND INITIAL ENVIRONMENTAL EVALUATION OF CANDIDATE SITES FOR HAZARDOUS WASTE DISPOSAL

J.1 Suggested Guidelines for Selection of Potential Areas for Major Facilities for Industrial Solid Waste Management

J.1.1 Introduction

Included in the Study is an agreement that criteria for selection of option areas for treatment/disposal facilities shall be set up in the beginning of the study. Based on these criteria the Chilean authorities will select option areas (candidate sites) to be assessed by the Study Team in the next phase of the project in July-August 1995.

This annex contains the suggestion for the selection criteria to be applied as provided by the Study Team at the end of the first work period in Chile in February-March 1995.

J.1.2 Site Selection Method

It is generally assumed that the selection of the most proper sites for waste treatment and disposal (in this case one or more waste treatment plant(s) and landfill(s)) should take part applying a negative selection method because it is generally assumed that it is difficult to make most people think of such an enterprise in as a positive thing. The stages suggested are as follows:

a. Identification of potential localization areas and sites
b. Selection of candidate sites
c. Assessment of candidate sites

In the first stage (a) the areas most suited for the localization of a site will be identified by a preliminary investigation excluding those areas where it is for different reasons not commendable to establish a site. From these options the most evident among the areas identified as reasonable options are selected as candidate sites (b). For these ones a final investigation and recommendation will take place in the third phase (c).

It is assumed that 3-4 candidate sites should be selected for treatment plants and

landfills, respectively.

Of these issues, the Chilean side will conduct phase a and b based on the suggested selection criteria and other relevant national legislation, regulations, guidelines etc. At least an abstract of these criteria documents must be made available to the Study Team for the final assessment (c). Other relevant documents such as maps applied in the first phases and other issues as described in section J.1.3a below must be made available as well.

The considerations made by the Chilean authorities must also be made available to the Study Team for each of the selected candidate sites. These will be basic documents for further assessment and must therefore be available in English.

J.1.3 Conditions to be Considered for Selection of Potential Sites

The key factors to be considered in the selection of potential sites are:

1. Possibility of land acquisition
2. Compatibility with national or regional development plans
3. Environmental acceptability
4. Economic feasibility

It is assumed that 1. and 2. above will play a major role in the first stages of the project (a. and b. in section J.1.2 above), whereas 3. and 4. will be the major issues in stage c., because the relations to 1. and 2. have been clarified in the first to stages. However, the whole study basis must be established before the resumption of this part of the study by the Study Team in July 1995.

The reaction of potential neighbours should also be considered, but as it generally understood that Chilean legislation does not require neighbourhood consensus if only certain requirements of distance to the sites are fulfilled (600 metres from populated areas, 300 metres from single dwellings). This as therefore not considered a major issue if only it is assured that these requirements are fulfilled.

a. Study Basis

The study basis to be applied is assumed mainly to consist of maps, planning documents and public registers.

It is suggested that the following material be made available as far as possible for one or more of the stages of the selection procedure:

aa. Possibility of Land Acquisition

a. Maps showing present land use, and if possible recent aerial photographs:
   - Agriculture (soil category)
   - Forests
   - Natural resources

b. Maps showing regulatory constraints on land use, such as areas covered by national or international nature protection regulations and conventions for archaeological and historic monuments, habitats for vulnerable and endangered species (flora and fauna), valuable landscapes, etc.

c. Maps showing publicly owned land (state, region, province, municipality).

d. Register and maps showing ownership of areas within or close to candidate locality.

ab. Compatibility with National or Regional Development Plans

a. Maps and descriptions showing planned development in the region and land use policy plans in general (agriculture, recreational, tourist).

ac. Environmental Acceptability

The assessment of the environmental acceptability will be part of the work carried out by the Study Team. In the first stages of the project only a preliminary assessment of the environmental acceptability is assumed. The information mentioned in the following should, however, be gathered for this topic.

It is a general assumption that both a treatment plant and a landfill will be constructed according to modern standard, i.e. with limitation of air, noise and water emissions. The conditions of interest are formulated according to this.

a. Maps showing environmentally sensitive areas in general. These maps may be topographical maps, geological or hydrogeological maps, watershed area maps, or other special maps. The following special conditions should be borne in mind:

- Distance from airports (bird control);
- Ground water resource protection (natural low permeable layers of soil over important aquifers):
  - Usage of ground water in area;
- Small ground water abstraction nearby (replaceability):
  - Distance to dug wells downstream of site;
- Distance to populated areas (odour problems may reach beyond the above-mentioned 600 metres):
  - Specification on dense population and single dwellings;
- Unsuitable surface water conditions (regularly flooded flood plains or gorges in mountains flooded in the spring);
- Inappropriate slopes (risk of landslide, inappropriate construction conditions):
  - Description of topography;
  - Description of flood risk;
  - Slope stability and gradient of slope.

b. Information on meteorological conditions in the area:
- Annual precipitation and distribution thereof;
- Annual potential evapotranspiration and distribution thereof.

c. Predominant winds in the area:
- Wind rose showing frequency of wind directions and velocities.

d. Access to landfill liner material:
- Distance to sufficient amounts of clay with a quality suited for liner construction (permeability $<10^{-9}$ m/sec., good workability and compaction major characteristics).

e. Distance from central point of waste collection service area (air pollution increasing with distance).

f. Public nuisance from access roads or railways:
- Map showing access roads and railways in relation to populated areas an population density.

ad. Economic Feasibility

The economic feasibility will be part of the work of the Study Team. In the first stages of the project only a preliminary assessment of economic feasibility is assumed. Some basic features should be considered in the first stages and the following information be gathered for both this and the selected candidate sites for final evaluation.

a. Location of site:
. Distance from central point of waste collection are (transport costs).

b. Area of site (For a treatment plant it should be in the magnitude of 4-6 hectares).

c. Expected possible filling height and total volume (landfills).

d. Life expectancy (landfills). It should be noted that a life expectancy of less than 10 years is considered unacceptable for a landfill.

e. Accessability (need for road and/or railway construction).

f. Purchase price of land (for example $/ha).

g. Availability of public service (water supply, waste water discharge related to staffing facilities, power supply).

h. Technical considerations (technical construction problems etc. that may require additional costs).

J.1.4 Suggested Method of Work

The suggested method of work to get through the stages a-b mentioned in section J.1.2 are described in the following sections. The way to identify potential localization areas and sites (stage a) is described in section J.1.4a and J.1.4b, and the subsequent task of selecting candidate sites among the potential sites (stage b) is described in section J.1.4c.

Stage c, the assessment of candidate sites, is only described briefly as this is to be carried out by the Study Team in the coming phases of the project.

a. Identification of Potential Localization Areas

A lot of work is needed to select potential areas for localization of waste treatment and disposal facilities if one has to carefully consider every single plot of land.

In order to avoid this it is suggested to use the compiled maps mentioned under section J.1.3aa and J.1.3ab, i.e. regarding present and planned land use and regulatory constraints. If general maps on environmentally sensitive areas are available, they should be used in this preliminary phase as well.

By putting these maps in top of one another, preferably on transparent paper or plastic, areas without restrictions will emanate. This areas are potential for localization of facilities.

A map showing publicly owned land may be used as an invert - positive - indicator, because publicly owned land will often be more easily accessible than privately owned.

b. Identification of Potential Localization Sites

In the areas now available as potential localization areas, reasonable potential sites for establishing treatment and disposal facilities, respectively, should be established.

This is in reality the most difficult task, as there are no strict requirements at hand. The Potential Sites must be selected on the basis of consideration of a range of optimum conditions that should be met (not prioritized):

- Area of sufficient size (see J.1.3ad above, general size for treatment plants, variable depending on waste amount and filling height for landfills).

- Distance from inhabited areas preferably 600 metres for populated areas and 300 metres for single houses - or more.

- Distance from airports more that 5-6 kilometres (bird control).

- Localization downstream of important drinking water catchment areas (ground water and surface water).

- Good road and/or railway access (large roads, not much traffic in residential areas).

- No problems with flooding in wet season (steep slopes and narrow valleys/gorges should be avoided).

- Technical construction problems should not be expected (for example risk of land subsidence).

- Areas with one or few owners should be preferred (will ease land purchase). Publicly owned land may be preferred.

These criteria should result in the identification of one or more potential sites within each potential area. Preferably 10-15 potential sites for treatment plants and disposal plants should be identified within the Metropolitan area.

c. Selection of Candidate Sites

Among potential sites mentioned above, the candidate sites for further examination in stage c should be selected in stage b: Selection of candidate sites.

In order to conduct this it is suggested that a screening sheet be filled in for each of the potential sites identified in stage a. An example of a screening sheet is shown as table J.1.4a below.

The filled in screening sheets may be used either as they are or the information in them compiled into a overall evaluation sheet for all potential sites for the same purpose. In an overall evaluation sheet the description from the screening sheets would have to be condensed to one or two words or - even better - to characters on a scale from 1 to 5 - with 5 as "best".

On the basis of these screening sheets and/or the compiling evaluation sheet, the 3-4 most suitable sites for treatment plant and disposal sites must be selected.

d. Assessment of Candidate Sites

The candidate sites will be assessed by the Study Team on cooperation with the Counterpart Team as stage c. of the selection procedure. The result of this is assumed to be a motivated list of priority for the candidate sites.

Table J.1.4a Screening Sheet for a Potential Site

Name of Site:

Employment of Site (Treatment of Disposal):

Topic	Description
1) Possibility of Land Acquisition	
a. Land use	
b. Land ownership (number of owners)	
c. Necessity of compensation	
d. Other consideration	
2) Compatibility with Regional Development Plans	
a. Competing development plans	
b. Conformity with structure plan and land use plan	
c. Direction of urbanization towards site	
d. Other considerations	
3) Environmental Acceptability	
a. Present use of site area	
b. Present use of adjacent areas	
c. Topography of area (hole, flat, light slopes, hilly)	
d. Distance to environmentally sensitive areas	
e. Type(s) of environmental sensitivity	
f. General soil quality of site	
g. Risk of flooding	
h. Water supply in area (public, single wells)	
i. Distance to populated areas other than single houses	

Topic	Description
j. Distance to nearest single house	
k. Number of single houses within 600 metres of site	
l. Distance from central Santiago	
m. Access road passing residential areas (Y/N)	
n. Distance to clay for landfill liner	
o. Other considerations	
4) Economic Feasibility	
a. Location of site (distance from central Santiago)	
b. Area of site (ha)	
c. Expected filling height	
d. Expected total volume	
e. Availability of covering soil (sandy soils preferred)	
f. Availability of public service (water supply, electric power, sewage treatment)	
g. Accessability by road and/or train	
h. Purchase price of area (per ha and total)	
i. Compulsory extra land acquisition	
j. Benefits of site upon completion	
k. Technical considerations	
l. Other considerations	

It should be noted that some of the points in the table are more relevant for landfills than for treatment plants and vice versa. For example, access to covering soil and assumed maximum filling height have little relevance for a treatment plant. Such obviously irrelevant questions should not be answered.

J.2 Selection of Candidate Sites for Solid Waste Disposal and Evaluation of the Sites

J.2.1 Introduction

The Comparative Environmental Evaluation (CEE) presented in this annex J.2 to the Final Report of the Master Plan Study on Industrial Solid Waste Management in the Metropolitan Region (MR) in Santiago de Chile aims at making a recommendation for localities in the MR to be considered as a future site for an industrial waste (hazardous waste) landfill.

The Report is structured as follows:

- In chapter J.2.2 below compiled, relevant data for a comparative environmental evaluation is presented in 11 sections for each of the 11 localities selected for preliminary consideration (candidate sites). For each of the 11 localities the presentation of data and information is summed up in a preliminary evaluation at the end of each sections (section J.2.2a-l).

- In chapter J.2.3 the comparative evaluation (CEE) is made, and on the basis of that a ranked - or group-ranked - list is made of the candidate landfill sites.

It should be emphasized that the evaluations and the recommendations in the following have the form of a Comparative Environmental Evaluation. The CEE has been done on the basis of information from open sources (published reports etc.) and on verbal or written information received from different Chilean administrative bodies as mentioned in section J.2.1b.

The evaluations and recommendations presented below will thus not render a full Environmental Impact Assessment (EIA) for the most promising localities dispensable. The CEE is only intended as a tool for selecting the localities to be subject to an EIA.

An Initial Environmental Evaluation (IEE) along the lines provided by JICA for the top priority sites from the present CEE is presented in Annex J.3 of the Final Report.

A summary of the below information and the comparative evaluation and recommendations can be found in section 7.3 of the Main Report together with a summary of the above-mentioned IEE.

a. Selection of Candidate Sites for an Industrial Landfill

The 11 localities which are dealt with in this report have been selected by the Chilean Counterpart. The selection guidelines provided by the Study Team in the Progress Report and described in Annex J.1 of this report were not applied, as this was deemed impossible within the strict time limit for the task. Instead, the selection has taken place in continuation of a study conducted by CRIOT, the Regional Committee of Territorial Infrastructure and Legislation of the Metropolitan Region, aiming at defining possible locations for the final disposal of domestic solid waste. The potential sites for industrial (hazardous waste) landfills were selected partly from the CRIOT study, partly - based on similar criteria - from the Chilean team's knowledge of sites in the Metropolitan Region.

The potential sites selected for further consideration were:

1. Montenegro (next to the potential municipal waste site selected on the basis of the CRIOT study)
2. Cerro Carneros
3. Quilapilún (Tres Orejas)
4. Estación Puangue
5. San Diego
6. Santa Amelia
7. Mandinga
8. Escorial Norte
9. Rincón los Rulos
10. Las Canteras
11. El Convento

The localizations of the candidate sites are indicated on the map of the Metropolitan Region overleaf (figure J.2.1a).

b. Background for the Comparative Environmental Evaluation

As will be understood from the above, there is no detailed project for a landfill on each of the candidate sites. Nor has it been possible to gather and present a full compilation of information as is normally done when conducting an Environmental Impact Assessment. In fact, the information collected only come from open sources such as yearbooks, contemporary information etc. which could be obtained from different national and local institutions in Chile. The main sources of information have been the National Service for Geology and Mining (SERNAGEOMIN), the Metropolitan

Sanitary Works Company (EMOS), the Natural Resources Information Center (CIREN). For example, the general geological descriptions for each of the sites in chapter 2 has been provided directly by SERNAGEOMIN.

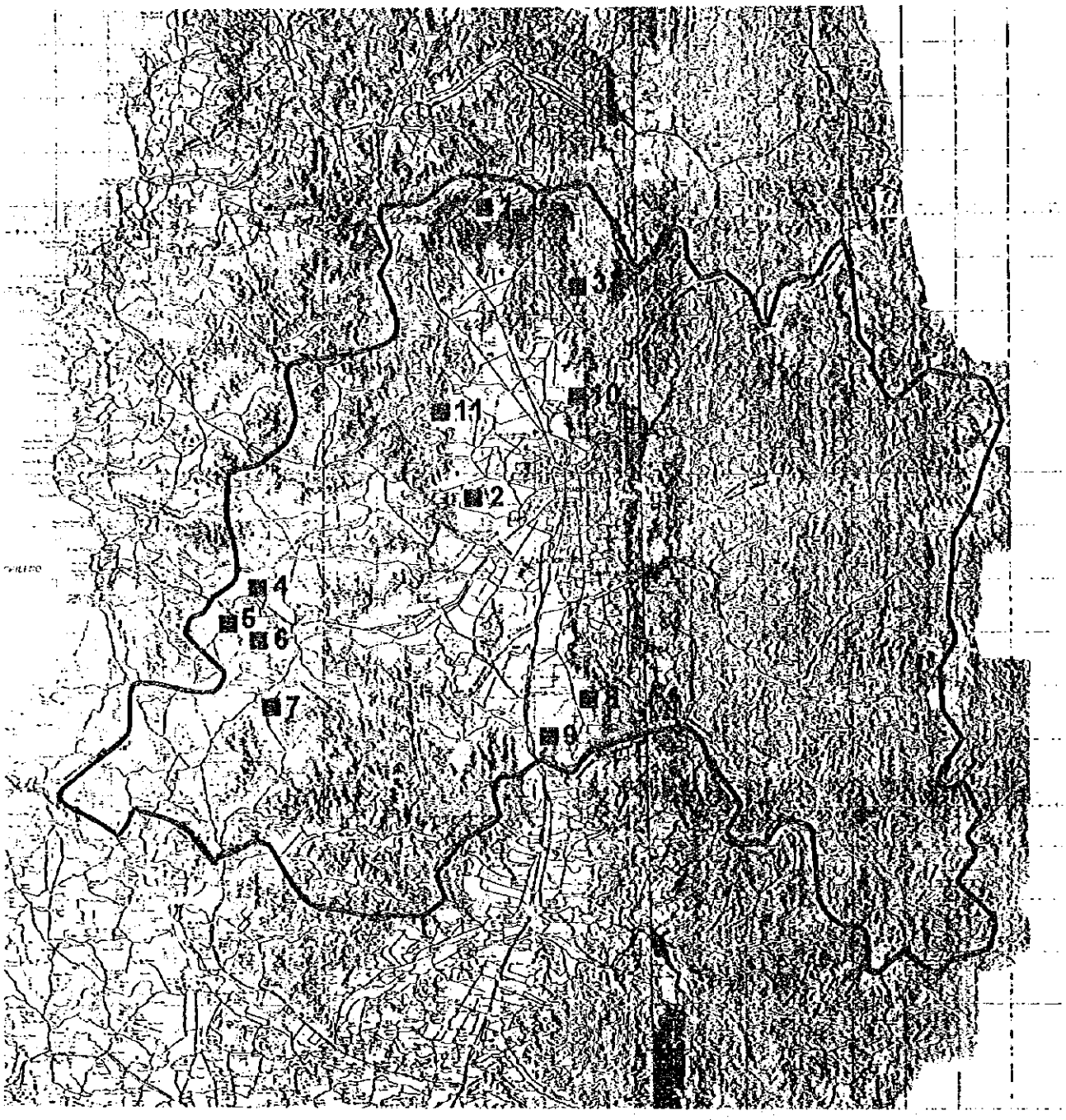

Figure J.2.1a Map of the Metropolitan Region with potential landfill localities indicated

In order to remedy for the missing projects, the study has made a number of assumptions as to the construction, requirements etc. for a landfill intended to receive hazardous industrial waste. These assumptions are presented in sections 7.1 and 7.2 of the Main Report and further developed in Annex K of the report.

The landfill volume is calculated on the assumption that the landfill is shaped like the hills of the region, that is with a slope of 1:3 at the foot and 1:5 at the summit, averaging 1:4.

Especially for the Montenegro site, detailed investigation and design have been done by the company Kenbourne Ingenierá Ambiental S.A. ((KIASA) and DEMARCO. La Escuela de Ingeniería en Construction de la Facultad de Ingeniería de la Universidad Católica de Valparaíso has conducted an EIA for the site. Much information has been drawn from this.

c. Limitations in the Comparative Environmental Evaluation

There are certain limitations to the present CEE:

- First and foremost the CEE is made on the basis of a limited amount of data, and only such data that were directly available from open sources (reports, yearbooks, etc.) or from communication with public institutions such as the SERNAGEOMIN, EMOS, CIREN, and Ministries.

- These data have built-in limitations as they do not provide evidence on all the aspects which should be illuminated in a CEE. But some information may be deducted from other information applying basic engineering knowledge and understanding. This has to some extent been done in the following, and it is thus evident that not all the information provided bear full scientific proof. It is also worth mentioning that the Study itself has not had the opportunity to create information, for example by executing specific on site investigations.

- For site no. 1, Montenegro, a full EIA has been conducted as a basis for a decision on the establishment of a municipal waste landfill on the area (i.e. next to the area suggested for an industrial waste landfill. The information related to this candidate site is thus of a higher quality than that provided for the other sites.

In spite of the limitations of the data and the deducted evidence, the information is deemed to be of sufficient quality to allow for a preliminary (comparative)