A BRIEF SUMMARY AND INTERPRETATION

OF KEY POINTS, FACTS, AND CONCLUSIONS

FOR

University of Wisconsin Study:

"LIFE CYCLE COMPARISON OF FIVE ENGINEERED SYSTEMS FOR MANAGING FOOD WASTE"

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APRIL, 1998

In order to develop a factual database relative to the actual merits and concerns for different systems of managing food waste, the National Association of Heating- Plumbing -Cooling Contractors commissioned a University of Wisconsin - Madison, Life Cycle Comparison of five Engineered Systems for Managing Food Waste. The comparison included the required land, total system energy, total system materials, total emissions to the environment and total system costs for each method.

Dr. Robert Ham of the Civil Engineering Department and one of the country's recognized landfill experts was chosen to lead and oversee the study. Carol Diggelman, a graduate student in the Civil and Environmental Engineering Department at UW and a Professor in Environmental Engineering at the Milwaukee School of Engineering in Milwaukee, Wisconsin was chosen to do the research. The results of this four year research project are contained in a 571 page report titled "LIFE-CYCLE COMPARISON OF FIVE ENGINEERED SYSTEMS FOR MANAGING FOOD WASTE" which compares all five systems on the basis of processing 100 kilograms of food waste.

The five systems are:

1. Food Waste Disposer plus a Publicly Owned Treatment Works (FWD / POTW).
2. Municipal Solid Waste Collection / landfilling (MSW Collection / Landfilling).
3. Municipal Solid Waste Collection / Composting (MSW Collection / Composting).
4. Municipal Solid Waste Collection / Waste To Energy (MSW Collection / WTE; Incineration).
5. Food Waste Disposer plus an On-Site (Septic) Sysytem (FWD / OSS)

The first four systems are based on specific state of the art operational systems. The on-site system design is based on simply increasing the septic tank and drain field size by 25 % to accommodate a food waste disposer. This requirement is based on a typical required increase of 25 % solids loading to the system, based on previous research.

Assumptions for the study based on the best available data:

1.The base of 100 kilograms of food waste was chosen as a convenient basis of comparison for the five engineered systems. An average person generates 0.29 pounds of food waste per day. Of this, 75 % or 0.21 pounds per day is processed through a food waste disposer. 100 kilograms of food waste is therefore the amount processed by the "average" U.S. family of 2.63 persons over a period of 382 days, or just slightly over one year.

2. Typical food waste is 70 % water and 30 % solids.

3. The typical composition of food waste and human waste solids is :

	% C	% H	% O	% N	% S
Human Waste, Solid Organics	59.7	9.5	23.8	7.0	0
$C_{10}H_{19}O_3N$					
Food Waste, Solid Organics	50.5	6.72	39.6	2.74	0.44
$C_{21.53}H_{34.21}O_{12.66}N_{1.00}S_{0.07}$					

4. The final destination of food waste in the U.S.:
   a. Municipal Solid Waste Collection /Landfill...................................41%
   b. Food Waste Disposer / Publicly Owned Treatment Works.. 37 %*
   c. Food Waste Disposer / On-Site (Septic) System......................... 12 %*
   d. Municipal Solid Waste Collection / Waste To Energy(Incineration)... 10 %
   e. Municipal Solid Waste Collection / Composting.....................................0%

*Wastewater food waste includes contributions from dishwashers and kitchen sinks.

CONCLUSION

Of the five alternative food waste systems measured, a food waste disposer processing food waste through a publicly owned treatment works has the lowest cost to the municipality; the least air emissions, especially greenhouse gases ! ; converts the food WASTE to a RESOURCE which may be recycled; and as a result overall is the most environmentally friendly and sustainable option for recycling non-edible food RESOURCES. The food waste disposer is also the most convenient method of disposing of food waste and is the most likely to be used as the vehicle for source separation of food waste from the solid waste stream.

LIFE-CYCLE COSTS

In terms of life-cycle costs, the systems ranked in this order (lowest to highest):

1. Municipal Solid Waste Collection / Landfilling.
2. Municipal Solid Waste Collection / Composting.
3. Food Waste Disposer / Publicly Owned Treatment Works.
4. Municipal Solid Waste Collection / Waste To Energy (Incineration).
5. Food Waste Disposer / On-Site (Septic) System.

However, in terms of direct costs to the municipality, the Food Waste Disposer / Publicly Owned Treatment Works combination is by far the lowest cost. The rankings and costs are:

1.Food Waste Disposer / Publicly Owned Treatment Works ....$ 0.49.

2. Municipal Solid Waste Collection / Landfilling ....$13.65.
3. Municipal Solid Waste Collection / Composting ....$16.60.
4. Municipal Solid Waste Collection / Waste To Energy (Incineration) ....$20.30.
5. The Food Waste Disposer / On-Site Septic System is the highest cost at $67.20 but since all costs are borne directly by the homeowner, there is zero cost to the municipality.

Other benefits of the Food Waste Disposer / Publicly Owned Treatment Works are:

ENVIRONMENTAL

Environmentally, the disposer is the most convenient and most likely to be used method to achieve source separation of the putrescible waste from the solid waste stream. Typically, 75 % of non-edible food waste may be processed through a food waste disposer. Presently 37 % of U.S. household food waste goes to a POTW. Food waste is typically 70 % water, therefore utilizing a wastewater treatment plant is a more natural method of processing this material than is a method which collects this water and HAULS it to a “solid waste” facility. Removing the putrescible food waste at the kitchen sink and diverting it from the solid waste stream also reduces disease causing vectors such as flies, rodents, roaches, etc. that are attracted to food waste.

RECYCLE FOOD NUTRIENTS

Since human wastes influent to wastewater treatment systems is carbon limited (food carbon is exhaled by humans as carbon dioxide, enriching the sewage in Nitrogen and Phosphorus), the addition of food waste provides additional carbon to enhance the generation of biosolids. The greater the amount of biosolids produced at the POTW, the greater the amount of nutrients, nitrogen and phosphorous, that is assimilated into the biomass, which is removed from the system as sludge and removed from the effluent.

When biosolids from the POTW, or septage processed through a POTW is applied to the soil, this is a viable method of recycling. This process is themost beneficial for retaining the food waste nutrients in a form that can be recycled.

HELPS LANDFILLS

Landfilling is the method of disposing of solid waste that is required for every community in the U.S. Presently 41 % of U.S. food waste goes to landfills. Hauling food waste that is 70 % water to a "solid waste" facility represents over 72 % of the life cycle costs of disposing of a potentially recyclable resource. Adding this water to a well designed landfill also increases the quantity of leachate that is generated. Due to the generally acidic nature of leachate from food waste, more metals are contained in the leachate than if the food waste was not in the landfill. This leachate is then typically hauled to a POTW for treatment to prevent the leachate from contaminating soils and potentially the groundwater (hauling the water not once but twice).

Almost all of the nutrient value of the food is lost in the landfill; the only portion that is potentially recycled is that which is captured in the leachate and processed through the POTW. Eventually almost all of the carbon in the food waste at the landfill is converted to methane. In a well designed landfill about 66% of the methane is recovered and beneficially reused as fuel. However the balance of 34 % of the methane escapes to the atmosphere. The methane gas has up to 25 times the global warming impact of carbon dioxide.

Putrescible food waste added to the normal household solid waste also adds to disease causing vector problems such as flies, rodents and roaches while awaiting collection. In cities that have mandated food waste disposers, solid waste collection frequency has been reduced from twice weekly to weekly or even bi-weekly.

BENEFITS OVER COMPOSTING

Municipal compost facilities are not as prevalent as landfills. They are considered an additional system and a landfill is still required. Hauling food waste that is 70 % water to a compost facility represents over 59 % of the life cycle costs of the compost operation.

Since municipal composting requires more moisture than is available in most materials, the addition of food waste does enhance the composting process. This higher moisture content does require periodic turning of the material to keep the process aerobic. If the process goes anaerobic, then there is the potential for significant odors to be generated and the result is community opposition to composting. A number of facilities in the U.S. have been shut down for odor problems. This typically requires locating the facility away from population centers and hauling the high water content food waste longer distances.

Composting also results in the loss of most of the nutrients in the food to the extent that the resulting product is of very low value and typically is not worth the cost of hauling and spreading it onto soil. In some communities the compost is of such low value that it is used as landfill cover. Food waste can be processed through the POTW at a much lower cost to the municipality, retain the nutrients for recycling, and reduce the atmospheric emissions.

INDIVIDUAL COMPOST SYSTEMS LIMITATIONS

The typical backyard compost system, which is not analyzed in this study is typically not as well maintained as a municipal system. This results in more anaerobic conditions, more odors, more methane generated and released to the atmosphere, more potential for leachate to seep into groundwater and a low nutrient, low quality product. These systems also tend to attract disease causing vectors. Yet, many homeowners perceive composting to be the “ideal” method of recycling food waste. The attached fact sheet based on information from the study contradicts this belief.

WASTE TO ENERGY LIMITATIONS

Hauling food waste that is 70 % water to a waste-to-energy facility represents over 48 % of the life cycle costs of the operation. Energy required for evaporation of the water in the food waste results in a very small net energy gain from the incineration of food waste. Instead of the nutrients being captured for recycling, most are given off to the atmosphere as acidic or greenhouse gases. Scrubbers are required in a well designed system to reduce these emissions and are a significant factor in making this the highest cost municipal system. Refer to the attached fact sheet for a comparison of the emissions generated by the various methods.

ON-SITE SYSTEM

An 0n-Site (Septic) System (OSS), is a requirement for processing wastewater in rural areas which are located beyond the municipal collection systems. As stated earlier, the system for this study was based on a 25 % larger system when a food waste disposer is used. Since this is not a state of the art system, this results in the system with the highest life cycle cost.

However, systems with a disposer, an adequate soil type and a “standard” sized system have functioned trouble free for more than ten years in cold climates. State of the art for on-site systems is the use of bio-additives to neutralize any potential additional loading due to food waste. This allows using a “standard” sized system without any additional system cost, significantly reducing the life cycle cost of the FWD / OSS system. A state of the art system such as In-Sink-Erator’s Septic Disposer using Bio-Charge™ would reduce the size required for the system and reduce the system cost.

LIFE CYCLE ANALYSIS OF FIVE FOOD WASTE MANAGEMENT SYSTEMS

FOR 100 KILOGRAMS (220.5 POUNDS) OF FOOD WASTE

DISPOSAL OPTION

	FWD / POTW	MSW / LANDFILL	MSW / COMPOST	MSW / WTE	FWD / OSS
	(Food Waste Disposer + Publicly Owned Treatment Works)	(Municipal Solid Waste collection plus Landfilling)	(Municipal Solid Waste collection plus Composting)	(Municipal Solid Waste collection plus Waste To Energy) (Incineration)	(Food Waste Disposer + On-Site Septic System)
PARAMETER					
Land Required (Square feet)	0.003	0.202	0.814	0.020	20.432
Rank	1	3	4	2	5
Energy Required (Btu)	45,744	80,112	143,299	286,433	925,824
(Total - Exportable Food					
Waste Energy) Rank	1	2	3	4	5
Materials Required (Pounds)	287.4	338.2	89.6	116.1	4881
Rank	3	4	1	2	5
Oxygen Required (Pounds)	25	0	67	95	0
Rank	3	1	4	5	1
Life Cycle Emissions (pounds)					
Carbon dioxide	97	81	100	140	130
Rank	2	1	3	5	4
Methane	0.00028	5	0.00028	0.00037	15
Rank	1	4	1	3	5
Total Greenhouse Gases	97	101	100	140	190
(Carbon dioxide+4*Methane)Rank	1	3	2	4	5
Acid Gases (Pounds)	0.1	<0.05	0.2	2.9	1.0
Nitrogen & Sulfur Oxides	2	1	3	5	4
Water Vapor (Pounds)	24	24	160	200	0
Rank	3	3	4	5	1
Total air emissions	120	110	260	343	140
Rank	2	1	4	5	3
Total Water Required (Pounds)	2547	83	64	75	3994
Carrier Water (Pounds)	2273	0	0	0	2273
Rank	4	3	1	2	5
Water and waterborne wastes	2800	370	370	420	4800
Rank	3	1	1	2	5
Solid wastes	4.4	6	2.7	1.3	480
Rank	4	3	2	1	5
Other	(sludge) 340	(residues) 25	(compost) 39	(ash) 3.3	(septage) 310
Rank	5	2	3	1	4
Life Cycle Costs					
Disposer (Homeowner cost					
for separation & convenience)					
Low	$8.83	0	0	0	$8.83
High	$17.45				$17.45
Total System Cost					
Low	$9.32	$13.65	$16.60	$20.30	$58.58
Rank	1	2	3	4	5
High	$17.94	$13.65	$16.60	$20.30	$67.20
Rank	3	1	2	4	5
Public municipality cost					
(external to the home)	$0.49	$13.65	$16.60	$20.30	$67.20
Rank	1	2	3	4	5

The brief one page fact sheet titled " LIFE CYCLE ANALYSIS OF FIVE FOOD WASTE MANAGEMENT SYSTEMS" comparing the five systems for land, energy, materials, emissions and costs has been inserted above. This fact sheet was developed to present the key parameters for each system and also ranks the systems for each parameter.

Carol Diggelman's conclusions, recommendations, and two pages of detailed comparison charts from the original report are copied verbatim and attached for reference. Copies of the 118 page Executive Summary and the 571 page Full Report are available upon request.

1. As shown on page 11, in general, as total flows to the environment increase, so do total system costs, all per 100 kg food waste. Rank by total system cost is a reasonable predictor of overall rank for the 12 selected parameters-total land, total system materials (minus food waste and carrier water), total system energy (minus food and carrier water energy), water, total system cost, air emissions, acid gases (NO_x and SO_x), greenhouse gases, wastewater, waterborne wastes, solid waste, and food waste byproducts.
2. Total flows to the environment from wastewater systems are about 10 times those from MSW systems, primarily because of FWD carrier water.
3. The FWD/OSS, the only rural system, ranked either first or second for most parameters. Because a larger fraction of the total FWD/OSS was attributable to the 100 kg of food waste; land, materials, energy and flows to the environment attributable to the 100 kg were higher for the rural system than for the four municipal systems.
4. The FWD/OSS has the highest flows to the environment of the five systems; most is water and waterborne wastes discharged with minimal performance control to the subsurface. About half of the effluent BOD_5 is discharged directly to the absorption bed which may contribute to biomass assimilation and clogging in the absorption bed. Although food waste carbon removes some ammonia-nitrogen from wastewater as it is assimilated into biomass, a system stoichiometric excess of ammonia-nitrogren remains to be discharged into the subsurface, potentially bypassing plant root zones to pollute groundwater.
5. The MSW Collection/WTE ranks second highest overall and for total system cost. Burning food waste yields little exportable energy in these systems, so diverting food waste to FWD/POTW systems should be defined as recycling and encouraged, just as diverting other recycables with no heating value, such as metal and glass, is encouraged.

6. The FWD/POTW system ranks in the middle of the five systems overall and for total system materials and total system cost. Most of the cost is for the FWD and is borne by the homeowner; the cost to process food waste through the POTW is less than $0.50 per 100 kg of food waste. The FWD/POTW has the lowest land and total system energy requirements but the highest food waste byproduct, sludge, requiring management.
7. Wastewater collection and treatment systems and MSW collection systems and landfills are required systems for both urban and rural residences for reasons of basic public health and sanitation. When a FWD Is incorporated in a household wastewater collection system, there is redundancy in food waste management and most food waste can be managed through either system. Food waste going into a FWD/POTW system, from which either effluent and/or sludge is/are returned to agricultural soils in compliance with Federal and State regulations and in which methane is collected and combusted to produce electricity, is being effectively recycled.
8. Adding food waste carbon to a carbon limited wastewater system contributes to a net removal of nutrients (nitrogren and phosphorus) from effluent, as nutrients are assimilated with carbon into biomass and removed from the system as sludge.
9. Land requirements for each system give a first approximation of a system's appropriation of and reduction in net primary productivity (mass of biomass produced per area or per Joule of incident energy). Even though impacts to net primary productivity are beyond the scope of this project, the FWD/POTW system with the lowest land requirements has the lowest impact on net primary productivity from 100 kg of food waste. When coupled with potential increases in net primary productivity from effluent and sludge nutrients, this system is potentially the most sustainable of the five systems.
10. The MW Collection/Compost system ranks lowest overall; it has the lowest total system materials and water requirements and generates the lowest amount of wastewater and waterborne wastes. Food nutrients are returned to soil from compost systems.
11. Composting is an optional food waste management system that increases redundancy in food waste management; however, wastewater collection/treatment and MSW Collection / Landfill systems are still required.
12. The MSW Collection/Landfill system is the default system for food waste management; it ranks next to lowest overall and lowest for cost. It also ranks low for water, wastewater, total air emissions and food waste byproducts.

13. As indicated on page 12, for MSW systems the MSW Collection system contributes from half to 3/4 of the total system cost. Systematic diversion of wet, putrescible food waste from MSW to FWDs has the potential to produce drier, more storable MSW and reduce the need for weekly collection and the cost of MSW collection.
14. The MSW Collection system requires about 17 times the land, about 18% of the total materials, 88% of the total system energy, is about half the high estimate and is about the same as the low estimate of the cost of the FWD; the total flows to the environment for the MSW Collection system are about 18% those of the FWD, because there is no carrier water.
15. If household plumbing were redesigned to use non-potable water for flushing wastes (both human through toilets and food through FWDs), diverting food wastes to municipal wastewater systems becomes a more sustainable choice.

Final Recommendations:

1. Diverting food waste through FWDs to a POTW should be encouraged when solids' handling systems are adequate, methane is combusted to generate energy, and effluent and/or sludge are returned to soil; food waste is effectively being recycled and should be so designated in Federal and State regulations.
2. Benefits to MSW management systems from the systematic use of FWDs should be quantified; because by transferring putrescible FW from solid to wastewater management systems, there a reduction in regulatory requirements for MSW collection systems (weekly collection), landfill systems (daily cover requirement), compost systems (more stringent management requirements) and reduced solids' handling for WTE systems.
3. Separate regulations that give different design requirements for POTWs depending on FWD usage should be challenged, especially if no other household appliance or device is so listed.
4. To make the life-cycle inventory a cost-effective process, there needs to be an accurate, up-to-date data base of unit factors for water and waterborne wastes, air emissions, and solid waste for materials and fuels that is readily available to the public.

Comparison of Land, Materials, Energy, and Costs of Five System Used to Manage Food Waste												
Neg.-negligible; NI-no information NA-Not Applicable	FWD	OSS	FWD+ OSS	POTW	POTW+ FWD	MSW Collection	Compost	Compost+ Collection	W-T-E	WTE + Collection	Landfill	Landfill+ Collection
	Table 4.17	Table 5.19		Table 6.103		Table 7.18	Table 8.17		Table 9.27		Table 7.43	
Land, ft^2	ft^2/100kg	ft^2/100kg	ft^2/100kg	ft^2/100kg	ft^2/100kg	ft^2/100kg	ft^2/100kg	ft^2/100kg	ft^2/100kg	ft^2/100kg	ft^2/100kg	ft^2/100kg
	0.0006	20.43	20.43	0.003	0.003	0.01	0.80	0.81	0.01	0.02	0.19	0.20
Materials	lb/100kg	lb/100kg	lb/100kg	lb/100kg	lb/100kg	lb/100kg	lb/100kg	lb/100kg	lb/100kg	lb/100kg	lb/100kg	lb/100kg
Construction & Landfill Materials	0.1	3143.2	3143.3	7.9	8.0	2.7	5.9	8.6	5.0	7.7	243.7	246.4
Equipment, vehicles	0.1	Neg.	0.1	0.1	0.1	0.2	0.4	0.5	0.1	0.3	0.1	0.3
Electricity	1.4	Neg.	1.4	1.4	2.8	5.4	9.5	14.9	22.1	27.4	0.0	5.4
Natural Gas	0.5	Neg.	0.5	0.0	0.5	NI	0.0	0.0	2.4	2.4	0.6	0.6
Diesel Fuel	0.1	12.9	13	0.1	0.2	1.4	0.2	1.6	1.9	3.3	1.4	2.8
Gasoline	0.7	Neg.	0.7	0.0	0.7	NI	0.0	0.0	0.0	0.0	0.0	0.0
FWD Materials	1.5	0	1.5	0.0	1.5	NA	0.0	0.0	0.0	0.0	0.0	0.0
Water	260.4	3733.4	3993.8	2286.3	2546.7	38.5	25.5	64	36.5	75	44.3	82.8
Food Waste	0.0	220.5	220.5	220.5	220.5	0.0	220.5	220.5	220.5	220.5	220.5	220.5
Total	264.9	7109.9	7374.8	2516.2	2781.1	48.2	261.9	310.1	288.4	336.6	510.5	558.7
Total - FW & CW	264.9	4616.2	4881.1	22.5	287.4	48.2	41.4	89.6	67.9	116.1	290.0	338.2
Energy	Btu/100kg	Btu/100kg	Btu/100kg	Btu/100kg	Btu/100kg	Btu/100kg	Btu/100kg	Btu/100kg	Btu/100kg	Btu/100kg	Btu/100kg	Btu/100kg
Embodied Materials	308	526506	526814	5707	6014	18983	13351	32334	2289	21272	6628	25611
Embodied-Process equip./vehicles	1477	Neg.	1477	1021	2498	2027	6975	9002	2068	4095	1635	3662
Electricity	6177	Neg.	6177	6056	12233	23373	41061	64434	99225	122598	NI	23373
Natural Gas	13126	Neg.	13126	416	13542	NI	NI	NI	61347	61347	15299	15299
Diesel	3717	302149	305866	1659	5376	33856	3549	37405	43108	76963	31877	65733
Gasoline	16780	NI	16780	52	16832	NI	NI	NI	NI	NI	NI	NI
FWD Material	47197	0.0	47197	0.0	47197	NA	NA	NA	NA	NA	NA	NA
Water	547	7840	8387	4798	5345	81	43	124	77	158	93	174
Total	89329	836495	925824	19708	109037	78320	64979	143299	208113	286433	55531	133851
Total - Exportable FW Energy*	89329	836495	925824	-43585	45744	78320	64979	143299	208113	286433	1792	80112
Costs - $	$17.45	$49.75	$67.20	$0.49	$17.94	$9.90	$6.70	$16.60	$10.39	$20.30	$3.75	$13.65
Exportable Electricity** kWh	0	0	0	19	19	0	0	0	0	0	16	16

* Exportable energy for POTW = 63,293 Btu/100kg FW; for Landfill = 53739 Btu/100kg FW

Summary of Life Cycle Emissions from Acquisition, Use and Decommissioning of Five Enhanced Systems for the Management of Food Waste

	FWD	OSS	FWD+ OSS	POTW	POTW+ FWD	MSW Collection	Compost	Compost+ Collection	W-T-E	WTE + Collection	Landfill	Landfill+ Collection
Air Emissions	lb/100kg	lb/100kg	lb/100kg	lb/100kg	lb/100kg	lb/100kg	lb/100kg	lb/100kg	lb/100kg	lb/100kg	lb/100kg	lb/100kg
Particulates	2.8e-02	2.4e-01	2.7e-01	1.8e-03	3.0e-02	1.6e-02	1.4e-02	3.0e-02	9.4e-03	2.5e-02	-1.2e-02	3.8e-03
Nitrogren Oxides	4.5e-02	6.2e-01	6.6e-01	5.1e-02	5.0e-02	6.6e-02	3.6e-02	1.0e-01	2.8e+00	2.8e+00	7.8e-03	7.4e-02
HC (Not Methane)	4.7e-02	2.1e-01	2.5e-01	2.6e-03	4.9e-02	2.7e-02	1.5e-02	4.3e-02	1.1e-01	1.4e-01	1.8e-01	2.1e-01
Sulfur Oxides	6.4e-02	2.9e-01	3.6e-01	5.7e-03	7.0e-02	5.9e-02	6.1e-02	1.2e-01	1.9e-02	7.8e-02	-8.9e-02	-3.0e-02
Carbon Monoxide	1.3e-01	4.9e-01	6.2e-01	5.8e-03	1.4e-01	5.5e-02	3.1e-02	8.6e-02	6.5e-02	1.2e-01	3.3e-02	8.8e-02
Carbon Dioxide	1.4e+01	1.1e+02	1.3e+02	8.4e+01	9.7e+01	9.6e+00	9.4e+01	1.0e+02	1.3e+02	1.4e+02	7.1e+01	8.1e+01
Aldehydes	1.6e-04	1.1e-02	1.1e-02	5.4e-05	2.1e-03	1.2e-03	1.3e-04	1.3e-03	1.5e-03	2.7e-03	1.1e-03	2.3e-03
Other Organics	2.1e-02	2.1e-01	2.3e-01	1.1e-03	2.2e-02	2.3e-02	2.5e-03	2.6e-02	3.0e-02	5.4e-02	2.2e-02	4.5e-02
Ammonia	4.7e-06	6.9e-05	7.4e-05	3.9e-07	5.1e-06	8.0e-06	1.3e-06	9.3e-06	1.0e-05	1.8e-05	6.5e-06	1.5e-05
Lead	3.5e-06	2.0e-08	3.5e-06	1.1e-08	3.5e-06	2.3e-09	3.5e-10	2.6e-09	2.9e-09	5.1e-09	1.8e-09	4.1e-09
Methane	2.5e-04	1.5e+01	1.5e+01	2.9e-05	2.8e-04	1.5e-04	1.3e-04	2.8e-04	2.2e-04	3.7e-04	5.0e+00	5.0e+00
Kerosene	1.0e-06	2.5e-07	1.3e-06	1.3e-07	1.2e-06	1.1e-06	1.9e-06	3.1e-06	7.4e-08	1.2e-06	-4.1e-06	-2.9e-06
HCl	1.4e-07	2.1e-05	2.3e-06	1.2e-08	1.5e-07	2.5e-07	3.8e-08	2.8e-07	3.1e-07	5.6e-07	2.0e-07	4.5e-07
Water Vapor - FW	0.0e+00	0.0e+00	0.0e+00	2.4e+01	2.4e+01	0.0e+00	1.6e+02	1.6e+02	2.0e+02	2.0e+02	2.4e+01	2.4e+01
Total Air Emissions	1.4e+01	1.3e+02	1.4e+02	1.1e+02	1.2e+02	9.9e+00	2.6e+02	2.7e+02	3.4e+02	3.5e+02	1.0e+02	1.1e+02
SW / CW	1.6e+00	4.7e+02	4.8e+02	2.8e+00	4.4e+00	9.7e-01	1.7e+00	2.7e+00	3.4e-01	1.3e+00	5.0e+00	6.0e+00
* Other	0.0e+00	3.1e+02	3.1e+02	3.4e+02	3.4e+02	0.0e+00	3.9e+01	3.9e+01	3.3e+00	3.3e+00	2.5e+01	2.5e+01
Water / Waterbone Wastes												
Water	2.6e+02	3.6e+03	3.8e+03	2.1e+03	2.3e+03	3.9e+01	2.1e+01	5.9e+01	2.9e+01	6.7e+01	1.9e+02	2.3e+02
Acid	1.0e-09	6.6e-02	6.6e-02	6.6e-02	6.6e-02	1.7e-09	2.7e-10	2.0e-09	2.2e-09	4.0e-09	1.4e-09	3.2e-09
Metal Ion	2.1e-05	3.2e-04	3.4e-04	1.8e-06	2.3e-05	3.7e-05	5.8e-06	4.3e-05	4.7e-05	8.4e-05	3.0e-05	6.7e-05
Dissolved Solids	1.3e-02	1.8e-01	1.9e-01	2.5e-+00	2.5e+00	2.1e-02	3.4e-03	2.4e-02	2.7e-02	4.8e-02	1.8e-02	3.9e-02
Suspended Solids	7.1e-03	1.2e-01	1.2e-01	2.0e-01	2.1e-01	1.2e-03	1.3e-03	2.4e-03	3.8e-04	1.5e-03	2.5e-02	2.7e-02
BOD	1.1e-03	3.5e-03	4.6e-03	1.3e-04	1.2e-03	4.5e-03	3.9e-04	4.9e-03	3.2e-05	4.5e-03	1.3e-02	1.8e-02
COD	4.0e-03	8.7e-04	4.8e-03	1.3e-05	4.0e-03	1.3e-04	1.1e-04	2.4e-04	1.3e-04	2.6e-04	2.5e-02	2.5e-02
Phenol	7.0e-08	1.0e-06	1.1e-06	5.8e-09	7.6e-08	1.2e-07	1.9e-08	1.4e-07	1.5e-07	2.7e-07	9.7e-08	2.2e-07
Oil	1.4e-03	2.5e-03	3.9e-03	3.3e-05	1.5e-03	3.1e-04	1.8e-04	4.8e-04	4.6e-04	7.7e-04	4.2e-04	7.3e-04
Sulfuric Acid	2.4e-03	5.5e-04	3.0e-03	3.1e-04	2.7e-03	2.6e-03	4.6e-03	7.2e-03	1.7e-04	2.8e-03	-9.6e-03	-6.9e-03
Iron	6.1e-04	1.4e-04	7.5e-04	7.6e-05	6.8e-04	6.6e-04	1.1e-03	1.8e-03	4.3e-05	7.0e-04	1.0e-02	1.1e-02
Ammonia + NO_3	1.7e-06	2.5e-05	2.7e-05	1.4e-07	1.8e-06	2.9e-06	4.5e-07	3.3e-06	3.7e-06	6.5e-06	2.5e-03	2.5e-03
Chromium	4.1e-09	6.0e-08	6.5e-08	3.4e-10	4.4e-09	7.0e-09	1.1e-09	8.1e-09	8.9e-09	1.6e-08	5.7e-09	1.3e-08
Lead	1.8e-09	2.7e-08	2.8e-08	1.5e-10	2.0e-09	3.1e-09	4.8e-10	3.6e-09	3.9e-09	7.0e-09	2.5e-09	5.6e-09
Zinc	2.7e-08	3.9e-07	4.2e-07	2.2e-09	2.9e-08	4.5e-08	7.1e-09	5.2e-08	5.7e-08	1.0e-07	3.7e-08	8.2e-08
Total Water Wastes	3.0e-02	1.3e+01	1.3e+01	2.8e+00	2.8e+00	3.0e-02	1.1e-02	4.1e-02	2.8e-02	5.9e-02	8.5e-02	1.2e-01
Total	2.8e+02	4.5e+03	4.8e+03	2.5e+03	2.8e+03	4.9e+01	3.2e+02	3.7e+02	3.7e+02	4.2e+02	3.2e+02	3.7e+02