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BACKGROUND DOCUMENT FOR THE SURFACE IMPOUNDMENT MODELING SYSTEM (SIMS)

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NOTICE

This report was prepared by Radian Corporation, Research Triangle Park, NC. It has been reviewed for technical accuracy by the Emission Standards Division and the Technical Support Division of the Office Of Air Quality Planning And Standards, and the Air And Energy Engineering Research Laboratory of the Office Of Research And Development, U. S. Environmental Protection Agency, and approved for publication. Mention of trade names or commercial products is not intended to constitute endorsement or recommendation for use.

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PREFACE

This document presents a brief description of the operation and design of surface impoundments and background information on the development of the Surface Impoundments Modeling System (SIMS). The SIMS was funded by the U.S. Environmental Protection Agency's (EPA) Control Technology Center (CTC).

The CTC was established by EPA's Office of Research and Development (ORD) and Office of Air Quality Planning and Standards (OAQPS) to provide technical assistance to State and local air pollution control agencies. Three levels of assistance can be accessed through the CTC. First, a CTC HOTLINE has been established to provide telephone assistance on matters relating to air pollution control technology. Second, more in-depth engineering assistance can be provided when appropriate. Third, the CTC can provide technical guidance through publication of technical guidance documents, development of personal computer software, and presentation of workshops on control technology matters.

The technical guidance projects, such as this one, focus on national or regional interest that are identified through contact with State and local agencies. In this case, the CTC became interested in automating and developing default parameters for calculations of volatile organic compound (VOC) emissions from surface impoundments. The emission models were developed by the Emission Standards Division (ESD) during the evaluation of surface impoundments located in treatment, storage, and disposal facilities (TSDF). The technical document discusses these emission models, surface impoundment design and operation, default parameter development, and the emission estimation procedure. In addition, a User's Manual and Programmer's Maintenance Manual were written to accompany the PC program. The User's Manual presents a complete reference for all features and commands in the SIMS, while the maintenance manual presents the documentation of the SIMS computer code.

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LIST OF ABBREVIATIONS AND SYMBOLS

Abbreviations

A -- surface area of impoundment, m^2

a_v -- surface-to-volume ratio of impoundment, ft^{-1}

B -- biorate constant, g/s/g biomass

b_i -- biomass concentration of constituent i, g/m^3

C_o -- inlet concentration, g/m^3

C_L -- bulk liquid and effluent concentration, g/m^3

C_t -- concentration at time = t, g/m^3

D -- depth of impoundment, m

d -- impeller diameter, cm

d^* -- impeller diameter, ft

D_a -- diffusivity of constituent in air, cm^2/s

d_e -- effective diameter of impoundment, m

D_{ether} -- diffusivity of ether in water, cm^2/s

$D_{O_2,w}$ -- diffusivity of oxygen in water, cm^2/s

E -- emission rate of constituent from impoundment, g/s

F -- fetch, linear distance across impoundment, m

F/D -- fetch-to-depth ratio, dimensionless

f_{air} -- fraction of constituent emitted from impoundment, dimensionless

F_r -- Froude number, dimensionless

g_c -- gravitation constant, $lb_m ft/s^2/lb_f$

H -- Henry's law constant, atm m^3/mol K

J -- oxygen transfer rating of surface aerator, lb O_2/hr/hp

K -- overall mass transfer coefficient, m/s

K_Q -- overall mass transfer coefficient for quiescent portion of aerated impoundment, m/s

K_T -- overall mass transfer coefficient for turbulent portion of aerated impound, m/s

K_g -- gas phase mass transfer coefficient, m/s

K_l -- liquid phase mass transfer coefficient, m/s

MW_a -- molecular weight of air, g/mole

MW_l -- molecular weight of liquid, g/mole

N_a -- number of aerators

O_t -- oxygen transfer correction factor, dimensionless

P -- power number dimensionless

P_I -- power to impellar, ft lb_f/s

POWR -- total power to aerators, hp

Q -- flowrate of liquid, m^3/s

R_e -- Reynolds number, dimensionless

Sc_G -- Schmidt number on gas side, dimensionless

Sc_L -- Schmidt number on liquid side, dimensionless

T -- temperature, K

t -- time, sec

$U = U_{10}$ -- windspeed at 10 m above the liquid surface, m/s

U* -- friction velocity, m/s

V -- volume of impoundment, m^3

W -- rotational speed of impellar, rad/s

ρ_g -- density of air, g/m^3

ρ_l -- density of liquid, g/m^3

μ_g -- viscosity of air, g/cm s

μ_l -- viscosity of liquid, g/cm s

EXECUTIVE SUMMARY

The purpose of this document is to present background information on the data, equations, default development, and procedures used by the Surface Impoundment Modeling System (SIMS) Personal Computer (PC) Program. The PC Program estimates volatile organic compound (VOC) and toxic air pollutant emissions from surface impoundments (SI).

The SIMS program was written in response to the State and local need for a methodology to estimate emissions from SI located in treatment, storage, and disposal facilities (TSDF), publicly owned treatment works (POTW), and other similar processes. The emissions models contained in the program were developed by the Emission Standards Division (ESD) during the evaluation of TSDF. The program requires a minimum amount of information from the user which include the following:

1) Type of impoundment (aerated/nonaerated and biodegradation/no biodegradation);
2) Flow model (flow-through or disposal);
3) Impoundment surface area;
4) Total flowrate to impoundment; and
5) Industrial categories discharged to impoundment (a list is given).

Based on this minimum information and standard design practices for surface impoundments, the program assigns default values to all other input parameters required by the models. However, the program is designed to allow the user to replace most of the computer-assigned default values with actual values, when available.

The technical document provides a brief description of surface impoundment design and operation, summarizes the emission models used by the program, discusses default program development, and discusses the emissions estimation procedure used by the program.

Surface Impoundment Design and Operation

SI are used for the treatment storage, and disposal of liquid wastes. From available data, waste treatment is the primary application for SI in the municipal, industrial, and mining categories, while the majority of SI used for agricultural purposes are designated for storage. Only the oil and gas industry utilize the majority of SI for disposal. Current SI designs employ a combination of several application objectives such as treatment followed by temporary storage or by ultimate waste disposal.

Air emission rates are affected by the design and operation of the SI. The design and operating parameters considered most important in determining emissions are flow rate, surface area, liquid depth, retention time (for disposal SI), degree of aeration, biomass concentration (where biodegradation is a competing mechanism), and any physical design characteristics that influence the effective wind speed across the liquid surface.

Surface Impoundment Emission Models

VOC emissions from SI occur due to volatilization at the water surface. The rate of volatilization is based on the two-film resistance theory. This theory assumes the rate limiting factor for volatilization is the overall resistance to mass transfer at the interface of the liquid surface and the ambient air. The overall resistance is due to individual resistances in the liquid and gas phase films at the interface. Individual mass transfer coefficients account for these resistances in the liquid and gas phase films. The individual mass transfer coefficients are used to estimate overall mass transfer coefficients for each pollutant. These overall coefficients are applied in mass balance equations to estimate air emissions from SI. The forms of the mass balance equations depend on type of flow (i.e., flow through or disposal), impoundment type (i.e., aerated or nonaerated), and whether or not pollutants are biodegraded in the impoundment. For the emission models contained in SIMS, all SI are assumed to be well mixed (i.e., the pollutant concentration is the same throughout the SI).

The basic approach used by the models to estimate emissions is as follows:

1) Estimate individual liquid and gas mass transfer coefficients for each pollutant, K_l and K_g;

2) Estimate equilibrium constants, K_{eq}, for each pollutant from the following expression:

$$K_{eq} = H/RT$$

where: H = Henry's law constant, atm·m³/mol°K

R = Ideal gas law constant, atm·m³/mol

T = wastewater temperature, °K;

3) Estimate overall mass transfer coefficient, K, for each pollutant from the following expression:

$$1/K = 1/k_l + 1/(k_g K_{eq})$$

4) Apply a mass balance around the SI to estimate emissions.

The emission rate, E, in g/s, is given in Table E-1 for all mass balance equation types included in SIMS.

Default Parameter Development

Default values were developed using the evaluation of TSDF for many of the required inputs for the emissions models. However, default values were not developed for (1) the concentration profile in the wastewater feed to the SI, (2) the depth of the impoundment, and (3) certain physical property data.

Because concentration data may not be available to State and local agencies, methods were developed to assign default concentration values based on the minimum information expected to be available. Raw concentration profiles were developed for different industrial categories. These profiles are used to define the composition of the impoundment feed based on the industrial categories discharging to the SI. A listing of the 29 categories is presented in Table E-2. In cases where the impoundment is fed by process units in more than one type of industrial category, a flow weighting scheme

TABLE E-1. EMISSION RATE EQUATIONS

Conditions	Emission Rate, g/s
Flowthrough, no biodegration aerated or nonaerated	$(KAQ\ C_o)/(Q + KA)$
Flowthrough, biodegradation aerated or nonaerated	$KA[-(K_s(KA/Q + 1) + (V/Q)K_{max}b_i - C_o) + ((K_s(KA/Q + 1) + (V/Q)K_{max}b_i - C_o)^2 + 4(KA/Q + 1)(K_sC_o))^{0.5}]/(2(KA/Q + 1))$
Disposal, no biodegradation aerated or nonaerated	$(1 - \exp(-KAt/V))VC_o/t$
Disposal, biodegradation	$(1 - \exp((K_{max}/K_s)b_it - KAt/V))\ KA/(KA + (K_{max}/K_s)b_iV)$

where:

- A = surface area, m^2
- Q = flow rate, m^3/s
- C_o = pollutant inlet concentration, g/m^3
- V = volume, m^3
- t = residence time in SI, sec

TABLE E-2. INDUSTRIAL CATEGORIES

Industrial Category[a]	Industrial Category Code
Adhesives and Sealants	1
Battery Manufacturing	2
Coal, Oil, Petroleum Products, and Refining	3
Dye Manufacturing and Formulation	4
Electrical and Electronic Components	5
Electroplating and Metal Finishing	6
Equipment Manufacturing and Assembly	7
Explosives Manufacturing	8
Gum and Wood Chemicals, and Related Oils	9
Industrial and Commercial Laundries	10
Ink Manufacturing and Formulation	11
Inorganic Chemicals Manufacturing	12
Iron and Steel Manufacturing and Forming	13
Leather Tanning and Finishing	14
Nonferrous Metals Forming	15
Nonferrous Metals Manufacturing	16
Organic Chemicals Manufacturing	17
Paint Manufacture and Formulation	18
Pesticides Manufacturing	19
Pharmaceuticals Manufacturing	20
Photographic Chemicals and Film Manufacturing	21
Plastics Molding and Forming	22
Plastics, Resins, and Synthetic Fibers Manufacturing	23
Porcelain Enameling	24
Printing and Publishing	25
Pulp and Paper Mills	26
Rubber Manufacturing and Processing	27
Textile Mills	28
Timber Products Processing	29

[a]Pesticides Formulation has been omitted from the original list of 30 industry categories because of the lack of data available for this industrial category.

is required. In addition, if the impoundment is located at a POTW, it is also necessary to know what percentage of the feed is from industrial (rather than municipal) sources.

A default depth of the impoundment was developed by plotting flow rate versus depth from data contained in recent literature. The correlation gives a linear relationship between flow rate and depth. Separate correlations were developed for flowthrough and disposal impoundments because of the great differences in data ranges. Given a specific flow rate, a default depth can be determined by the following equations.

Flowthrough

$$Q = 4673.3\ D - 3809.5 \qquad Q \geq 1446\ m^3/day$$

$$Q = 863.8\ D \qquad 0 < Q < 1446\ m^3/day$$

Disposal

$$Q = 354.6\ D - 700 \qquad Q \geq 253\ m^3/day$$

$$Q = 101.2\ D \qquad 0 < Q < 253\ m^3/day$$

Physical property data such as diffusivities and Henry's law constants were developed for the compounds contained in the concentration profile and are included in Attachment 3.

Emission Estimation Procedure

There are eight emission estimation procedures for the SIMS:

1) flowthrough, aerated, biological system;
2) flowthrough, nonaerated, biological system;
3) flowthrough, aerated, nonbiological system;
4) flowthrough, nonaerated, nonbiological system;
5) disposal, aerated, biological system;
6) disposal, nonaerated, biological system;

7) disposal, aerated, nonbiological system;

8) disposal, nonaerated, nonbiological system;

Assuming the user has the minimum information discussed earlier, Figure E-1 presents a decision tree for estimating VOC emissions. It is important to realize that the accuracy of the emissions estimate decreases with the use of the defaults, especially concentration of VOC. If a specific parameter is known or can be estimated with some accuracy, it is recommended that the estimated value be used in the SIMS program. Two detailed example calculations are presented in Chapter 5 of this document.

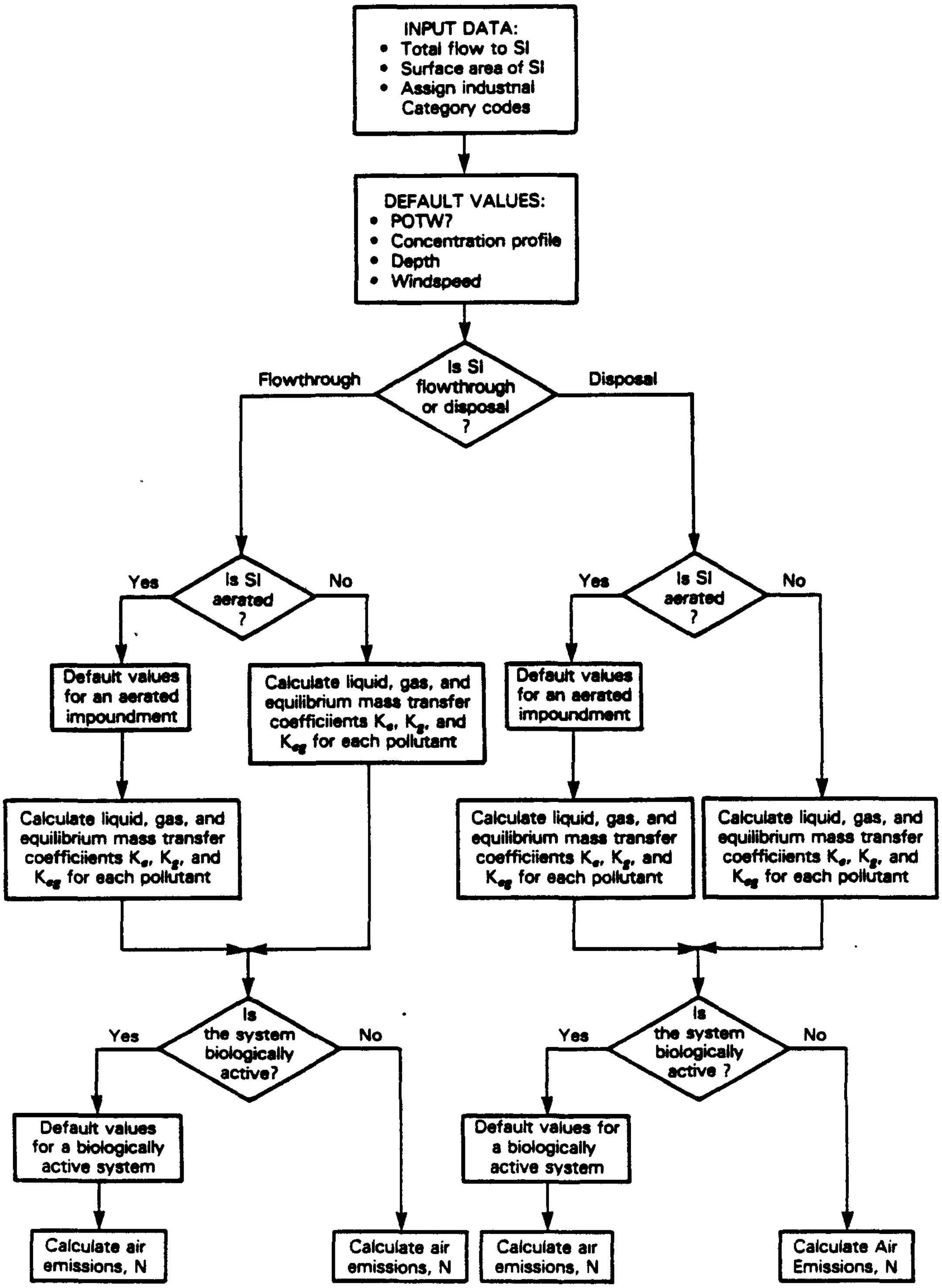


Figure E-1. Decision Tree to Estimate VOC Emissions

1.0 INTRODUCTION

The assessment of volatile organic compound (VOC) and toxic air pollutant emissions is essential in order to develop State implementation plans (SIP) for the control of atmospheric ozone. Additionally, this information is basic to the review of Prevention of Significant Deterioration (PSD) applications and other Federal, State, and local agency programs involving assessment of air pollution.

The U.S. Environmental Protection Agency (EPA) has recently recognized the State and local need for a methodology to estimate emissions from surface impoundments located in treatment, storage, and disposal facilities (TSDF), publicly owned treatment works (POTW), and other similar operations. A set of emission models for surface impoundments was developed by the Emission Standards Division (ESD) during the evaluation of TSDF. These models can be used to estimate VOC emissions from surface impoundments based on input parameters such as impoundment type (aerated or nonaerated), impoundment dimensions, influent flow rate, and inlet pollutant concentrations. However, in some cases, State and local agency personnel may not have information on all the input parameters required by these models.

For this reason, the air emission models were incorporated into a user friendly, personal computer-based program. The program requires certain minimum information from the user. Based on this information, and standard design practices for surface impoundments, the program assigns default values to all other input parameters required by the models. In addition, the program is designed to allow the user to replace most of the computer-assigned default values with actual data, when available.

In some cases, there could be volatile inorganic compound emissions from surface impoundments. However, because the ESD emission models were developed for VOC emissions, they do not necessarily apply to volatile inorganic compound (VIC) emissions. For this reason VIC emissions are not addressed in this document.

The purpose of this document is to present background information on the data, equations, and procedures used by the program to estimate emissions. A brief description of surface impoundment design and operation is provided in Chapter 2. The air emissions models used by the program are summarized in Chapter 3. The development of the default parameters required by the emission models are discussed in Chapter 4. Chapter 5 presents the overall procedure employed by the program to assign default values and estimate emissions.

The focus of this project was the estimation of emissions from surface impoundments. Although emissions from the collection system which transports the wastewater from its generation point to the impoundment may be significant, they were not included in this study. Emissions from wastewater collection systems are being addressed in other EPA studies.

Surface Impoundment Modeling System (SIMS) data is primarily intended for regional studies. However, the program can be used as a screening tool for evaluating permits, keeping in mind that the models in SIMS do not represent EPA policy. These models are, however, based on the best information available to the EPA at this time.

2.0 SURFACE IMPOUNDMENT DESIGN AND OPERATION

Surface impoundments are used in a variety of applications by facilities in many different industrial categories. The design and operation of these impoundments are affected by the type of application in which they are used. A surface impoundment can be a basin, lagoon, treatment tank or any confinement where wastewater is held for a period of time. However, the Surface Impoundment Modeling System (SIMS) is limited to completely mixed surface impoundments. Therefore, the SIMS is not applicable to plug flow (no axial mixing) systems. (An example of a plug flow system is a narrow, fast moving canal). A brief discussion of the various applications and impoundment design and operating practices are provided in this chapter. Also discussed is how these design and operating practices are incorporated into the emission models developed by ESD and the computer program developed during this project.

2.1 APPLICATIONS

Surface impoundments are used for the treatment, storage, and disposal of liquid wastes. Table 2-1 shows the results of a national study surveying surface impoundment applications.[1] In this document, an impoundment with a retention time more than 30 days is considered a disposal impoundment. If the retention time is less than 30 days then it is considered a storage or treatment impoundment.

Table 2-1 shows that waste treatment is the primary application for the surface impoundments in the municipal, industrial, and mining categories. The majority of surface impoundments used for the agricultural purposes are designated for storage; only the oil and gas industry utilize the majority of their surface impoundments for disposal. Current surface impoundment design practices utilize a flexible applications approach, normally employing a combination of several application objectives (e.g., treatment followed by temporary storage or treatment followed by ultimate waste disposal).

As previously mentioned, impoundment applications vary depending on the type of industrial facility using the impoundment. Typical applications identified for different industries are detailed below:

TABLE 2-1. RESULTS OF A SURVEY ON SURFACE IMPOUNDMENT APPLICATIONS

	Storage	Disposal	Treatment
	(Percentage Use in Each Application, %)		
Agricultural	55	26	19
Municipal	5	31	64
Industrial	17	31	52
Mining	18	26	56
Oil & Gas	29	67	4

1. Mining and Milling Operations - production of various waste waters such as acid mine water, solvent wastes from solution mining, and wastes from dump leaching. Surface impoundments may be used for separation settling, washing, sorting of mineral products from tailings, and recovery of valuable minerals by precipitation.

2. Oil and Gas Industry - one of the largest users of surface impoundments. Surface impoundments may contain salt water associated with oil extraction and deep-well repressurizing operations, oil-water, and gas-fluids to be separated or stored during emergency conditions, and drill cuttings and drilling muds.

3. Textile and Leather Industry - Surface impoundments are primarily used for wastewater treatment and sludge disposal. Organic species impounded include dye carriers such as halogenated hydrocarbons and phenols; heavy metals impounded include chromium, zinc, and copper. Tanning and finishing wastes may contain sulfides and nitrogenous compounds.

4. Chemical and Allied Products Industry - Surface impoundments are used for wastewater treatment, sludge disposal, and residuals treatment and storage. Waste constituents are process-specific and include phosphates, fluoride, nitrogen, and assorted trace metals.

5. Other Industries - Surface impoundments are found at petroleum refining, primary metals production, wood treating, and metal finishing facilities. Surface impoundments are also used for the containment and/or treatment of air pollution scrubber sludge and dredging spoils sludge.

2.2 DESIGN AND OPERATION

Air emission rates are affected by the design and operation of surface impoundments. The design and operating parameters considered most important in determining emissions are: influent flow rate; surface area; liquid depth; degree of aeration; retention time (or turnovers per year in the case of disposal impoundments); physical design characteristics that influence the effective wind speed across the surface of the impoundment; and for impoundments where biodegradation is a factor, the biomass concentration.

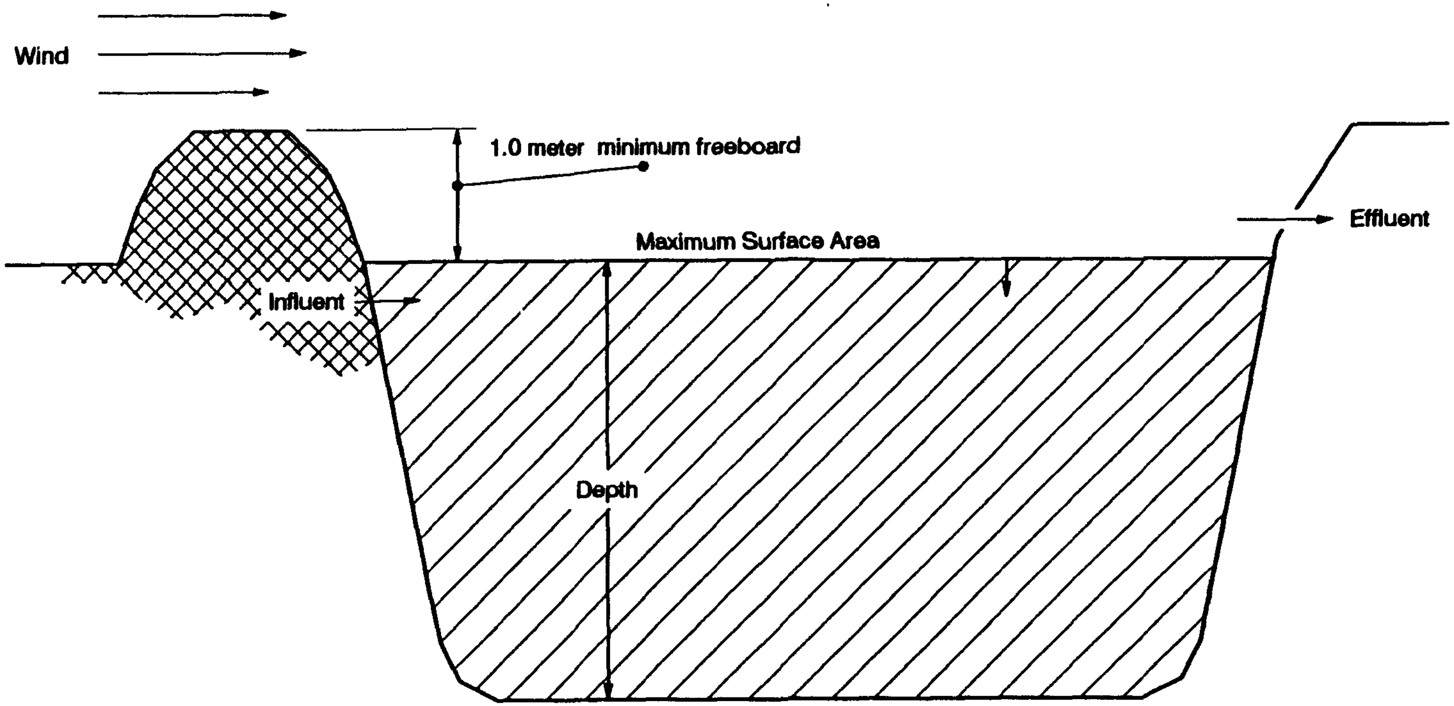
2.2.1 Physical Design[2]

The most common and economical shape for a surface impoundment is rectangular with straight sides. The rectangular shape is normally preferred because it presents fewer problems during construction and lining. Circular shapes increase the costs of grading, liner installation, and construction.

The three major positions of surface impoundments with respect to the natural grade are (1) below grade, (2) above-grade, and (3) a combination (below and above grades). A below-grade surface impoundment is excavated such that most of the capacity is below the natural grade of the surrounding land. An above-grade impoundment is built so that most of the capacity is at an elevation higher than the immediate surroundings. Combination types have characteristics of both the above and below-grade installations. The design chosen is determined by the economics of storage, containment, excavation difficulty, and material use. In general, most surface impoundments are constructed as the combination type because this design minimizes earthwork costs.

A knowledge of all the parameters which govern the depth of liquid in the impoundment are used to properly size the unit. These parameters include changes in liquid level due to storm surges as well as factors which influence the behavior of liquid while in the impoundment, such as wind speed and dike slope. Determination of these parameters will, in part, dictate the final design of the impoundment by establishing the maximum operating liquid level and minimum freeboard requirements.

Freeboard is typically defined as the distance between the actual liquid height in the impoundment and the top of the impoundment (height at which stored liquid would overflow). Freeboard has an affect on the air emission rate from an impoundment. As the freeboard height decreases, the liquid surface is more exposed to the ambient wind above the impoundment. For this reason, air emissions will increase as the freeboard height decreases. Determination of the design freeboard height requires that several specific parameters, including fetch, maximum liquid depth, and embankment slope, be accurately measured. Figure 2-1 presents the relationship of freeboard to wind, surface area, depth, and fetch (or effective diameter) in a surface impoundment. Fetch is defined as the maximum unobstructed distance across a free liquid surface over which wind can act. Typically, the longest fetch will be the diagonal measurement across the surface of the impoundment. The fetch to depth ratio for the impoundment is an important parameter in determining emissions.



$$F_{etch} = 2\sqrt{\frac{(\text{Surface Area})}{\pi}}$$

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Figure 2-1. Relationship of Freeboard to Wind, Surface Area, Depth, and F_{etch} in a Surface Impoundment

It should be noted that the models described in Chapter 3 do not incorporate a variable for freeboard. If freeboard at a particular facility is significant, then the effective windspeed will be less than the measured windspeed. Currently no data are available to provide guidance on adjusting windspeed to account for freeboard.

In addition to freeboard, the effective wind speed across the liquid surface of the impoundment is affected by other parameters. These include: the design of the dikes around the impoundment and whether the impoundment is constructed above or below grade. Design characteristics of the impoundment that significantly decreases the effective wind speed above the liquid surface will decrease air emissions.

The surface area and volume of the impoundment also have a significant effect on air emissions. A 1981 survey compiled by Westat[3] showed that the median surface area for storage impoundments was 1,500 m^2 and the median depth was 1.8 m. These median values for area and depth yield a total liquid volume of 2,700 m^3.

2.2.2 Flow and Level Control[4]

The flow of liquid into and out of an impoundment, and the need to control it, will be defined by the treatment process involved or the storage requirements of the surface impoundment. The major components which ultimately govern the flow into and out of an impoundment are the inflow and outflow structures. In some situations, such as flowthrough systems, inflow and outflow structures may have the same design. However, in most cases they will differ. Normally the inflow structure is a pipe equipped with a flow valve. Typical outflow structures are weirs, spillways, and drain pipes.

Some impoundments are equipped with active level control systems. Level sensing elements, such as floats, probes, and ultrasonic beams, detect changes in the liquid level. This level change causes a level control element such as a pump or control valve to take action and influence the amount of liquid flowing into or out of the impoundment.

As discussed in the previous section, values for the median surface area and depth of impoundments were compiled during a survey by Westat. Information on retention times for impoundments were also gathered during the study. Based on the survey, retention times ranged from 1 to 550 days, with over half of the values at 46 days or less.[5] The flow range represented by this range in retention times can be determined from the median value for impoundment volume reported in the previous section (2,700 m^3). A flow range of 5 to 2,700 m^3 per day (m^3/day) is obtained by dividing the median volume by the range in retention times. These ranges in flow and retention time have a significant impact on air emissions.

2.2.3 Biodegradation

Surface impoundments may be designed for biological activity. The major mechanisms of organic removal in biologically active impoundments include biodegradation, volatilization, removal with the effluent, and removal by adsorption on the waste sludge. A study of purgeable volatile organics in a pilot-scale wastewater treatment system showed that less than 0.4 percent (generally lees than 0.1 percent) of the volatiles were found in the waste-activated sludge.[6] Another study of municipal wastewater treatment concluded that only a modest amount of purgeable toxics were transferred to the sludge.[7] A third study found that the concentrations of volatiles organics in sludges from pilot-scale systems were generally comparable to or less than the corresponding concentrations in the process effluent.[8] This indicated that volatile organics do not have a high affinity for wastewater solids and do not concentrate in the sludges.

Biologically active impoundments are used to treat entire plant wastes as well as to polish the effluent from other treatment processes. Solids usually settle out in the impoundment or are removed in a separate vessel. Generally, the solids are not recycled; however, if the solids are returned, the process is the same as a modified activated sludge process.[9] For information purposes, typical design parameters for an activated sludge process are given in Table 2-2.[10] Typical parameters associated with biologically active impoundments are given in Table 2-3.[11,12] The loading parameter is expressed in terms of kg BOD per area or volume, and typical retention times in aerated impoundments range from 7 to 20 days. The level of suspended solids in these impoundments is over an order of magnitude less than the level in conventional activated sludge processes. Although the parameters in Table 2-3 are listed as "typical," large variations exist among facilities, and at a single facility the values may change with time. For example, a study conducted

TABLE 2-2. DESIGN PARAMETERS FOR ACTIVATED SLUDGE PROCESSES[5]

Process	F/M,[a] kg BOD/kg biomass day	Loading kg BOD/m^3 day	MLSS,[b] g/L	Retention time, h
Conventional[c]	0.2 - 0.4	0.3 - 0.6	1.5 - 3.0	4 - 8
CSTR[d]	0.2 - 0.6	0.8 - 2.0	3.0 - 6.0	3 - 5
Contact stabilization	0.2 - 0.6	1.0 - 1.2	1.0 - 3.0[e] 4.0 - 10[f]	0.5 - 1[e] 3 - 6[f]
Extended aeration	0.05 - 0.15	0.1 - 0.4	3.0 - 6.0	18 - 36
O_2 systems	0.25 - 1.0	1.6 - 3.3	6.0 - 8.0	1 - 3

[a]F/M = Food to microorganism ratio.
[b]MLSS = Mixed liquor suspended solids.
[c]Plug flow design.
[d]CSTR = Continuous stirred-tank reactor.
[e]Contact unit.
[f]Solids stabilization unit.

TABLE 2-3. IMPOUNDMENTS DESIGNED FOR BIODEGRADATION[6,7]

Type	Application	Typical daily loading kg BOD_5/m^3 day	Retention Time, day	Typical depth, m	Suspended solids, g/L
Facultative	Raw municipal wastewater	0.0011 - 0.0034[a]	25 - 180	1.2 - 2.5	0.11 - 0.40
	Effluent from primary treatment, trickling filters, aerated ponds, or anaerobic ponds				
Aerated	Industrial wastes	0.008 - 0.32	7 - 20	2 - 6	0.26 - 0.30
	Overloaded facultative ponds				
	Situations where limited land area is available				
Aerobic	Generally used to treat effluent from other processes, produces effluent low in soluble BOD_5 and high in algae solids	0.021 - 0.043[b]	10 - 40	0.3 - 0.45	0.14 - 0.34
Anaerobic	Industrial wastes	0.16 - 0.80	20 - 50	2.5 - 5	0.08 - 0.16

over 12 months at an aerobic impoundment used to treat municipal wastewater reported suspended solids levels of 0.02 to 0.1 g/L and volatile suspended solids of 0.01 to 0.06 g/L.[13] Anther study of eight quiescent impoundments at four different sites with confirmed biological activity estimated active biomass concentrations from the rate of oxygen consumption that ranged from 0.014 to 0.22 g/L with an average of 0.057 g/L.[14]

The biomass concentration is an important parameter in estimating biodegradation rates. The best value to use for a specific site is a direct measurement such as volatile suspended solids for the system of interest. In the absence of site-specific data, a number may be chosen from the ranges for suspended solids given in Tables 2-2 and 2-3. Alternatively, typical or default values for biomass concentration given in Table 2-4 may be used.

Numerous models have been proposed for the removal of organic compounds by biodegradation.[15] However, there is a general agreement that the biodegradation rate is zero-order with respect to concentration for high organic loadings relative to biomass, and becomes first-order with respect to concentration for low residual organic levels.

First-order or monod-type kinetics assumes that biodegradation of any one constituent is independent of the concentrations of other constituents. The significant features of this model are that at high concentrations, the biodegradation rate is independent of (or zero-order with respect to) the component concentration; and at low concentrations the rate becomes directly proportional (or first-order to) the component concentration.

2.2.4 Mechanical Aeration

Mechanical aerators are often used for the purpose of supplying oxygen required by the microorganisms to biodegrade pollutants in the impoundment. However, not all impoundments equipped with aeration devices contain biomass, which is necessary for biodegradation to occur. Some impoundments are aerated for purposes such as evaporative cooling.

The emission models used by the computer program require values for the parameters that describe the mechanical aeration system. Typical parameters for impeller speed and diameter are 126 rad/s (1,200 rpm) and 61 cm (2 ft), respectively. For impeller power, Metcalf and Eddy, Inc., suggest a range of

TABLE 2-4. TYPICAL OR DEFAULT VALUES FOR BIOMASS CONCENTRATION[a]

Units	Biomass concentration (g/L)
Quiescent impoundments	0.05[b]
Aerated impoundments	0.30[c]
Activated sludge units	4.0[d]

[a]These values are recommended for use in the emission equations when site-specific data are not available.
[b]Based on the range (0.0014 to 0.22) and average (0.057) from actual impoundments.
[c]From the data in Table 2-3 for aerated impoundments. Assumes biomass is approximated by the suspended solids level.
[d]Midrange value from Table 2-2 for CSTR based on mixed liquor suspended solids.

15 to 30 kw/1000 m^3 (0.6 to 1.15 hp/1,000 ft^3) for mixing in impoundments.[16] However, more power may be needed to supply additional oxygen or to mix certain treatment solutions such as in activated sludge units. A review of information gathered during the evaluation of TSDF showed power usage as high as 92.2 kw/1000 m^3 (3.5 hp/1,000 ft^3) at a specific TSDF impoundment.[17] Data included in the TSDF report show an average value of 52.67 kw/1000 m^3 (2.0 hp/1000 ft^3) for activated sludge units.[15]

Data from Metcalf and Eddy indicated that an aerator with a 75-hp motor and a 61-cm diameter propeller turning at 126 rad/s would agitate a volume of 658 m^3 (23,240 ft^3).[18] Assuming a uniform depth in the impoundment of 1.8 m, the agitated surface area was estimated as 366 m^2 (658/1.8). The agitated surface is assumed to be turbulent and comprises a 24 percent (366/1,500 x 100) of the total area. The balance of the surface area of the impoundment (76 percent) is assumed to be quiescent. As a comparison, Thibodeaux reported a turbulent area of 5.22 m^2/hp and investigated a range of 0.11 to 20.2 m^2/hp. The value of 5.22 m^2/hp and a total of 75 hp yields an estimated turbulent area of 392 m^2 (26 percent), which compares favorably with the 24 percent turbulent area calculated by the alternative approach.[19] For activated sludge units, data presented in the TSDF report show an average agitated surface area of 52 percent.[15]

2.3 REFERENCES

1. EPA. 1983. Surface Impoundment National Assessment Report. EPA 570/9-84-002. U. S. Environmental Protection Agency. Cincinnati, OH.

2. K. W. Brown and Associated, Inc. Hazardous Waste Surface Impoundments. Prepared for the U. S. Environmental Protection Agency. Contract No. 68-03-1816.

3. Westat Corporation. National Survey of Hazardous Waste Generators and TSDF's Regulated Under RCRA in 1981. Prepared for the U. S. Environmental Protection Agency. Contract No. 68-01-6861. April 1984.

4. Reference 2. pp. 3-80 through 3-93.

5. Reference 3.

6. Petrasek, A., B. Austern, and T. Neiheisel. Removal and Partitioning of Volatile Organic Priority Pollutants in Wastewater Treatment. Presented at the Ninth U. S. - Japan Conference on Sewage Treatment Technology. Tokyo, Japan. September 1983. p. 16.

7. Bishop, D. The Role of Municipal Wastewater Treatment in Control of Toxics. Presented at the NATO/CCMS Meeting. Bari, Italy. September 1982. p. 18.

8. Hannah, S., B. Austern, A. Eralp, and R. Wise. Comparative Removal of Toxic Pollutants by Six Wastewater Treatment Processes. Journal WPCF. 58(1):30. 1986.

9. Metcalf and Eddy, Inc. Wastewater Engineering. New York, McGraw-Hill. 1972. p. 542-554.

10. Eckenfelder, W., M. Goronszy, and T. Quirk. The Activated Sludge Process: State of the Art. CRC Critical Review in Environmental Control. 15(2):148. 1984.

11. U. S. Environmental Protection Agency. EPA Design Manual: Municipal Wastewater Stabilization Ponds. Publication No. EPA-625/1-83-015. October 1983. p. 3.

12. Reference 19, p. 557.

13. Englande, A. J. Performance Evaluation of the Aerated Lagoon System at North Gulfport, Mississippi. Prepared for U. S. Environmental Protection Agency. Publication No. EPA-600/2-80-006. March 1980. p. 39-41.

14. Allen, C. Project Summary: Site Visits of Aerated and Nonaerated Surface Impoundments. Prepared for U. S. Environmental Protection Agency. Contract No. 68-03-3253. Assignment 2-8. June 1987. p. 2.

15. Hazardous Waste TSDF - Background Information for Proposed RCRA Air Emission Standards, Volume 2, U. S. Environmental Protection Agency, Office of Air Quality Planning and Standards, March 1988, p. C-26 - 27.

16. Reference 9, p. 502.

17. GCA Corporation. Hazardous Waste TSDF Waste Process Sampling. Prepared for U. S. Environmental Protection Agency. Report No. EMB/85-HNS-3. October 1985. p. 1-11.

18. Reference 9.

19. Thibodeaux, L. and D. Parker. Desorption Limits of Selected Gases and Liquids from Aerated Basins. AIChE Symposium Series. 72(156):424-434. 1976.

3.0 SURFACE IMPOUNDMENT EMISSION MODELS

Mass transfer models were developed to estimate pollutant emissions from surface impoundments during EPA's evaluation of hazardous waste TSDF.[1] The basic estimation approach, the form of the emission equations, and the input parameters required by the models are discussed in this chapter.

3.1 BASIC EMISSION ESTIMATION APPROACH

Emissions from surface impoundments result from the volatilization of organic compounds at the water surface. In order to determine the rate of volatilization, models based on two-film resistance theory were developed. This theory assumes the rate limiting factor for volatilization is the overall resistance to mass transfer at the liquid surface and the ambient air interface. The overall resistance is due to the individual resistances in both the liquid and gas phase films at the interface.

Individual mass transfer coefficients account for the resistances in the liquid and gas phase films. These individual coefficients can be used to estimate overall mass transfer coefficients for each pollutant. Air emissions from the impoundment are estimated by applying these overall coefficients in mass balance equations. The forms of the mass balance equations depend on a number of factors which are discussed in more detail in the next section (Section 3.2). The basic approach used by the models to estimate emissions can be summarized as follows:

(1) estimate individual liquid and gas phase mass transfer coefficients for each pollutant, k_l and k_g;

(2) estimate equilibrium constants for each pollutant from the following expression: $K_{eq} = H/RT$

where: K_{eq} = equilibrium constant

H = Henry's Law constant

R = ideal gas law constant

T = wastewater temperature

(3) estimate overall mass transfer coefficient for each pollutant from the following expression: $1/K = 1/k_l + 1/(k_g K_{eq})$

where: K = overall mass transfer coefficient

(4) apply a mass balance around the surface impoundment to estimate emissions

3.2 EMISSION EQUATIONS

The emission models account for the following factors concerning the design and operation of the surface impoundment: (1) the flow regime through the impoundment (i.e., flow-through or disposal), (2) the impoundment type (i.e., aerated or nonaerated), and (3) whether pollutants are biodegraded in the impoundment. These factors affect the correlations used to estimate the individual mass transfer coefficients as well as the forms of the mass balance emission equations.

3.2.1 Flow-through Impoundments

Flow-through impoundments act as temporary storage for wastewater prior to subsequent treatment or discharge to a receiving body. Assuming a well-mixed system with no reactions and no separate organic phase, the mass balance for a flow-through impoundment yields the following equation:[2]

$$QC_o = QC_L + V\,K_{max} b_i C_L/(K_s + C_L) + KAC_L$$

where:

Q = flow rate, m^3/s

C_o = inlet concentration, g/m^3

C_L = bulk liquid and effluent concentration, g/m^3

K_{max} = maximum rate constant, g/s-g biomass

K_s = half saturation constant, g/m^3

b_i = biomass concentration, g/m^3

V = volume, m^3

K = overall mass transfer coefficient, m/s

A = area, m^2

In the equation, the pollutant mass loading into the impoundment is represented by the term, QC_o. The two predominant removal mechanisms accounted for in the equation are volatilization and biodegradation. The rates of removal by these two mechanisms are estimated from the terms, KA/V (for volatilization) and $VK_{max}b_iC_L/(K_s + C_L)$ (for biodegradation). Volatile organics not removed by these two mechanisms are assumed to leave with the effluent flowing from the impoundment. The rate of removal with the effluent is represented by the term, QC_L.

To determine the fraction of volatile organics emitted or biodegraded using the Monod model, the above equation is solved for the equilibrium or bulk concentration, C_L:

$$K'C_L^2 + [K_sK' + (V/Q)\ K_{max}b_i - C_o]C_L - K_sC_o = 0$$

where $K' = (KA/Q + 1)$

Using the quadratic formula,

$$C_L = [-b + (b^2 - 4ac)^{0.5}]/2a$$

where

$$a = K' = (KA/Q + 1)$$

$$b = K_s(KA/Q + 1) + (V/Q)K_{max}b_i - C_o$$

$$c = -K_sC_o$$

[NOTE: The plus sign in the quadratic equation is selected to ensure positive effluent concentrations.]

The fraction of the inlet organic emitted to the air is calculted by the following equation:

$$f_{air} = \frac{\text{Mass of pollutant i emitted to the air}}{\text{Total mass of pollutant i}} = KAC_L/QC_o$$

Therefore, for a well-mixed flow-through impoundment with biodegradation, the expression for estimating the air emission rate (E, g/s) of each pollutant is:

$$E = f_{air}QC_o = KA[-(K_s(KA/Q + 1) + (V/Q)K_{max}b_i - C_o) + [(K_s(KA/Q + 1) + (V/Q)K_{max}b_i - C_o)^2 + 4(KA/Q + 1)(K_sC_o)]^{0.5}]/[2(KA/Q + 1)]$$

For flow through impoundments which contain no biomass, the biomass concentration (b_i) equals zero and no biodegradation of pollutants occurs in the impoundment. For this case, the air emission equation reduces to the following:

$$E = f_{air}QC_o = [KA/(Q + KA)]QC_o$$

As discussed in Section 3.1, individual liquid and gas phase mass transfer coefficients are used to estimate the overall mass transfer coefficient for each pollutant in the impoundment. Values for the individual mass transfer coefficients depend on whether or not the impoundment is aerated or nonaerated. Empirical correlations, available in the literature, can be used to estimate values for these individual coefficients. The correlations used in the computer program for nonaerated impoundments are presented in Table 3-1.[3] The correlations presented in Table 3-1 relate the individual coefficients to the physical properties of the pollutants, the dimensions of the impoundment, and the ambient wind speed. The correlations used in the computer program for aerated impoundments are presented in Table 3-2.[4] These correlations relate the individual coefficients to the physical properties of the pollutants, the dimensions of the impoundment, and the characteristics of the aerators.

3.2.2 Disposal Impoundments

Disposal impoundments are defined as units that receive wastewater for ultimate disposal rather than for storage or treatment. Generally, wastewater is not continuously fed to or discharged from these types of impoundments. Therefore, the assumption of an equilibrium bulk concentration, which is applicable for flow-through impoundments, is no longer applicable for disposal impoundments; the concentration of volatile organics in a disposal impoundment decreases with time. The emission estimating procedure accounts for the decreasing liquid-phase concentration which is the driving force for air

TABLE 3-1. EQUATIONS FOR CALCULATING INDIVIDUAL MASS TRANSFER COEFFICIENTS FOR VOLATILIZATION OF ORGANIC SOLUTES FROM QUIESCENT SURFACE IMPOUNDMENTS

Liquid phase

Springer et al. (for all cases except $F/D<14$ and $U_{10}>3.25$ m/s):

$$k_L = 2.78 \times 10^{-6} \left[\frac{D_w}{D_{ether}}\right]^{2/3}$$ (0 < U_{10}<3.25) (m/s) (All F/D ratios)

$$k_L = [2.605 \times 10^{-9} (F/D) + 1.277 \times 10^{-7}]\, U_{10}^2 \left[\frac{D_w}{D_{ether}}\right]^{2/3}$$ (U_{10}>3.25)(m/s) (14<F/D<51.2)

$$k_L = 2.611 \times 10^{-7}\, U_{10}^2 \left[\frac{D_w}{D_{ether}}\right]^{2/3}$$ (U_{10}>3.25)(m/s) (14<F/D<51.2)

where

U_{10} = windspeed at 10 m above the liquid surface, m/s

D_w = diffusivity of constituent in water, cm^2/s

D_{ether} = diffusivity of ether in water, cm^2/s

F/D = Fetch-to-depth ratio (fetch is the linear distance across the impoundment).

Gas phase

MacKay and Matasugu (in Hwang):

$$k_G = 4.82 \times 10^{-3}\, U^{0.78}\, Sc_G^{-0.67} d_e^{-0.11} (m/s)$$

where

U = windspeed, m/s

Sc_G = Schmidt number on gas side = $\frac{\mu_G}{\rho_G D_a}$

μ_G = viscosity of air, g/cm·s

TABLE 3-1. EQUATIONS FOR CALCULATING INDIVIDUAL MASS TRANSFER COEFFICIENTS FOR VOLATILIZATION OF ORGANIC SOLUTES FROM QUIESCENT SURFACE IMPOUNDMENTS (Continued)

ρ_G = density of air, g/cm^3

D_a = diffusivity of constituent in air, cm^2/s

d_e = effective diameter of impoundment = $\left(\frac{4A}{\pi}\right)^{0.5}$, m

A = area of impoundment, m^2.

Liquid phase

MacKay and Yeun (for F/D <14 and U_{10}>3.25 m/s):

$k_L = 1.0 \times 10^{-6} + 34.1 \times 10^{-4}\ U^*\ Sc_L^{-0.5}$ (U^*>0.3) (m/s)

$k_L = 1.0 \times 10^{-6} + 144 \times 10^{-4}\ U^{*2.2}\ Sc_L^{-0.5}$ (U^*<0.3) (m/s)

where

U^* = friction velocity (m/s) = $0.01\ U_{10}\ (6.1 + 0.63\ U_{10})^{0.5}$

U_{10} = windspeed at 10 m above the liquid surface, m/s

Sc_L = Schmidt number on liquid side = $\frac{\mu_L}{\rho_L D_w}$

μ_L = viscosity of water, g/cm·s

ρ_L = density of water, g/cm^3

D_w = diffusivity of constituent in water, cm^2/s.

TABLE 3-2. EQUATIONS FOR CALCULATING INDIVIDUAL MASS TRANSFER COEFFICIENTS FOR VOLATILIZATION OF ORGANIC SOLUTES FROM TURBULENT SURFACE IMPOUNDMENTS

<u>Liquid phase</u>

Thibodeaux:

$k_L = [8.22 \times 10^{-9} J\ (POWR)\ (1.024)^{T-20}\ O_t\ 10^6\ MW_L/(Va_v\rho_L)]\ (D_w/D_{O_2,w})^{0.5}$ (m/s)

where

J = oxygen transfer rating of surface aerator, lb O_2/h·hp

POWR = total power to aerators, hp

T = water temperature, °C

O_t = oxygen transer correction factor

MW_L = molecular weight of liquid

V = volume affected by aeration, ft^3

a_v = surface-to-volume ratio of surface impoundment, ft^{-1}

ρ_L = density of liquid, g/cm^3

D_w = diffusivity of constituent in water, cm^2/s

$D_{O_2,w}$ = diffusivity of oxygen in water = 2.4×10^{-5}, cm^2/s.

<u>Gas phase</u>

Reinhardt:

$k_G = 1.35 \times 10^{-7}\ Re^{1.42}\ p^{0.4}\ Sc_G^{0.5}\ Fr^{-0.21}\ D_a MW_a/d$ (m/s)

where

$Re = d^2 w \rho_a/\mu_a$ = Reynold's number

d = impeller diameter, cm

w = rotational speed of impeller, rad/s

TABLE 3-2. EQUATIONS FOR CALCULATING INDIVIDUAL MASS TRANSFER COEFFICIENTS FOR VOLATILIZATION OF ORGANIC SOLUTES FROM TURBULENT SURFACE IMPOUNDMENTS (Continued)

ρ_a = density of air, g/cm^3

μ_a = viscosity of air, g/cm·s

= 4.568×10^{-7} T(°C) + 1.7209×10^{-4}

p = $P_I\ g_c/(\rho_L d^{*5} w^3)$ = power number

P_I = power to impeller, $ft \cdot lb_f/s$

= 0.85 (POWR) ($550\ ft \cdot lb_f/s \cdot hp$)/number of aerators ($N_a$), where 0.85 = efficiency of aerator motor

g_c = gravitation constant, 32.17 $lb_m \cdot ft/s^2/lb_f$

ρ_L = density of liquid, lb/ft^3

d^* = impeller diameter, ft

Sc_G = Schmidt number on gas side = $\mu_a/(\rho_a\ D_a)$

Fr = $d^* w^2/g_c$ = Froude number

D_a = diffusivity of constituent in air, cm^2/s

MW_a = molecular weight of air.

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emissions. For a disposal impoundment that is filled with a batch of wastewater, the disappearance rate of a volatile pollutant due to air emissions and biodegradation can be expressed as:[5]

$$dC_t/C_t = (-K_{max}b_i/K_s - KA/V)\ dt$$

where

C_t = concentration in the impoundment at time = t, g/m^3

t = time since disposal (residence time in the impoundment), sec

After integration from time = 0 to time = t, the above equation yields the following expression for the fraction of each pollutant emitted in the air:

$$f_{air} = \frac{\text{Mass of pollutant i emitted to the air}}{\text{Total mass of pollutant i}} =$$

$$(1-C_t/C_o)(KA)/(KA + K_{max}b_iV/K_s)$$

where

$$C_t/C_o = \exp\ (-K_{max}b_it/K_s - KAt/V)$$

Therefore, the average emission rate for each pollutant over the period of time = t is:

$$E = f_{air}VC_o/t$$

For disposal impoundments which contain no biomass, the biomass concentration (b_i) equals zero and no biodegradation of pollutants occurs in the impoundment. For this case, the fraction emitted from the impoundment reduces to:

$$f_{air} = (1-C_t/C_o)$$

where

$$C_t/C_o = \frac{\text{Concentration of pollutant i at time t}}{\text{Initial concentration of pollutant i}} =$$

$$\exp\ (-\ KAt/V)$$

And, the average emission rate for each pollutant over the period of time = t is:

$$E = f_{air}VC_o/t$$

Values for the overall mass transfer coefficient (K) in the above expressions are estimated by the same technique used to estimate overall coefficients for flow-through impoundments. The individual liquid and gas phase mass transfer coefficients are based on the same correlations presented for flow-through impoundments in Table 3-1 and Table 3-2. Therefore, values for the overall mass transfer coefficients in disposal impoundments depend only on whether the impoundment is aerated or nonaerated.

3.3 REFERENCES

1. Office of Air Quality, Planning and Standards. U.S. Environmental Protection Agency. Hazardous Waste Treatment, Storage, and Disposal Facilities (TSDF) - Air Emission Models. EPA - 450/3-87-026. December 1987.

2. Reference 1. p. 4-26, January 1989 Draft.

3. Reference 1. p. 4-6 through 4-7.

4. Reference 1. p. 4-31 through 4-32.

5. Reference 1. p. 4-45, January 1989 Draft.

4.0 DEFAULT PARAMETER DEVELOPMENT

In some cases, State and local air pollution control agencies may not have information available for some of the inputs required by the air emission models. However, State and local agencies should know at a minimum, the total flow to the impoundment, the industries which generate the influent, whether the impoundment is aerated or nonaerated, and the impoundment surface area.

Default values were developed during EPA's evaluation of TSDF for many of the required inputs. However, default values were not developed for: (1) the concentration profile in the wastewater feed to the impoundment, (2) the depth of the impoundment, and (3) certain physical property data. The purpose of this chapter is to discuss the methods and the data used to develop default values for these parameters. Default parameters developed during the evaluation of TSDF for the other inputs required by the emission models are also covered in the chapter.

It is important to realize that the accuracy of the emissions estimate decreases with the use of defaults and these values should only be used if no data are available.

4.1 CONCENTRATION PROFILES

As previously discussed, the emission models require inputs for the concentrations of each pollutant constituent in the feed to the surface impoundment. These concentration data may not be available to State and local agencies. For this reason, methods were developed to assign default concentration values based on the minimum information expected to be available in all cases. However, concentration defaults should not be used for estimating individual toxic emissions.

The first step was to develop raw concentration profiles for each industrial category. These profiles will be used to define the composition of the impoundment feed based on the industrial categories discharging to the impoundment. The development of the raw concentration profiles is discussed in Section 4.1.1.

In cases where process units in more than one type of industrial category feed the impoundment, a flow weighting scheme is required to use the raw concentration profiles developed for each industry. This flow weighting scheme is presented in Section 4.1.2. If the impoundment is located at a POTW, it is also necessary to know what percentage of the feed to the impoundment is from industrial (rather than municipal) sources. The development of this factor is discussed in Section 4.1.3.

There are several terms which are important to the following discussion. These are defined as follows.

Direct Discharge - Industrial facilities which collect wastewater, treat it on-site, and discharge the treated water to a receiving stream are called direct dischargers. Their effluent flows are termed direct discharges.

Indirect Discharge - Some industrial facilities collect wastewater and send it to a publicly owned treatment work (POTW). The POTW then treats this wastewater along with any wastewater it receives and discharges the water to a receiving stream. In this case, the industrial facility is called an indirect discharger.

Raw Concentration - Raw concentration refers to the concentration of pollutants prior to any treatment. For a direct discharge, raw concentration is the concentration prior to the facilities on-site treatment facility.

Current Concentration - Current concentration refers to the concentration of pollutants after pretreatment. For an indirect discharge, current concentration is the concentration in the effluent sent to the POTW.

4.1.1 Industrial Category Raw Concentrations

The raw concentration profiles for each of the industrial categories covered by this study were calculated directly from the Domestic Sewage Study (DSS)[1] data by dividing pollutant loadings (mass per unit time) by total indirect wastewater flows (volume per unit time). The DSS covers only indirect discharges.

It was assumed, however, that the raw concentrations for indirect discharges are approximately the same as direct discharges from these industrial categories. That is, the raw pollutant concentrations in process wastewater in each of these categories are not affected by whether wastewater treatment is conducted on-site or off-site. It is not expected that the types of processes used by facilities in the same industry are strongly affected by whether the facility indirectly or directly discharges wastewater. For this reason, the average raw concentrations for indirect and direct dischargers should be reasonably similar.

Table 4-1 is a list of the 29 industrial categories and the industrial category code assigned to each category in the DSS. These industrial categories constitute the larger generators of hazardous wastes. Each of the industrial categories in Table 4-1 encompasses multiple Standard Industrial Classification (SIC) codes grouped together for the purposes of the DSS. A list of the SIC codes grouped in each of the industrial categories presented in Table 4-1 is shown in Appendix A.

The pollutant loadings used to develop default raw concentrations were obtained from Appendix G of the DSS and are presented in Appendix B. Table 4-2 lists the 50 organic pollutants covered by the DSS. The pollutants are classified as priority pollutants (P), and/or volatile pollutants (V), and/or ignitable or reactive (I/R) pollutants. The indirect wastewater flow rates presented in the DSS for each industrial category are shown in Table 4-3. The primary data sources for the pollutant loadings and indirect wastewater flow rates presented in the DSS are OWRS, Industrial Technology Division (ITD) Development Documents, DSS Industry Profile Forms (updated data from the development documents), and the Industrial Studies Data Base (ISDB) developed by the Office of Solid Waste (OSW).

The ITD data bases were developed based on Section 308 surveys and sampling data gathered under the Clean Water Act (CWA). The ISDB was based on information gathered from Section 3007 surveys under authority of the Resource Conservation and Recovery Act (RCRA). In the DSS, data on loadings for four organic chemical industries were presented in both the ITD and the ISDB data bases. Loadings are available for more pollutants in the ISDB. Therefore, this data base was used in developing the default concentration profiles for these four industries. All other industrial categories contain data gathered only from the ITD development documents or an updated version in the DSS Industry Profile Forms.

4.1.2 Flow Weighting of Concentration Profiles

At some facilities, wastewater generated by processes in more than one industrial category may feed an impoundment. If the flows from each

TABLE 4-1. INDUSTRIAL CATEGORIES

Industrial Category[a]	Industrial Category Code
Adhesives and Sealants	1
Battery Manufacturing	2
Coal, Oil, Petroleum Products, and Refining	3
Dye Manufacturing and Formulation	4
Electrical and Electronic Components	5
Electroplating and Metal Finishing	6
Equipment Manufacturing and Assembly	7
Explosives Manufacturing	8
Gum and Wood Chemicals, and Related Oils	9
Industrial and Commercial Laundries	10
Ink Manufacturing and Formulation	11
Inorganic Chemicals Manufacturing	12
Iron and Steel Manufacturing and Forming	13
Leather Tanning and Finishing	14
Nonferrous Metals Forming	15
Nonferrous Metals Manufacturing	16
Organic Chemicals Manufacturing	17
Paint Manufacture and Formulation	18
Pesticides Manufacturing	19
Pharmaceuticals Manufacturing	20
Photographic Chemicals and Film Manufacturing	21
Plastics Molding and Forming	22
Plastics, Resins, and Synthetic Fibers Manufacturing	23
Porcelain Enameling	24
Printing and Publishing	25
Pulp and Paper Mills	26
Rubber Manufacturing and Processing	27
Textile Mills	28
Timber Products Processing	29

[a]Pesticides Formulation has been omitted from the original list of 30 industry categories because of the lack of data available for this industrial category.

TABLE 4-2. DSS SELECTED CONSENT DECREE POLLUTANTS

Acrolein - P, I/R, V	Diethyl Phthalate - P
Benzene - P, I/R, V	2,4-Dimethyl Phenol - P
Bis-(2-Chloroethyl) Ether - P, I/R, V	Dimethyl Phthalate - P
Bis-(2-Ethyl Hexyl) Phthalate - P	Di-N-Octyl Phthalate - P
Bromomethane - P, V	Ethyl Benzene - P, I/R, V
Butyl Benzyl phthalate - P	Hexachloro-1,3-Butadiene - P
Carbon Tetrachloride - P, V	Hexachloroethane - P
Chlorobenzene - P, I/R	Methylene Chloride - P, V
p-Chloro-m-Cresol - P	Naphthalene - P
Chloroethane - P, I/R, V	Nitrobenzene - P
Chloroform - P, V	PCB (Polychlorinated biphenyls) - P
Chloromethane - P, I/R, V	Pentachlorophenol - P
2-Chloronapthalene - P	Phenol - P
Di-N-Butyl Phthalate - P	1,1,2,2-Tetrachloroethane - P, V
1,2-Dichlorobenzene - P	Tetrachloroethylene - P, V
1,3-Dichlorobenzene - P	Toluene - P, I/R, V
1,4-Dichlorobenzene - P	Bromoform - P
1,1-Dichloroethane - P, I/R, V	1,2,4-Trichlorobenzene - P
1,2-Dichloroethane - P, I/R, V	1,1,1-Trichloroethane - P, V
1,1-Dichloroethylene - P, I/R, V	1,1,2-Trichloroethane - P, V

TABLE 4-2. DSS SELECTED CONSENT DECREE POLLUTANTS (Continued)

Trans-1,2-Dichloroethylene - P, I/R, V	Trichloroethylene - P, V
2,4-Dichlorophenol - P	Trichlorofluoromethane - V
1,2-Dichloropropane - P, I/R, V	2,4,6-Trichlorophenol - P
Dichlorodifluoromethane - V	Vinyl Chloride - P, I/R, V

P = CWA priority pollutant
I/R = Ignitable or reactive compound
V = Volatile compound

TABLE 4-3. TOTAL INDIRECT FLOWRATES BY INDUSTRIAL CATEGORY

Industrial Category	Total Indirect[c] Discharge Flow (MGD)
Adhesives and Sealants	2.7
Battery Manufacturing	7.9
Coal, Oil, Petroleum Products, and Refining	92.3
Dye Manufacturing and Formulation	11.3
Electrical and Electronic Components	33.5
Electroplating and Metal Finishing	575.7
Equipment Manufacturing and Assembly[a]	4,507.0
Explosives Manufacturing	1.0
Gum and Wood Chemicals, and Related Oils	3.5
Industrial and Commercial Laundries	526
Ink Manufacturing and Formulation	1.0
Inorganic Chemicals Manufacturing	18.5
Iron and Steel Manufacturing and Forming	430.7
Leather Tanning and Finishing	6.4
Nonferrous Metals Forming	36.0
Nonferrous Metals Manufacturing[b]	61.4
Organic Chemicals Manufacturing	65.9
Paint Manufacture and Formulation	0.8
Pesticides Manufacturing	4.3
Pharmaceuticals Manufacturing	48.0

TABLE 4-3. TOTAL INDIRECT FLOWRATES BY INDUSTRIAL CATEGORY

Industrial Category	Total Indirect[c] Discharge Flow (MGD)
Photographic Chemicals and Film Manufacturing	1.6
Plastics Molding and Forming	18.4
Plastics, Resins, and Synthetic Fibers Manufacturing	21.2
Porcelain Enameling	5.6
Printing and Publishing	46.4
Pulp and Paper Mills	1,029.3
Rubber Manufacturing and Processing	128.2
Textile Mills	339.2
Timber Products Processing	1.0

[a]Calculated from data found in Radian Memorandum, October 22, 1986; Subject: Estimate of Solvent Dischargers to POTW from the Electroplating and Metal Finishing and Equipment Manufacturing and Assembly Industrial Categories, p. 4 and 10.

[b]Calculated from Reference 2.

[c]Represents flow discharged from the industrial category to the POTW.

industrial category are known, then the average concentration can be calculated from the raw concentration profiles for each category and the flows for each category. If only the categories of the industrial dischargers are known then it is necessary to develop a default flow weighted concentration profile for the total flow stream.

To flow weight the raw concentration profiles developed for each industry, total flow rates (indirect plus direct) for each industry were used. Total industrial flow rates listed by SIC code are available in the 1982 Census of Manufacturers' (COM) subject series "Water Use in Manufacturing".[2] Flow rate data gathered from this source are summarized in Table 4-4 which lists the industrial categories, industrial category codes, total number of indirect plus direct industrial dischargers, and total industrial flow rates.

Total flow rates for Adhesives and Sealants, Battery Manufacturing, Explosives Manufacturing, Industrial and Commercial Laundries, Ink Manufacturing and Formulation, Leather Tanning and Finishing, and Printing and Publishing are not available in the COM. For these industries, total indirect flow rates from the DSS were divided by the total number of indirect dischargers to get an average flow rate per facility for these industrial categories. With this average flow rate per facility, a total industrial flow rate (by industrial category code) was obtained by multiplying this average flow per facility by the total number of facilities in that industry (direct plus indirect dischargers).

The following equation is used to determine the flow-weighted concentration of each pollutant in the feed:

$$C_{i,FW} = \frac{\text{sum of concentration of pollutant i multiplied by the flowrate of industrial category code j}}{\text{sum of flowrate from industrial category code j}}$$

$$= (C_{i,1}F_1 + C_{i,2}F_2 + \ldots\ldots\ldots C_{i,n}F_n)/\sum_{i=1}^{n} F_i$$

where:

$C_{i,FW}$ = flow-weighted concentration of pollutant i

$C_{i,1}$ = concentration of pollutant i in the first industrial category code

TABLE 4-4. WATER DISCHARGE STATISTICS[1]

Industrial Category	Assigned Industrial Category Code	Total No. Dischargers (Direct and Indirect)	Total Flow[a] Discharged (MGD)
Adhesives and Sealants[b]	1	307	2.8
Battery Manufacturing[b]	2	170	9.0
Coal, Oil, Petroleum Products and Refining	3	236	692.4
Dye Manufacturing and Formulation	4	75	30.9
Electrical and Electronic Components	5	208	26.5
Electroplating and Metal Finishing	6	872	68.8
Equipment Manufacturing and Assembly	7	105,772	5,763.0
Explosives Manufacturing[b]	8	28	7.0
Gum and Wood Chemicals, and Related Oils	9	10	6.5
Industrial and Commercial Laundries[b]	10	68,800	528.0
Ink Manufacturing and Formulation[b]	11	460	2.1
Inorganic Chemicals Manufacturing	12	301	743.4
Iron and Steel Manufacturing and Forming	13	259	1,867.1
Leather Tanning and Finishing[b]	14	158	7.2
Nonferrous Metals Forming	15	201	76.1
Nonferrous Metals Manufacturing	16	162	117.4
Organic Chemicals Manufacturing	17	211	343.5
Paint Manufacture and Formulation	18	41	2.1

TABLE 4-4. WATER DISCHARGE STATISTICS (Continued)

Industrial Category	Assigned Industrial Category Code	Total No. Dischargers (Direct and Indirect)	Total Flow[a] Discharged (MGD)
Pesticides Manufacturing	19	18	15.3
Pharmaceuticals Manufacturing	20	112	87.1
Photographic Chemicals and Film Manufacturing	21	25	15.7
Plastics Molding and Forming	22	219	33.6
Plastics, Resins, and Synthetic Fibers Manufacturing	23	184	331.3
Porcelain Enameling	24	91	10.8
Printing and Publishing[b]	25	38,763	46.5
Pulp and Paper Mills	26	600	1,760.2
Rubber Manufacturing and Processing	27	175	87.4
Textile Mills	28	620	103.7
Timber Products Processing	29	223	68.8

[a]Zero dischargers, or dischargers to the ground (well, spray, seepage) were not included.

[b]Calculation from Domestic Sewage Study (DSS).

$C_{i,n}$ = Concentration of pollutant i in the nth industrial category code

F_1 = relative flow rate of wastewater from the first industrial category code

F_n = relative flow rate of wastewater from the nth industrial category code

The relative flow rates (F_n) used in the equation are the total wastewater flow rates obtained for each industry from the COM. The concentration variables used in the equation ($C_{i,n}$) are obtained from the raw concentration profiles developed for each industrial category.

4.1.3 Surface Impoundments at POTW

At POTW, the total flow to the surface impoundment consists of both municipal and industrial wastewater. For this reason, the concentration of pollutants in the industrial wastewater will be diluted by the municipal flow. Therefore, it was necessary to develop a default value for the percentage of industrial flow in wastewater to POTW. This value is used by the program to adjust the raw industrial concentrations to account for the municipal flow to the impoundment.

The contribution of municipal and industrial flow rates to the total feed for approximately 1,600 POTW are listed in the 1984 NEEDS data base.[3] Based on this source, industrial flow rates were found to compose 19.5 percent of the total flow rates to POTW on a national basis. This factor will be used to normalize the raw concentration profiles in cases where the impoundment is located at a POTW. That is, if the total, but not the industrial flow to the impoundment is known, the raw concentrations developed for each industrial category will be multiplied by 0.195 to account for the dilution by non-industrial wastewater sources.

4.2 DEPTH OF IMPOUNDMENT

Depth of the impoundment is also needed as an input parameter for the emission models. A correlation was developed for the default depth from data in Metcalf and Eddy's Wastewater Engineering.[4] Several approaches were evaluated. Plots of (1) retention time versus depth, (2) depth versus the ratio of flow rate to surface area, and finally (3) flow rate versus depth were generated. Data were used for four types of treatment processes to generate the plots. Table 4-5 lists these processes and their applications. Table 4-6 lists the respective ranges for surface area, retention time, depth, and flow rate for each process. Each plot was generated by matching the minimum and maximum values in each range for each parameter and each process. That is, to generate the plot of flow rate versus depth, the minimum value of the depth parameter in each process was plotted versus the minimum value for flow rate in each process. The maximum value of the depth parameter in each process was plotted versus the maximum value for flow rate in each process.

The plot of flow rate versus depth was found to provide the best correlation, giving a linear relationship between flow rate and depth. The four processes were broken into two groups, flow-through and non-flowthrough (or disposal) impoundments, because of the great differences in data ranges. Anaerobic processes have such long retention times that they can be considered as non-flowthrough, or disposal impoundments. The other three processes are flow-through. Figure 4-1 shows the plot of flow rate, Q, versus depth, D, for flow-through and disposal impoundments. Given a specific flow rate, a default depth can be determined by the following linear equations.

Flow-through	$Q = 4673.30D - 3809.5$	$Q \geq 1446\ m^3/day$
	$Q = 863.8D$	$0 < Q < 1446\ m^3/day$
Disposal	$Q = 354.60D - 700$	$Q \geq 253\ m^3/day$
	$Q = 101.2D$	$0 < Q < 253\ m^3/day$

In order to insure that the calculated default depth produces a reasonable retention time for flow through impoundments, limits were placed on retention times. Table 4-7 presents the flow through impoundment retention times. These limits are used by the program to calculate minimum and maximum depths based on the input flow and surface area. The default depth is compared to the minimum and maximum depths. If the default depth does not fall between the minimum and maximum depth values, then the default depth is

TABLE 4-5. SURFACE IMPOUNDMENTS

Type	Common	Application
Aerobic	Maturation or tertiary pond	Used for polishing effluents from conventional secondary treatment processes such as trickling filter or activated sludge.
Aerobic - Anaerobic (oxygen source: algae)	Facultative pond	Treatment of untreated, screened or primary settled wastewater and industrial wastes.
Aerobic - Anaerobic (oxygen source: surface aerators)	Facultative pond with mechanical aeration	Treatment of untreated screened or primary settled wastewater and industrial wastes.
Anaerobic	Anaerobic lagoon (pond), anaerobic pretreatment ponds	Treatment of domestic and industrial wastes.

TABLE 4-6. TYPICAL DESIGN PARAMETERS FOR SURFACE IMPOUNDMENTS

Type	Surface Area (A) (m^2)	T (day)	Depth (m)	Flowrate (Q)[a] (m^3/day)
Aerobic	10120 - 40470	5 - 20	1 - 1.5	2024 - 3035
Aerobic/ Anaerobic (Oxygen Source: Algae)	10120 - 40470	7 - 30	1 - 2	1446 - 2698
Aerobic/ Anaerobic (Oxygen Source: Aerators)	10120 - 40470	3 - 10	2 - 6	6747 - 24282
Anaerobic	2020 - 10120	20 - 50	2.5 - 5	253 - 1012

[a]Flowrate calculated by using available ranges. $Q = V/T = AD/T$

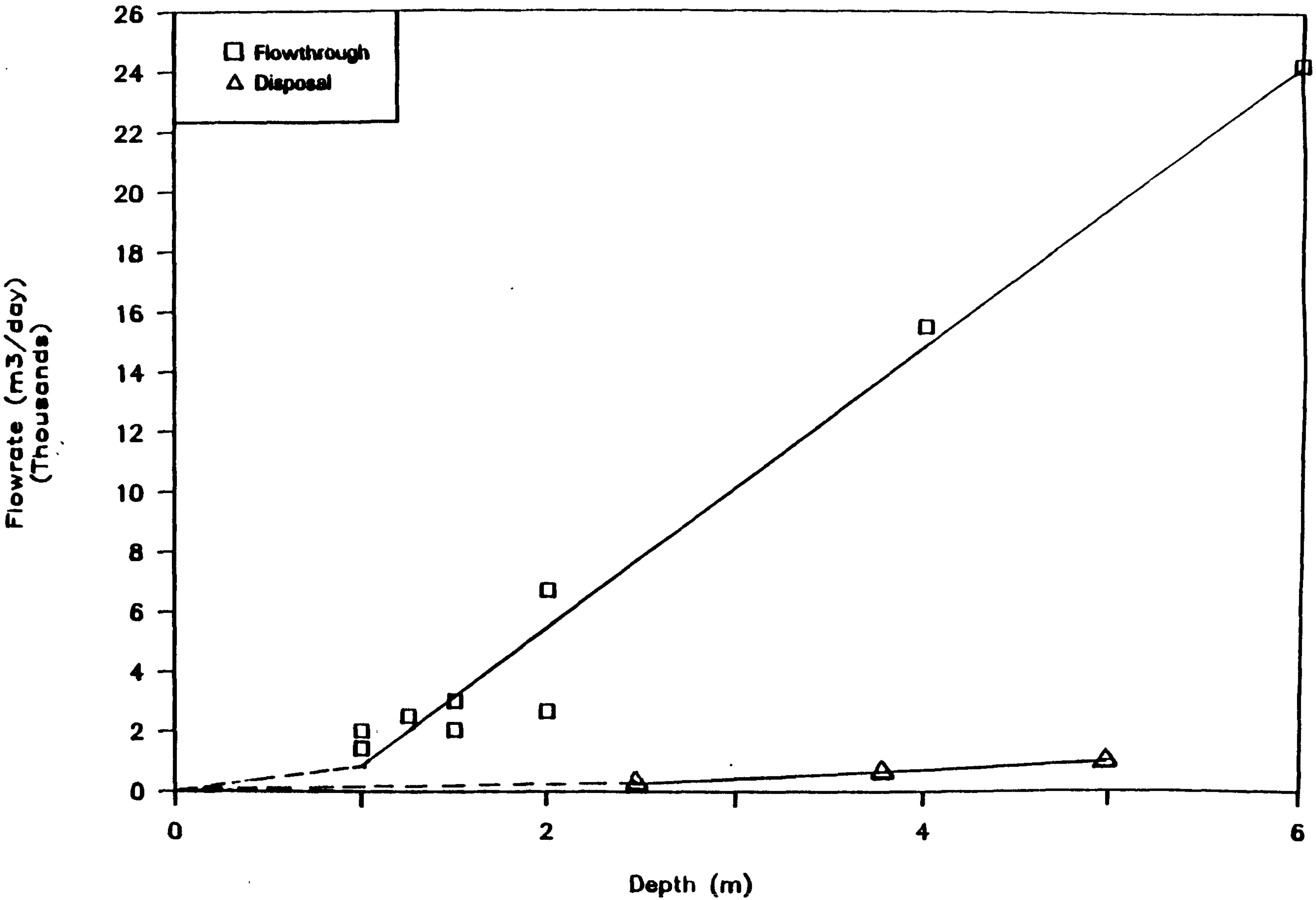

Figure 4-1. Flow rate versus depth

TABLE 4-7. LIMITS ON FLOW THROUGH IMPOUNDMENT RETENTION TIME

Impoundment Type	Retention Time Limits	
	Minimum	Maximum
Quiescent	10 days	30 days
Aerated	5 days	10 days
Activated Sludge	5 hours	10 hours

set equal to the minimum or maximum depth (whichever is closer). If the user manually inputs a depth which falls outside the minimum and maximum values ± 10 percent, the program will use the manually input depth but will flag the input for the user.

4.3 OTHER INPUT PARAMETERS REQUIRED BY THE EMISSION MODELS

Section 4.1 and 4.2 discussed the development of concentration and depth defaults required for use in the models. The purpose of this section is to provide information on the default values developed during the TSDF project for the other input parameters required by the model.

The types of other default parameters fall into two categories: 1) pollutant-specific parameters, and 2) site-specific parameters. The pollutant-specific default parameters are contained in Appendix C. These parameters include physical properties (i.e., diffusivities, vapor pressures) which are specific to a particular pollutant. The site-specific parameters and defaults for these parameters are provided in Table 4-8.

TABLE 4-8. SITE-SPECIFIC DEFAULT PARAMETERS

Default Parameter	Default Value
Temperature of water	25°C
Windspeed	4.47 m/s
Biomass concentration (for biologically active systems)	
Quiescent impoundments	0.05 g/l
Aerated impoundments	0.30 g/l
Activated sludge units	4.0 g/l
Total power to aerators	
(for aerated SI)	0.75 hp/1000 ft^3
(for activated sludge)	2 hp/1000 ft^3
Power to impeller (for aerated SI)	0.85 (total power to aerators)
Impeller speed (for aerated SI)	126 rad/s (1200 rpm)
Impeller diameter (for aerated SI)	61 cm (2 ft)
Turbulent surface area	
(for aerated SI)	0.24 (total surface area of SI)
(for activated sludge)	0.52 (total surface area of SI)
Oxygen transfer rating to surface aerator (for aerated SI)	3 lb oxygen/hp·hr
Oxygen transfer correction factor (for aerated SI)	0.83

4.4 REFERENCES

1. Science Applications International Corporation. Domestic Sewage Study (DSS) EPA 68-01-6912. U. S. Environmental Protection Agency, Analysis and Evaluation Division, Washington, D. C., October 1985.

2. 1982 Census of Manufacturers, MC82-S-6 subject series, "Water Use in Manufacturing", U. S. Department of Commerce, Bureau of the Census, March 1986.

3. 1984 NEEDS survey to Congress: Assessment of Publicly Owned Wastewater Treatment Facilities in the United States. U. S. EPA Office of Municipal Pollution Control, Municipal Facilities Divisions, Washington, D. C., February 1985.

4. Metcalf, and Eddy. Wastewater Engineering Treatment/Disposal/Reuse. McGraw-Hill Book Company, New York, NY, 1979.

5.0 EMISSION ESTIMATION PROCEDURE

This section discusses the actual emissions estimation procedure used by the computer program. The equations used were previously discussed in Section 3.0, and the development of default parameters were discussed in Section 4.0. In this section the actual step by step calculation procedure is explained, and example calculations are presented.

The default parameters for concentration assume the surface impoundment is the first portion of the treatment system. For cases where it is desired to estimate emissions from an impoundment which is not the first unit, the model can still be used if the concentration profiles are manually adjusted to account for pollutant removal in the upstream treatment system. Systems with short intervals of aeration followed by quiescent flow can be modeled by assuming a series of impoundments and adjusting the concentration profile to account for the air emissions from the previous treatment cycle.

The data in Table 5-1 is the minimum information expected to be available by a program user. Assuming this minimum information scenario, Figure 5-1 shows a decision tree to estimate VOC emissions. There are 8 different potential estimation procedures:

1) flowthrough, aerated, biological system,
2) flowthrough, non-aerated, biological system,
3) flowthrough, aerated, non-biological system,
4) flowthrough, non-aerated, non-biological system,
5) disposal, aerated, biological system,
6) disposal, non-aerated, biological system,
7) disposal, aerated, non-biological system, and
8) disposal, non-aerated, non-biological system.

For clarity of how the VOC emissions are estimated, two examples are presented below. The two examples are:

I. disposal, non-aerated, non-biological impoundment
II. flowthrough, aerated, biological impoundment

TABLE 5-1. EXAMPLE MODEL DATA FOR A SURFACE IMPOUNDMENT

Total flow (Q) = 0.0623 m^3/s (flowthrough), 0.001 m^3/s (disposal)[a,b]

Surface Area (A) = 17,652 m^2 (flowthrough), 9,000 m^2 (disposal)[a,b]

Number of industrial flow rates discharged to impoundment[c] = 3

SIC codes and industrial category for each industrial flow rate into the impoundment[c]

1) 2865: Dye Manufacture and Formulation
2) 2879: Pesticides Manufacture
3) 2869: Organic Chemicals Manufacturing

The impoundment is flowthrough/disposal, aerated/non-aerated, and is/is not a biological system.

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[a]Ref 1, aeration basin dimensions.
[b]Ref 2, disposal impoundments.
[c]Random choice

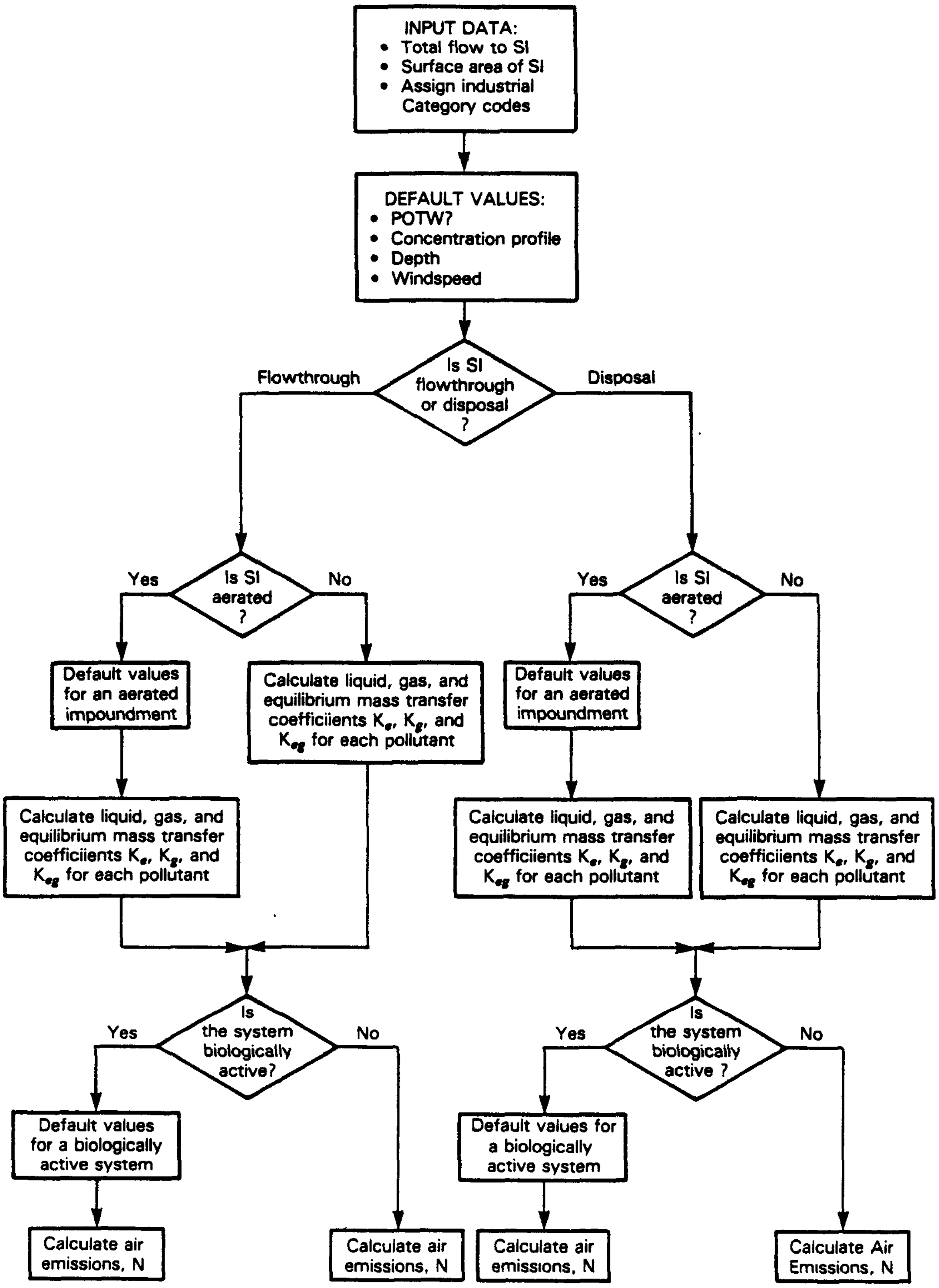

Figure 5-1. Decision Tree to Estimate VOC Emissions

As shown in Figure 5-1, the first step for every case is to input the minimum data required. Total flow to the impoundment, total surface area of the impoundment, and industrial categories for each industrial flow rate into the impoundment are required. The user must first match SIC codes with the corresponding industrial category. The SIC codes and their corresponding categories are shown in Appendix A. The assigned code addresses data collected for that particular industrial category. The second step of the program also used for every case, defines some general site-specific parameters needed for estimating VOC emissions. These parameters are concentration profile, industrial flow rates for each industrial category code, depth of the impoundment, and windspeed. This step also requires the user to specify if the impoundment is at a publicly owned treatment work (POTW). If the impoundment is at a POTW and only the total flow is known, the percent industrial flow will be estimated since the total flow is the sum of municipal and industrial wastewater. For step two, these parameters will be given a default value if no information is supplied.

Step three is the calculation of the individual and overall mass transfer coefficients. In order to calculate these coefficients two branches of the decision tree must be descended. The first branch describes the flow scheme (flowthrough or disposal) while the second branching determines the type of impoundment (aerated or nonaerated).

Step four is the calculation of the total emissions for a pollutant. When performing a mass balance around the impoundment, if biodegradation takes place, it must be accounted for as a removal process for both aerated and nonaerated impoundments. From Figure 5-1, it can be seen that the limbs for the aerated and non-aerated cases come together before branching again. The form of the emission equations also varies with flow scheme (i.e., flowthrough or disposal).

The following two examples present the actual calculation steps involved.

I. Estimation procedure for VOC emissions for Model I - a non-aerated, non-biological disposal impoundment.

Step 1: Input the minimum data

$Q = 0.001\ m^3/s$

$A = 9,000\ m^2$

number of industrial flow rates discharging to impoundment = 3 industrial category codes for each discharge

Number	Assigned Industrial Category Code[a]
1	4
2	19
3	17

[a]The computer assigns an industrial category code to each industrial category. Each category contains assigned SIC codes. (See Appendix A for a listing.)

Step 2: Define some general site-specific parameters.

A. Concentration profile

Unless the user can supply a concentration for each pollutant to the impoundment, a default pollutant concentration is substituted by the program. If the impoundment is at a POTW, current concentrations will be assigned. A "current" concentration accounts for pretreatment of an industrial waste before it is discharged to a POTW. For this example, the surface impoundment is not at a POTW. Table 5-2 presents the appropriate concentration profile for Model I.

B. Total Industrial Flow Rates for each Industrial Category Code given

The computer will first ask the user to supply the industrial flow rates for each industrial category code. If this information is not available the program will give a default value for the industrial flow rates, depending on whether the impoundment is at a POTW or not. (Municipal flow must be accounted for if the impoundment is at a POTW.) For this impoundment, the total individual industrial flow rates are unknown. The default flow rates are the following:

TABLE 5-2. CONCENTRATION PROFILE

Industrial Category: Compound	Dye Manufacture and Formulation Concentration (g/m^3)	Organic Chemicals Manufacturing Concentration (g/m^3)	Pesticides Manufacture Concentration (g/m^3)	Total Concentration (g/m^3)
Acrolein	--	2.6×10^{-4}	--	2.29×10^{-4}
Benzene	--	11.68	9.13×10^{-2}	10.29
Bis(2-ethyl Hexyl)phthalate	--	8.02	--	7.07
Bromomethane	--	4.25×10^{-3}	--	3.74×10^{-3}
Butyl Benzyl phthalate	--	8.02	--	7.07
Carbon tetrachloride	--	1.06	0.143	0.940
Chlorobenzene	7.86×10^{-4}	2.0×10^{-5}	--	7.97×10^{-5}
Chloroform	--	9.06	1.3×10^{-3}	7.98
Chloromethane	--	0.15	0.02	0.133
Dibutylphthalate	--	5×10^{-6}	--	4.41×10^{-6}
1,2 dichlorobenzene	9.6	1.45×10^{-3}	0.0878	0.763
1,4 dichlorobenzene	16.32	--	--	1.29
1,2 dichloroethane	--	--	3.83×10^{-4}	1.53×10^{-5}
2,4 dichlorophenol	--	--	0.724	2.90×10^{-2}
Diethyl Phthalate	--	3.50×10^{-5}	--	3.08×10^{-5}
Ethyl Benzene	--	8.25	5.44×10^{-4}	7.27
Methylene chloride	--	1.04	1.09	0.960
Napthalene	--	8.02	--	7.07
PCB's	0.0187	--	--	1.48×10^{-3}
Phenol	0.179	27.30	0.108	24.07
1,1,2,2 tetrachloroethane	--	9.98×10^{-6}	--	8.79×10^{-6}
Tetrachloroethylene	1.67	1.04	4.35	1.22
Toluene	--	14.32	48.31	14.55
1,2,4 Trichlorobenzene	8.44×10^{-3}	--	--	6.67×10^{-4}
1,1,2 Trichloroethane	--	1.51	--	1.33
2,4,6 Trichlorophenol	--	--	5.97×10^{-3}	2.39×10^{-4}
Vinyl chloride	--	0.102	--	8.99×10^{-2}

Industrial Category Code	Industrial Category	Fraction of Total Industrial Flow Rate	Flow Rate (m^3/s)
4	Dye Manufacture and Formulation	0.079	7.9×10^{-5}
17	Organic Chemicals	0.881	8.81×10^{-4}
19	Pesticides Manufacturing	0.040	4×10^{-5}

C. Depth of the Impoundment

If the depth of the impoundment is not easily obtained the computer will assign a default depth which depends on the total flow rate and whether the impoundment is flowthrough or disposal. For a disposal impoundment, the equations are the following:

$$D = \frac{Q + 700}{354.6} \text{ for } Q \geq 253 \text{ m}^3\text{/day}$$

$$D = \frac{Q}{101.2} \text{ for } 0 < Q < 253 \text{ m}^3\text{/day}$$

Q = total flow rate to impoundment (m^3/day)

D = depth of impoundment (m)

Q = 0.001 m^3/s (86.4 m^3/day)

and $D = \frac{86.4}{101.2} = 0.854$ m

D. Windspeed

A default value of 4.47 m/s is assigned for the windspeed.

Step 3: Calculation of the individual liquid and gas mass transfer coefficients, the equilibrium mass transfer coefficient, and the overall mass transfer coefficient.

The individual liquid and gas mass transfer coefficients are calculated based on the type of impoundment, aerated or nonaerated. For quiescent impoundments, fetch to depth ratio (F/D) and windspeed (W) determine what ultimate liquid and gas mass transfer coefficient equations are used. (The fetch is the linear distance across the surface of the impoundment.) For this model, F/D is 125.3 and the windspeed is 4.47 m/s (assigned default).

The liquid mass transfer coefficient, k_l, is estimated using an equation developed by Springer et. al., while the gas mass transfer coefficient k_g is estimated by MacKay and Matasuga:

A) k_l (m/s) = $2.611 \times 10^{-7}\ U_{10}^{2}[D_w/D_{ether}]^{2/3}$

$U_{10} > 3.25$ m/s

$F/D > 51.2$

B) k_g (m/s) = $4.82 \times 10^{-3}\ U^{0.78}\ Sc_G^{-0.67} d_e^{-0.11}$

The equilibrium mass transfer coefficient, K_{eq}, is also calculated for each pollutant:

C) $K_{eq} = H/RT$

The overall mass transfer coefficient, K, is calculated from the above individual coefficients by:

$$1/K(m/s) = 1/k_l + 1/(K_{eq} \times k_g)$$

For simplicity, only the calculational procedure for benzene will be shown.

A) $k_l(m/s) = 2.611 \times 10^{-7}\ U_{10}^{2}[D_w/D_{ether}]^{2/3}$

Area = 9,000 m^2 — $D_{ether} = 8.5 \times 10^{-6}\ cm^2/s$

D (Depth) = 0.854 m — $D_{w,Benzene} = 9.8 \times 10^{-6}\ cm^2/s$

$U_{10} = U = 4.47$ m/s

Fetch - effective diameter, d_e

$d_e = 2(Area/\pi)^{0.5} = 2(9,000/\pi)^{0.5}$

$d_e = 107.0$

$F/D = 107.0/0.854$

$F/D = 125.3$

$k_l(m/s) = 2.611 \times 10^{-7}\ (4.47\ m/s)^2\ [9.8 \times 10^{-6}\ cm^2/s/8.5 \times 10^{-6}\ cm^2/s]^{2/3}$

$k_l = 5.74 \times 10^{-6}$ m/s

B) $k_g(m/s) = 4.82 \times 10^{-3} \quad U^{0.78} \ Sc_G^{-0.67} d_e^{-0.11}$

$d_e = 107.0$ $\quad\quad \mu_G = 1.81 \times 10^{-4}$ g/cm-s

$U = 4.47$ m/s $\quad\quad \rho_G = 1.2 \times 10^{-3}$ g/cm^3

$D_{a,Benzene} = 0.088$ cm^2/s

Sc_G = Schmidt number on the gas side, μ_G/ρ_G Da

$= (1.81 \times 10^{-4}$ g/cm-s$)/[(1.2 \times 10^{-3}$ g/cm$^3)(0.088$ cm^2/s$)]$

$= 1.71$

$k_g(m/s) = 4.82 \times 10^{-3}(4.47)^{0.78}(1.71)^{-0.67}(107.0)^{-0.11}$

$k_g = 6.47 \times 10^{-3}$ m/s

C) $K_{eq} = H/RT$

H = Henry's law constant for benzene, 5.5×10^{-3} atm m^3/g mol

R = universal gas constant, 8.21×10^{-5} atm m^3/g mol °K

T = temperature, 298°K

$$K_{eq} = \frac{5.5 \times 10^{-3} \text{ atm m}^3\text{/g mol}}{(8.21 \times 10^{-5} \text{ atm m}^3\text{/g mol °K})(298\text{°K})}$$

$K_{eq} = 0.225$

D) $1/K(m/s) = 1/k_l + 1/(K_{eq}\ k_g)$

$1/K(m/s) = 1/5.74 \times 10^{-6}$ m/s $+ 1/[(0.225)(6.47 \times 10^{-3}$ m/s$)]$

$K = 5.72 \times 10^{-6}$ m/s

Step 4: The final step is to determine the emissions of each pollutant. The emissions equation is written as a mass balance around the impoundment and considers removal mechanisms as well as volatilization. Biodegradation is a removal mechanism that is considered for the emission models. For Model I there is no biodegradation and the configuration is a disposal impoundment. The following emission equation applies.

$E(g/s) = f_{air}\ Q\ C_o$

where $f_{air} = 1 - \exp(-KA/Q)$

or $E(g/s) = [1-\exp(-KA/Q)]QC_o$

Because more than one industrial flow rate is usually discharged to an impoundment, the total inlet concentration and flow rate are used to calculate the total emissions. From Table 5-2 the total concentration of benzene is 10.29 g/m^3. The total inlet flow rate is 0.001 m^3/s. The total emissions for benzene in Example I is:

$$E(g/s) = [1-\exp(-(5.72 \times 10^{-6}\ m/s)\ (9{,}000\ m^2)/(0.001\ m^3/s))]$$
$$(0.001\ m^3/s)(10.29\ g/m^3)$$
$$E = 0.01029\ g/s$$

II. Estimation procedure for emissions from Model II an aerated, biological flowthrough impoundment.

Step 1: Input the minimum data.

The input data is the same as Model I for everything except the flow, now 0.0623 m^3/s, and the surface area, now 17,652 m^2.

Step 2: Define some general site-specific parameters.

A. Concentration profile

Because the category codes supplied to this industrial impoundment is identical to Model I, the concentration profile is also identical.

B. Total industrial flow rates for each industrial category code

The following individual industrial flow rates apply:

Industrial Category Code	Fraction of Flowrate	Flowrate, (m^3/s)
4	0.079	4.92×10^{-3}
17	0.881	5.49×10^{-2}
19	0.040	2.48×10^{-3}

C. Windspeed

A default value of 4.47 m/s is assigned for the windspeed.

D. Depth of impoundment

For a flowthrough impoundment the equations for the default depth are the following:

$$D = \frac{Q + 3809.5}{4673.3} \qquad Q \geq 1{,}446\ m^3/day$$

$$D = \frac{Q}{863.8} \qquad 0 < Q < 1{,}446\ m^3/day$$

$$Q = 0.0623\ m^3/s \quad (5{,}383\ m^3/day)$$

and

$$D = \frac{5,383 + 3809.5}{4673.3}$$

$$D = 1.97 \text{ m}$$

A check is made to ensure that a 1.97 m depth will keep the retention time within the set limits. An area of 17.652 m^2, depth of 1.97 m, and flow rate of 0.0623 m^3/s gives a retention time of 6.5 days, which is between the limits of 5 and 10 days set for aerated impoundments.

Step 3: Calculation of the individual liquid, gas, and equilibrium mass transfer coefficients, and the overall mass transfer coefficient.

Because we are now dealing with an aerated impoundment, the procedure for estimating k_l and k_g is different than that for a nonaerated impoundment. Both turbulent and quiescent mass transfer coefficients are calculated for this case. For the turbulent area, the liquid mass transfer coefficient, k_l, is estimated by Thibodeaux, while the gas mass transfer coefficient, k_g, is estimated by Reinhart.

A1) $k_l(m/s) = [8.22 \times 10^{-9} J(POWR)(1.024)^{T-20} O_t(10^6)MW_L/Vav\ \rho_L)] (D_w/D_{O2,w})^{0.5}$

B1) $k_g(m/s) = (1.35 \times 10^{-7})Re^{1.42}p^{0.4}Sc_G^{0.5}Fr^{-0.21}D_aMW_a/d$

where $p = P_I g_c/(\rho_L d^{*5} w^3)$

At this point, it is necessary to assign default values to some parameters needed to solve the above equations. The following values are assigned as default for an aerated impoundment: 1) oxygen transfer rating of surface aerator, J = 3 lb oxygen/hp hr; 2) Total power to aerators, POWR = 0.75 hp/1,000 ft^3 of the impoundment; 3) Water Temperature, T = 25°C; 4) oxygen transfer correction factor, O_t = 0.83; 5) Turbulent surface area, Va_v = 0.24 (total surface area of impoundment); 6) impeller speed, w = 126 rad/s; 7) power to impeller, P_I = 0.85 (total power to the aerator); 8) impeller diameter, d* = 2 ft (or d = 61 cm); and 9) number of aerators, Na = 3.

The calculation for the equilibrium mass transfer coefficient depends only on the temperature for a specific compound, and therefore will always be the same for any model provided the temperature is constant.

C1) $K_{eq} = \frac{H}{RT}$

The overall mass transfer coefficient is again calculated from the individual coefficients.

D1) $1/K(m/s) = 1/k_l + 1/(K_{eq}\ k_g)$

Equations A) through D) will again be solved for the pollutant benzene.

A1) $k_l(m/s) = [8.22 \times 10^{-9} J(POWR)(1.024)^{T-20} O_t (10^6)$
$MW_L(Va_v\ \rho_L)](D_w/D_{O2,w})^{0.5}$

Area = 17,652 m^2 | MW_l = 18 g/g mol

D (Depth) = 1.97 m | ρ_l = 1 g/cm^3

U_{10} = U = 4.47 m/s | $D_{w,\ Benzene} = 9.8 \times 10^{-6}\ cm^2/s$

J = 3 lb O_2/hp hr | $D_{O_{2,w}} = 2.4 \times 10^{-5}\ cm^2/s$

POWR = 0.75 hp/1,000 ft^3 (V)

T = 25°C

O_t = 0.83

Vav = (0.24)(Area)(Depth)

$k_l(m/s) = [8.22 \times 10^{-9}(3\ lb\ O_2/hp\text{-}hr)]\ [(0.75\ hp/1{,}000\ ft^3)$
$(17{,}652\ m^2)(1.97\ m)(ft^3/0.028317\ m^3)](1.024)^5\ (0.83)\ (10^6)$
$(18\ g/g\ mol)/(0.24)(17{,}652\ m^2)(ft^2/0.0929\ m^2)(1\ g/cm^3)]$
$[(9.8 \times 10^{-6}\ cm^2/s)/(2.4 \times 10^{-5}\ cm^2/s)]^{0.5}$

$k_l = (2.27 \times 10^{-5})(368.86)(0.639)$

$k_l = 5.35 \times 10^{-3}$ m/s

B1) $k_g(m/s) = (1.35 \times 10^{-7})Re^{1.42}p^{0.4}Sc_G^{0.5}Fr^{-0.21}D_a MW_a/d$

d = 61 cm | W = 126 rad/s

d* = d in ft = 2.0 ft | $P_I = 0.85\ (POWR)/N_a$

$\mu_a = 1.81 \times 10^{-4}$ g/cm s | ρ_L = 62.4 lb/ft^3

$\rho_a = 1.2 \times 10^{-3}$ g/cm^3

$D_{a,Benzene}$ = 0.088 cm^2/s | N_a = POWR/75 hp (921/75 = 12)

$g_c = 32.17\ lb_m\ ft/lb_f\text{-}s^2$ | A = 17,652 m^2

MW_a = 29 g/g mol | D = 1.97 m

Re = Renold's number = $d^2\ w\ \rho_a/\mu_a$

$= (61\ cm)^2(126\ rad/s)(1.2 \times 10^{-3}\ g/cm^3)/(1.81 \times 10^{-4}\ g/cm\text{-}s)$

Re = 3.1×10^6

p = power number = $p_I g_c/(\ \rho_L d^{*5} w^3)$

$= [(0.85)(0.75\ hp/1{,}000\ ft^3)(17{,}652\ m^2)(1.97\ m)(550\ ft\ lb_f/s\ hp)$
$(ft^3/0.028317\ m^3)/12(32.17\ lb\ ft/lb_f\ s^2)]/(ft^3)(2\ ft)^5\ (126\ rad/s)^3]$

$p = 1.154 \times 10^6/3.994 \times 10^9$

$p = 2.89 \times 10^{-4}$

Sc_G Schmidt number on the gas side $= \mu_G/\rho_G D_a$

$= (1.81 \times 10^{-4}\ g/cm\text{-}s)/[(1.2 \times 10^{-3}\ g/cm^3)(0.088\ cm^2/s)]$

$Sc_G = 1.71$

Fr (Froude number) = d^*w^2/g_c

$= (2\ ft)(126\ rad/s)^2/32.17\ lb_m\ ft/lb_f\text{-}s^2$

$Fr = 990$

$k_g(m/s) = (1.35 \times 10^{-7})(3.1 \times 10^6)^{1.42}(2.89 \times 10^{-4})^{0.4}(1.71)^{0.5}$
$(990)^{-0.21}(0.088\ cm^2/s)(29\ g/g\ mol)/61\ cm$

$k_g = 0.110\ m/s$

C1) $K_{eq} = H/RT = 0.225$

D1) $1/K_T(m/s) = 1/k_l(m/s) + 1/K_{eq}k_g(m/s)$

$1/K_T(m/s) = 1/5.35 \times 10^{-3}\ m/s + 1/[(0.225)(0.110\ m/s)]$

$K_T = 4.40 \times 10^{-3}\ m/s$

Now the mass transfer coefficients must be determined for the quiescent area of the impoundment. The liquid mass transfer coefficient, k_l, for the quiescent area is estimated using an equation developed by Springer, et.al., while k_g is estimated using an equation developed by MacKay and Matasugu (F/D = 76.1, U_{10} = 4.47 m/s).

A2) $k_l(m/s) = 2.611 \times 10^{-7}\ U_{10}^2[D_w/D_{ether}]^{2/3}$

F/D > 51.2 $\qquad$ U_{10}> 3.25 m/s

B2) $k_g(m/s) = 4.82 \times 10^{-3}U^{0.78}Sc_G^{-0.67}d_e^{-0.11}$

C2) $K_{eq} = H/RT$

D2) $1/K_Q(m/s) = 1/k_l(m/s) + 1/K_{eq}k_g$

A2) $k_l(m/s) = 2.611 \times 10^{-7}\ U_{10}^2[D_w/D_{ether}]^{2/3}$

Area = 17,652 m² $\qquad$ $D_{ether} = 8.5 \times 10^{-6}\ cm^2/s$

D (Depth) = 1.97 m $\qquad$ $D_{w,\ Benzene} = 9.8 \times 10^{-6}\ cm^2/s$

U_{10} = 4.47 m/s

Fetch = effective diameter, d_e

$d_e = 2(Area/\pi)^{0.5} = 2(17{,}652\ m^2/\pi)^{0.5} = 149.9\ m$

F/D = 149.9 m/1.97 m = 76.1

$k_l(m/s) = 2.611 \times 10^{-7}\ (4.47\ m/s)^2[(8.5 \times 10^{-6}\ cm^2/s)(9.8 \times 10^{-6}\ cm^2/s)]^{0.5}$

$k_l(m/s) = 5.74 \times 10^{-6}$

B2) $k_g(m/s) = 4.82 \times 10^{-3}\ U^{0.78} Sc_G^{-0.67} de^{-0.11}$

$d_e = 149.9\ m$ $\mu_G = 1.81 \times 10^{-4}\ g/cm\ s$

$U = 4.47\ m/s$ $\rho_G = 1.2 \times 10^{-3}\ g/cm^3$

$D_{a,Benzene} = 0.088\ cm^2/s$

$Sc_G = 1.71$ (Same calculation as Model I)

$k_g(m/s) = 4.82 \times 10^{-3}(4.47\ m/s)^{0.78}(1.71)^{-0.67}(149.9\ m)^{-0.11}$

$k_g = 6.24 \times 10^{-3}\ m/s$

C2) $K_{eq} = 0.225$

D2) $1/K_Q(m/s) = 1/k_l(m/s) + 1/K_{eq}k_g(m/s)$

$1/K_Q(m/s) = 1/5.74 \times 10^{-6}\ m/s + 1/[(0.225)(6.24 \times 10^{-3}\ m/s)]$

$K_Q = 5.72 \times 10^{-6}\ m/s$

To determine the overall mass transfer coefficient an area-weighing of the turbulent and quiescent K's is performed.

$$K(m/s) = \frac{K_T A_T + K_Q A_Q}{A}$$

$K(m/s) = [(0.24)(17{,}652\ m^2)(4.40 \times 10^{-3}\ m/s) + (0.76)(17{,}652\ m^2)$
$(5.72 \times 10^{-6}\ m/s)]/(17{,}652\ m^2)$

$K = 1.06 \times 10^{-3}\ m/s$

Step 4: Again the final step is to determine the emissions. A mass balance is written around the impoundment. Model II is flow-through and biodegradation is a removal mechanism.

The biomass concentration will vary depending on what type of impoundment it is. If the user is unable to supply a biomass concentration then a default value will be supplied. There are three default biomass concentrations 1) 0.05 g/l for quiescent impoundments, 2) 0.30 g/l for aerated impoundments, and 3) 4.0 g/l for activated sludge units. Model II has a biomass concentration of 0.30 g/l (aerated impoundments).

The rate equation for monod-type biodegradation is written for disappearance of a single component in terms of overall biomass concentration and it is assumed that the biodegradation of any one constituent is independent of the concentrations of other constituents.

A) Calculate the effluent concentration of benzene

$C_L = [-b + (b^2 - 4ac)^{0.5}]/2a$

where

$a = KA/Q + 1$

$b = K_s(KA/Q + 1) + (V/Q) K_{max}b_i - C_o$

$c = -K_sC_o$

$K = 1.06 \times 10^{-3}$ m/s

$Q = 0.0623$ m^3/s

$V = 34,774$ m^3

$D = 1.97$ m

$b_{benzene} = 0.3$ g/l (300 g/m^3)

$C_{benzene} = 10.29$ g/m^3

$K_{max,benzene} = 5.28 \times 10^{-6}$ g/g-s

$K_{s,benzene} = 13.6$ g/m^3

$a = [(1.06 \times 10^{-3} \text{ m/s})(34,774 \text{ m}^3)/(1.97 \text{ m})(0.0623 \text{ m}^3/\text{s})] + 1$

$a = 301.3$

$b = (13.6 \text{ g/m}^3)[((1.06 \times 10^{-3} \text{ m/s})(34,774 \text{ m}^3)/(1.97 \text{ m})/(0.0623 \text{ m}^3/\text{s})) + 1]$
$+ ((34,774 \text{ m}^3)/(0.0623 \text{ m}^3/\text{s}))(5.28 \times 10^{-6} \text{ g/g-s})(300 \text{ g/m}^3)$
$- 10.29 \text{ g/m}^3$

$b = 4,098 + 884 - 10.29$

$b = 4,972$ g/m^3

$c = -(13.6 \text{ g/m}^3)(10.29 \text{ g/m}^3)$

$c = -140 \text{ g}^2/\text{m}^6$

$C_L = [-4,972 \text{ g/m}^3 + ((4,972 \text{ g/m}^3)^2 - 4(301.3)(-140 \text{ g}^2/\text{m}^6))^{0.5}/(2(301.3))]$

$C_L = (-4,972 + 4,989)/(602.6)$

$C_L = 0.0282$ g/m^3

B) Calculate the fraction VOC emitted for benzene

$f_{air} = KAC_L/(QC_o)$

$K = 1.06 \times 10^{-3}$ m/s

$A = 17,652$ m^2

$Q = 0.0623$ m^3/s

$C_{benzene} = 10.29$ g/m^3

$D = 1.97$ m

$V = 34,774$ m^3

$f_{air} = (1.06 \times 10^{-3}\ m/s)(17{,}652\ m^2)(0.0282\ g/m^3)/[(0.0623\ m^3/s)(10.29\ g/m^3)]$

$f_{air} = 0.528/0.641$

$f_{air} = 0.823$

C) Calculate the VOC emissions for benzene

$E(g/s) = f_{air}QC_o$

$E = (0.823)(0.0623\ m/s)(10.29\ g/m^3)$

$E = 0.528\ g/s$

5.1 REFERENCES

1. Control of Volatile Organic Compound Emissions from industrial Wastewater, Preliminary Draft. U.S. Environmental Protection Agency, April 1988.

2. Hazardous Waste TSDF - Background Information for Proposed RCRA Air Emission Standards Volume 2. U.S. Environmental Protection Agency Office of Air Quality Planning and Standards, March 1988.

APPENDIX A

INDUSTRIAL CATEGORIES

Appendix A contains a listing of the industrial categories covered by the DSS. Each category is broken down into several subcategories which are labeled by SIC code. Because there may be more than one SIC code for each category, an industrial category code has been assigned to each industrial category to alleviate any confusion.

Industrial Category Code: 1

Category Name: Adhesives and Sealants - Manufacture of household and industrial adhesives and sealants.

Subcategory	SIC Code
Animal Glues and Other Protein Adhesives	2891
Starch Adhesives	2891
Synthetic Resin Adhesives - Rigid Thermosets	2891
Synthetic Resin Adhesives - Rubbery Thermosets	2891
Synthetic Resin Adhesives - Thermoplastics	2891
Copolymers and Mixtures	2891
Inorganic Adhesives	2891
Other Adhesives	2891

Industrial Category Code: 2

Category Name: Battery Manufacturing - Facilities engaged in the manufacture of primary and/or storage batteries.

Subcategory	SIC Code
Cadmium	3691 3692
Calcium	3691 3692
Lead	3691 3692
Leclanche	3691 3692
Lithium	3691 3692
Magnesium	3691 3692
Zinc	3691 3692
Mercury	3691 3692
Other	3691 3692

Industrial Category Code: 3

Category Name: <u>Coal, Oil, Petroleum Products, and Refining</u>: - Petroleum refining, and production of paving, roofing, and lubricating materials.

<u>Subcategory</u>	<u>SIC Code</u>
Coal Coking and Oil and Tar Recovery	2951 2992 2999
Coal Tar Distillation	2951 2992 2999
Coal Gasification	2951 2992 2999
Coal Liquefaction	2951 2992 2999
Petroleum Distillation/ Fractionation-Fuel Gas Production	2911
Petroleum Distillation/ Fractionation-Light Distillates	2911
Petroleum Distillation/ Fractionation-Intermed. Prod. Distillates	2911
Petroleum Distillation/ Fractionation - Heavy Distillates	2911
Crude Feedstock Conversion to Petrochemical Production and Integrated Plants	2911

Industrial Category Code: 4

Category Name: Dye Manufacture and Formulation - Manufacture of chemicals which impart color to fabrics or other materials with which they come into contact.

Subcategory	SIC Code
Acid Dyes	2865
Azo Dyes	2865
Basic Dyes	2865
Direct Dyes	2865
Disperse Dyes	2865
Fiber-Reactive Dyes	2865
Fluorescent Dyes	2865
Mordant Dyes	2865
Solvent Dyes	2865
Vat Dyes	2865
Other Dyes	2865
Organic Pigments	2865

Industrial Category Code: 5

Category Name: <u>Electrical and Electronic Components</u> - Manufacture of components that enable devices to utilize electricity.

Subcategory	SIC Code
Semiconductors	3674
Electronic Crystals	3679 3339
Cathode Ray Tubes	3672 3673 3693
Receiving and Transmitting Tubes	3671 3673
Luminescent Materials	3641
Carbon and Graphite Products	3624
Transformers	3612 3677
Fuel Cells	3679
Electric Lamps	3641

Industrial Category Code: 6

Category Name: Electroplating/Metal Finishing - Industries engaged in electroplating, fabricating, and finishing of ferrous and nonferrous metal products.

Subcategory	SIC Code
Electroplating	3471
Electroless Plating	3679
Anodizing	3471
Coatings	3479
Chemical Etching and Milling	3479
Printed Circuit Board Manufacturing	3679
Cleaning/Degreasing	3471
Heat Treating	3398
Stamping	3465 3466 3469
Metal Fabrication/Metal Products Manufacture	3421 3422 3423 3425 3429 3433 3441 3442 3443 3444 3446 3448 3449 3451 3452 3493 3494 3495 3496 3498 3499 3910 3911 3914 3931 3961 3964

Industrial Category Code: 7

Category Name: <u>Equipment Manufacture and Assembly</u> - All activities relating to the manufacture and assembly of equipment, except those activities covered by other categories (e.g., electroplating/metal finishing operations).

Subcategory	SIC Code
Fabricated Metal products	all 3400 SIC codes, N.E.C[a]
Machinery, Except Electrical	all 3500 SIC codes, N.E.C.
Electric and Electronic Equipment	all 3600 SIC codes, N.E.C.
Transportation Equipment	all 3700 SIC codes, N.E.C.
Instruments and Related Products	all 3800 SIC codes, N.E.C.
Miscellaneous Metal Products	2500 2520 2522 2540 3993

[a] N.E.C. = Not elsewhere classified.

Industrial Category Code: 8

Category Name: Explosives Manufacture - Manufacture, load, assemble, and pack (LAP) of explosives, initiating compounds and propellants.

Subcategory	SIC Code
Manufacture and Load, Assemble, and Pack (LAP) of Initiating Compounds	2892
Manufacture of Propellants	2892
Manufacture of Explosives	2892
Formulation and Packaging of Blasting Agents, Slurry Explosives and Pyrotechnics	2899
Load, Assemble, and Pack of Explosive Devices	2892
Load, Assemble, and Pack of Small Arms Ammunition	3482
Load, Assemble, and Pack of Other Ammunition	3483

Industrial Category Code: 9

Category Name: <u>Gum and Wood Chemicals, Varnishes, Lacquers, and Related Oils</u> - Industries which manufacture chemical products derived from wood, as well as oil and resin products applied to wood.

Subcategory	SIC Code
Char and Charcoal Products	2861
Gum Resin and Turpentine	2861
Wood Resin, Turpentine, and Pine Oil	2861
Tall Oil Resin, Fatty Acids, and Pitch	2861
Sulfate Turpentine (Turpentine from Spent Kraft Mill Liquors)	2861
Lignin, Cellulose, and Derivatives of Spent Pulping Liquors	2861
Other Gum and Wood Chemicals	2861
Linseed Oil and Other Drying Oils	2851
Oleoresinous Varnishes	2851
Spirit Varnishes, Shellac	2851
Enamels	2851
Lacquers	2851

Industrial Category Code: 10

Category Name: Industrial and Commercial Laundries - Laundering of garments, linens, household fabrics, and industrial fabrics.

Subcategory	SIC Code
Power Laundries, Family and Commercial	7211
Linen Supply	7213
Diaper Service	7214
Coin-Op Laundries and Dry Cleaning	7215
Dry Cleaning Plants, Except Rug Cleaning	7216
Carpet and Upholstery Cleaning	7217
Industrial laundries	7218
Laundry and Garment Services, not elsewhere classified	7219
Miscellaneous Laundries	7210

Industrial Category Code: 11

Category Name: Ink Manufacture and Formulation - Manufacture and formulation of chemicals applied to paper or other materials in printing operations.

Subcategory	SIC Code
Printing Inks	2893
Letterpress, Dry Offset, and Lithograph	2893
Radiation Cure Inks	2893
Flexographic and Rotogravure Inks	2893
Other Inks	2893

Industrial Category Code: 12

Category Name: <u>Inorganic Chemicals Manufacturing</u> - Industries which manufacture inorganic chemicals.

Subcategory	SIC Code
Acids	2819
Alkalies, Chlorine, Chlorine Chemicals	2812
Sodium, Potassium, Calcium and Magnesium Salts	2819
Inorganic Pigments	2816
Other Metal Salts	2819
Other Metal Oxides	2819
Nitrogen Inorganic	2819
Phosphorus and Phosphate Chemicals	2819
Silicon Chemicals	2819
Uranium and Radioactive Materials Manufacturing and Processing	2819
Boron Chemicals	2819
Miscellaneous Inorganic Chemicals	2810 2819
Industrial Gases	2813

Industrial Category Code: 13

Category Name: <u>Iron and Steel Manufacturing and Forming</u> - Industries engaged in the manufacture (including casting) and forming of ferrous metals.

Subcategory	SIC Code
Cokemaking	3312
Sintering	3312
Ironmaking	3312
Steelmaking	3312 3313
Vacuum Degassing	3312 3313
Continuous Casting	3312
Hot Forming	3312 3315 3317 3493
Salt Bath Descaling	3312
Acid Pickling	3312
Cold Forming	3315 3316 3317
Alkaline Cleaning	3312
Hot Coating	3312 3479
Electrometallurgical/Metallothermic Products	3313
Iron and Steel Forgings	3462 3312
Iron and Steel Casting	3321 3322 3324 3325
Miscellaneous Iron and Steel Operations	3300

Industrial Category Code: 14

Category Name: Leather Tanning and Finishing - Hair removal, tanning, retanning, finishing, and products processing of animal hides.

Subcategory	SIC Code
Hair Pulp, Chrome Tan, Retan, Wet Finish	3111
Hair Save, Chrome Tan, Retan, Wet Finish	3111
Hair Save, Nonchrome Tan, Retan, Wet Finish	3111
Retan, Wet Finish	3111
No Beamhouse	3111
Through-the-blue	3111
Shearling	3111
Pigskin	3111
Retan, Wet Finish-Splits	3111
Leather Products Processing	3100 3131 3140 3144 3149 3171 3172

Industrial Category Code: 15

Category Name: Nonferrous Metals Forming - Rolling, drawing, and extruding of metals (including copper and aluminum).

Subcategory	SIC Code
Copper/Aluminum Metal Powder Production and Powder Metallurgy	3399
Other Nonferrous Metals Forming	3350 3356 3497
Aluminum Forming	3353 3355 3354 3463
Copper Forming	3351 3357

Industrial Category Code: 16

Category Name: Nonferrous Metals Manufacturing - Facilities engaged in manufacture (including casting) of nonferrous metals.

Subcategory	SIC Code
Aluminum Casting	3361
Copper and Copper Alloy Casting	3362
Magnesium Casting	3369
Zinc Casting	3369
Primary Smelting and Refining of Copper	3331
Primary Smelting and Refining of Lead	3332
Primary Smelting and Refining of Zinc	3333
Primary Production of Aluminum	3334
Primary Smelting and Refining of Other Nonferrous Metals	3339
Secondary Smelting and Refining of Nonferrous Metals	3341
Other Nonferrous Metals Casting	3369

Industrial Category Code: 17

Category Name: <u>Organic Chemicals Manufacturing</u> - Manufacture of basic organic chemical feedstocks, (solvents and intermediates) and the manufacture of organometallics and other organic chemicals.

Subcategory	SIC Code
Solvents - Alcohol	2869
Solvents - Aliphatic Hydrocarbons	2869
Solvents - Alkyl Halides	2869
Solvents - Amines	2869
Solvents - Aromatic Hydrocarbons	2869
Solvents - Halogenated Aromatics	2869
Solvents - Esters	2869
Solvents - Glycol Ethers	2869
Solvents - Ketones	2869
Cyclic Intermediates	2869
Fermentation Products	2869
Organometallics	2869
Rubber and Plastics in Additives Manufacture	2869

Industrial Category Code: 18

Category Name: Paint Manufacture and Formulation - Industries engaged in formulating paints by mixing various constituent chemicals (solvents, drying oils, pigment extenders, etc.).

Subcategory	SIC Code
Paint Formulation - Water Based Paints	2851
Paint Formulation - Solvent-Based Paints	2851

Industrial Category Code: 19

Category Name: <u>Pesticides Manufacture</u> - Manufacture of compounds containing any technical grade ingredient used to control, prevent, destroy, repel, or mitigate pests.

Subcategory	SIC Code
Phosphates and Phosponates	2879
Ureas and Uracils	2879
Miscellaneous Pesticides	2879
Phosphorothioates	2879
Phosphorodithioates	2879
Other Organophosphates	2879
Carbamates, Thiocarbamates, and Dithiocarbamates	2879
Amides, Anilides, Imides, and Hydrazides	2879
Other Nitrogen Containing Compounds	2879
Triazines	2879
Amines, Nitro Compounds, and Quaternary Ammonium Compounds	2879
DDT and Related Compounds	2879
Chlorophenoxy Compounds	2879
Aldrin-Toxaphene Group	2879
Dihaloaromatic Compounds	2879
Highly Halogenated Compounds	2879

Industrial Category Code: 20

Category Name: Pharmaceutical Manufacturing - Production and processing of medicinal chemicals and pharmaceutical products.

Subcategory	SIC Code
Fermentation Products	2833
Extraction Products	2831 2833
Chemical Synthesis Products	2833
Mixing/Compounding and Formulation Processes	2834
Other	2830 2833

Industrial Category Code: 21

Category Name: Photographic Chemicals and Film Manufacturing - Solution mixing, emulsion or coating solution preparation, coating, packaging, and testing.

Subcategory	SIC Code
Silver Halide Sensitized Products	3861
Diazo Sensitized Products - Aqueous	3861
Diazo Sensitized Products - Solvent	3861
Thermally Sensitized Products	3861
Photographic Chemical Products	3861

Industrial Category Code: 22

Category Name: Plastics Molding and Forming - Molding primary plastics and manufacturing plastics products.

Subcategory	SIC Code
Miscellaneous Plastics Products	3000 3070 3079

ndustrial Category Code: 25

ategory Name: Printing and Publishing - All forms of publishing, ommercial printing, and services for the printing trade.

Subcategory	SIC Code
Typesetting	2791
Photoengraving	2793
Electrotyping and Stereotyping	2794
Lithographic Platemaking and Related Services	2795
Commercial Printing, Letterpress	2771 2751
Commercial Printing, Lithographic	2752
Commercial Printing, Gravure	2754
Commercial Printing, Screen	2751
Newspapers	2710 2711
Periodicals	2721
Books	2730 2731
Miscellaneous	2700 2741 2750 2753 2760 2761 2771 2790
Blankbooks, Looseleaf Binders, and Devices	2782
Bookbinding	2789

Industrial Category Code: 26

Category Name: Pulp and Paper Mills - Manufacturing wood pulp and processing wood pulp into products.

Subcategory	SIC Code
Integrated Bleached Kraft Mills	2611 2621 2631
Integrated Unbleached Kraft Mills	2611 2621 2631
Integrated Semi-Chemical Mills	2611 2621 2631 2661
Integrated Sulfite	2611 2621
Groundwood Mills	2611 2621 2646
Nonintegrated Paper Mills	2621 2631
Secondary Fiber and De-Ink Mills	2621
Pulp Molding Mills	2646
Structure Board Manufacture	2661
Paper Products Processing	2600 2620 2640 2641 2642 2643 2645 2647 2648 2649 2650 2651 2653

Industrial Category Code: 27

Category Name: <u>Rubber Manufacture and Processing</u> - Production of elastomers and the molding and extruding processes which convert these elastomers into usable products.

Subcategory	SIC Code
Natural Rubber Manufacture - Latex Products	3011
Synthetic Rubber Manufacture - Butadiene/Styrene Rubber	2822 3011
Synthetic Rubber Manufacture - Butadiene/Acrylonitrile Rubber	2822 3069
Synthetic Rubber Manufacture - Chloroprene Rubber	2822 3069
Synthetic Rubber Manufacture - Butyl Rubber	2822 3011
Synthetic Rubber Manufacture - Thiokol Rubber	2822 3069
Synthetic Rubber Manufacture - Urethane Rubber	2822 3069
Synthetic Rubber Manufacture - Ethylene/Propylene Polymers, Terpolymers	2822 3041
Synthetic Rubber Manufacture - Synthetic Natural Rubber (Polyisoprene, Polybutadiene)	2822 3011
Synthetic Rubber Manufacture - Urethane Rubber	2822 3069
Synthetic Rubber Manufacture - Silicone Rubber	2822 9999
Rubber Processing and Fabricating (Compounding, Coating, Molding, Extruding)	3069
Manufacture of Other Rubbers	3069

Industrial Category Code: 28

Category Name: <u>Textile Mills</u> - Facilities which engage in the manufacture of natural or synthetic fiber and the processing of these fibers into usable products, particularly fabrics.

Subcategory	SIC Code
Processing of Natural Fibers	2211 2221 2231 2241
Synthetic Fibers, processing Cellulose Fibers	2221 2241
Synthetic Fibers, Processing Nylon Fibers	2221 2241
Synthetic Fibers, Processing Polyester Fibers	2221 2241
Synthetic Fibers, Processing Spandex Fibers	2221 2241
Synthetic Fibers, Processing Inorganic Fibers	2221 2241
Dyeing and Finishing of Processing Textiles	2261 2262 2269
Miscellaneous Textile Mill Operations	2200 2250 2252 2253 2254 2257 2258 2260 2270 2272

Industrial Category Code: 29

Category Name: Timber Products Processing - Production of lumber, wood, and basic board materials.

Subcategory	SIC Code
Veneer and Plywood Products	2435 2436
Structural Wood Members, not elsewhere classified	2439
Particleboard Manufacturing	2492
Wet Process Hardboard Manufacturing	2499
Insulation Board Manufacturing	2661
Miscellaneous Timber Products Processing	2400 2430 2434 2490

APPENDIX B

DSS POLLUTANT LOADINGS FOR THE SELECTED CONSENT DECREE INDUSTRIAL CATEGORIES

Hazardous Constituents	Adhesives and Sealants			Battery Manufacture		
	Raw	Current	After PSES	Raw	Current	After PSES
Toxic Metals						
Antimony and Compounds	0	0	0	2,316	459	459
Arsenic and Compounds	0	0	0	9	6	6
Cadmium and Compounds	2	2	2	15,342	33	33
Chromium and Compounds	636,738	287,190	287,190	4,160	61	61
Cyanide	404	304	304	95	5	5
Lead and Compounds	573	573	573	3,267,557	80	80
Mercury and Compounds	143	143	143	1,928	5	5
Nickel and Compounds	4	4	4	34,083	530	530
Selenium and Compounds	24	24	24	7	0	0
Silver and Compounds	287	287	287	414	8	8
Other Hazardous Metals	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL HAZARDOUS METALS	638,175	288,527	288,527	3,325,911	1,187	1,187
Copper and Compounds	4,829	2,496	2,496	2,856	585	585
Zinc and Compounds	194,856	160,681	160,681	96,996	239	239
Other Toxic Metals	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL TOXIC METALS	837,860	451,704	451,704	3,425,757	2,011	2,011

* All units in lbs/year.

Hazardous Constituents	Adhesives and Sealants			Battery Manufacture		
	Raw	Current	After PSES	Raw	Current	After PSES
Toxic Organics						
Acrolein	0	0	0	0	0	0
Benzene	1,003	1,003	1,003	0	0	0
Bis(2-Chloro-ethoxy) Methane	0	0	0	0	0	0
Bis(2-Chloroethyl) Ether	0	0	0	0	0	0
Bis(2-Ethyl Hexyl) Phthalate	24,129	14,776	14,776	535	28	28
Bromomethane	0	0	0	0	0	0
Butyl Benzyl Phthalate	21,816	21,816	21,816	16	1	1
Carbon Tetrachloride	143	143	143	0	0	0
Chlorobenzene	7	7	7	0	0	0
p-Chloro-m-Cresol	0	0	0	0	0	0
Chloroethane	0	0	0	0	0	0
Chloroform	68	68	68	0	0	0
Chloromethane	0	0	0	0	0	0
2-Chloronapthalene	0	0	0	0	0	0
Di-N-Butyl Phthalate	34,122	33,933	33,933	0	0	0
1,2-Dichlorobenzene	137	71	71	0	0	0
1,3-Dichlorobenzene	0	0	0	0	0	0
1,4-Dichlorobenzene	161	0	0	0	0	0
1,1-Dichloroethane	2	2	2	0	0	0
1,2-Dichloroethane	0	0	0	0	0	0
1,1-Dichloroethylene	117	117	117	8	1	1

* All units in lbs/year.

Hazardous Constituents	Adhesives and Sealants			Battery Manufacture		
	Raw	Current	After PSES	Raw	Current	After PSES
Trans-1,2-Dichloro-ethylene	7	7	7	0	0	0
1,2-Dichloropropane	0	0	0	0	0	0
Dichlorodifluoro-methane	0	0	0	0	0	0
2,4-Dichlorophenol	0	0	0	0	0	0
Diethyl Phthalate	730	730	730	0	0	0
2,4-Dimethylphenol	0	0	0	0	0	0
Dimethyl Phthalate	112	112	112	0	0	0
Di-N-Octyl Phthalate	0	0	0	175	7	7
Ethyl Benzene	474	443	443	0	0	0
Hexachloro-1,3-Butadiene	0	0	0	0	0	0
Hexachloroethane	0	0	0	0	0	0
Methylene Chloride	51,756	19,783	19,783	3	0	0
Naphthalene	785	399	399	48	2	2
N-Nitrosodimethyl Amine	0	0	0	0	0	0
Nitrobenzene	0	0	0	0	0	0
PCB	4	4	4	0	0	0
Pentachlorophenol	13,437	10,449	10,449	0	0	0
Phenol	46,645	32,261	32,261	0	0	0
1,1,2,2-Tetrachloro-ethane	0	0	0	0	0	0
Tetrachloroethylene	150	150	150	0	0	0
Toluene	10,983	10,983	10,983	1	0	0
Tribromomethane	0	0	0	0	0	0

SAIC

Hazardous Constituents	Adhesives and Sealants			Battery Manufacture		
	Raw	Current	After PSES	Raw	Current	After PSES
1,2,4-Trichloro-benzene	0	0	0	0	0	0
1,1,1-Trichloro-ethane	5,942	5,830	5,830	67	6	6
1,1,2-Trichloro-ethane	4	4	4	0	0	0
Trichloroethylene	1,314	1,012	1,012	3	0	0
Trichlorofluoro-methane	0	0	0	0	0	0
2,4,6-Trichloro-phenol	0	0	0	0	0	0
Vinyl Chloride	0	0	0	0	0	0
SUBTOTAL	214,048	154,103	154,103	846	45	45
Other Toxic Organics	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL TOXIC ORGANICS	214,048	154,103	154,103	846	45	45
Other Hazardous Organics	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL HAZARDOUS ORGANICS	214,048	154,103	154,103	846	45	45

Hazardous Constituents	Dyes and Pigments (ITD) Raw	Dyes and Pigments (ITD) Current	Dyes and Pigments (ITD) After PSES	Dyes and Pigments (ISDB) Raw	Dyes and Pigments (ISDB) Current	Dyes and Pigments (ISDB) After PSES
Toxic Metals						
Antimony and Compounds	0	0	0	0	0	0
Arsenic and Compounds	0	0	0	0	0	0
Cadmium and Compounds	0	0	0	0	0	0
Chromium and Compounds	307,030	305,930	395	18,276	18,120	24
Cyanide	1	1	1	8,537	8,537	186
Lead and Compounds	307,022	305,922	353	917,668	914,380	1,055
Mercury and Compounds	0	0	0	0	0	0
Nickel and Compounds	10	10	4	0	0	0
Selenium and Compounds	44	44	17	0	0	0
Silver and Compounds	0	0	0	0	0	0
Other Hazardous Metals	0	0	0	5,302	5,297	53
TOTAL HAZARDOUS METALS	614,107	611,907	770	949,783	946,334	1,318
Copper and Compounds	1,843,254	1,843,244	326	552,066	552,063	98
Zinc and Compounds	129	129	4	1,107	1,107	25
Other Toxic Metals	0	0	0	0	0	0
TOTAL TOXIC METALS	2,457,490	2,455,280	1,100	1,502,956	1,499,504	1,441

* All units in lbs/year.

Hazardous Constituents	Dyes and Pigments (ITD) Raw	Dyes and Pigments (ITD) Current	Dyes and Pigments (ITD) After PSES	Dyes and Pigments (ISDB) Raw	Dyes and Pigments (ISDB) Current	Dyes and Pigments (ISDB) After PSES
Toxic Organics						
Acrolein	264	264	8	0	0	0
Benzene	0	0	0	0	0	0
Bis(2-Chloro-ethoxy) Methane	0	0	0	0	0	0
Bis(2-Chloroethyl) Ether	0	0	0	0	0	0
Bis(2-Ethyl Hexyl) Phthalate	0	0	0	0	0	0
Bromomethane	0	0	0	0	0	0
Butyl Benzyl Phthalate	0	0	0	0	0	0
Carbon Tetrachloride	0	0	0	0	0	0
Chlorobenzene	0	0	0	27	27	17
p-Chloro-m-Cresol	0	0	0	0	0	0
Chloroethane	0	0	0	0	0	0
Chloroform	0	0	0	0	0	0
Chloromethane	0	0	0	0	0	0
2-Chloronapthalene	0	0	0	0	0	0
Di-N-Butyl Phthalate	0	0	0	0	0	0
1,2-Dichlorobenzene	0	0	0	330,435	330,435	52
1,3-Dichlorobenzene	0	0	0	0	0	0
1,4-Dichlorobenzene	0	0	0	561,930	561,930	203
1,1-Dichloroethane	0	0	0	0	0	0
1,2-Dichloroethane	0	0	0	0	0	0
1,1-Dichloroethylene	0	0	0	0	0	0

* All units in lbs/year.

Hazardous Constituents	Dyes and Pigments (ITB)			Dyes and Pigments (ISDB)		
	Raw	Current	After PSES	Raw	Current	After PSES
Trans-1,2-Dichloro-ethylene	0	0	0	0	0	0
1,2-Dichloropropane	0	0	0	0	0	0
Dichlorodifluoro-methane	0	0	0	0	0	0
2,4-Dichlorophenol	0	0	0	0	0	0
Diethyl Phthalate	0	0	0	0	0	0
2,4-Dimethylphenol	0	0	0	0	0	0
Dimethyl Phthalate	0	0	0	0	0	0
Di-N-Octyl Phthalate	0	0	0	0	0	0
Ethyl Benzene	0	0	0	0	0	0
Hexachloro-1,3-Butadiene	0	0	0	0	0	0
Hexachloroethane	0	0	0	0	0	0
Methylene Chloride	0	0	0	0	0	0
Naphthalene	24	24	13	0	0	0
N-Nitrosodimethyl Amine	0	0	0	0	0	0
Nitrobenzene	0	0	0	0	0	0
PCB	0	0	0	644	644	6
Pentachlorophenol	0	0	0	0	0	0
Phenol	435,936	435,936	13	6,161	6,161	27
1,1,2,2-Tetrachloro-ethane	0	0	0	0	0	0
Tetrachloroethylene	0	0	0	57,453	57,453	261
Toluene	5,290	5,290	39	0	0	0
Tribromomethane	0	0	0	0	0	0

* All units in lbs/year.

SAIC

Hazardous Constituents	Dyes and Pigments (ITD)			Dyes and Pigments (ISDB)		
	Raw	Current	After PSES	Raw	Current	After PSES
1,2,4-Trichloro-benzene	12,774	12,774	95	290	290	3
1,1,1-Trichloro-ethane	0	0	0	0	0	0
1,1,2-Trichloro-ethane	0	0	0	0	0	0
Trichloroethylene	20	20	17	0	0	0
Trichlorofluoro-methane	0	0	0	0	0	0
2,4,6-Trichloro-phenol	0	0	0	0	0	0
Vinyl Chloride	0	0	0	0	0	0
SUBTOTAL	454,308	454,308	185	956,940	956,940	569
Other Toxic Organics	0	0	0	0	0	0
TOTAL TOXIC ORGANICS	454,308	454,308	185	956,940	956,940	569
Other Hazardous Organics	N/A	N/A	N/A	25,132,003	25,132,003	299,055
TOTAL HAZARDOUS ORGANICS	454,308	454,308	185	26,088,943	26,088,943	299,624

Hazardous Constituents	Equipment Manufacture and Assembly			Explosive Manufacture		
	Raw	Current	After PSES	Raw	Current	After PSES
Trans-1,2-Dichloro-ethylene	N/A	N/A	N/A	0	0	0
1,2-Dichloropropane	N/A	N/A	N/A	0	0	0
Dichlorodifluoro-methane	N/A	N/A	N/A	0	0	0
2,4-Dichlorophenol	N/A	N/A	N/A	0	0	0
Diethyl Phthalate	N/A	N/A	N/A	0	0	0
2,4-Dimethylphenol	N/A	N/A	N/A	0	0	0
Dimethyl Phthalate	N/A	N/A	N/A	0	0	0
Di-N-Octyl Phthalate	N/A	N/A	N/A	0	0	0
Ethyl Benzene	N/A	N/A	N/A	0	0	0
Hexachloro-1,3-Butadiene	N/A	N/A	N/A	0	0	0
Hexachloroethane	N/A	N/A	N/A	0	0	0
Methylene Chloride	1,178,806	1,178,806	1,178,806	0	0	0
Naphthalene	N/A	N/A	N/A	0	0	0
N-Nitrosodimethyl Amine	N/A	N/A	N/A	0	0	0
Nitrobenzene	N/A	N/A	N/A	0	0	0
PCB	N/A	N/A	N/A	0	0	0
Pentachlorophenol	N/A	N/A	N/A	0	0	0
Phenol	N/A	N/A	N/A	3	3	3
1,1,2,2-Tetrachloro-ethane	N/A	N/A	N/A	0	0	0
Tetrachloroethylene	2,862,814	2,862,814	2,862,814	0	0	0
Toluene	505,202	505,202	505,202	0	0	0
Tribromomethane	N/A	N/A	N/A	0	0	0

SAIC

Hazardous Constituents	Equipment Manufacture and Assembly Raw	Equipment Manufacture and Assembly Current	Equipment Manufacture and Assembly After PSES	Explosive Manufacture Raw	Explosive Manufacture Current	Explosive Manufacture After PSES
1,2,4-Trichloro-benzene	N/A	N/A	N/A	0	0	0
1,1,1-Trichloro-ethane	8,420,041	8,420,041	8,420,041	0	0	0
1,1,2-Trichloro-ethane	N/A	N/A	N/A	0	0	0
Trichloroethylene	3,704,817	3,704,817	3,704,817	0	0	0
Trichlorofluoro-methane	N/A	N/A	N/A	0	0	0
2,4,6-Trichloro-phenol	N/A	N/A	N/A	0	0	0
Vinyl Chloride	N/A	N/A	N/A	0	0	0
SUBTOTAL	17,008,482	17,008,482	17,008,482	3	3	3
Other Toxic Organics	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL TOXIC ORGANICS	17,008,482	17,008,482	17,008,482	3	3	3
Other Hazardous Organics	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL HAZARDOUS ORGANICS	17,008,482	17,008,482	17,008,482	3	3	3

Hazardous Constituents	Gum and Wood Chemicals and Related Oils			Industrial and Commercial Laundries		
	Raw	Current	After PSES	Raw	Current	After PSES
Toxic Metals						
Antimony and Compounds	0	0	0	124,750	124,750	124,750
Arsenic and Compounds	125	125	125	12,200	12,200	12,200
Cadmium and Compounds	0	0	0	17,525	17,525	17,525
Chromium and Compounds	233	233	233	140,300	140,300	140,300
Cyanide	0	0	0	40,475	40,475	40,475
Lead and Compounds	137	137	137	911,425	705,175	705,175
Mercury and Compounds	0	0	0	1,725	1,725	1,725
Nickel and Compounds	2,866	2,866	2,866	50,050	50,050	50,050
Selenium and Compounds	12	12	12	3,500	3,500	3,500
Silver and Compounds	0	0	0	10,800	10,800	10,800
Other Hazardous Metals	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL HAZARDOUS METALS	3,373	3,373	3,373	1,312,750	1,106,560	1,106,500
Copper and Compounds	12,003	12,003	12,003	472,225	389,975	389,975
Zinc and Compounds	78,288	78,288	78,288	1,110,100	1,110,100	1,110,100
Other Toxic Metals	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL TOXIC METALS	93,664	93,664	93,664	2,895,075	2,606,575	2,606,575

Hazardous Constituents	Gum and Wood Chemicals and Related Oils			Industrial and Commercial Laundries		
	Raw	Current	After PSES	Raw	Current	After PSES
Toxic Organics						
Acrolein	0	0	0	0	0	0
Benzene	597	597	597	4,325	4,325	4,325
Bis(2-Chloro-ethoxy) Methane	0	0	0	0	0	0
Bis(2-Chloroethyl) Ether	0	0	0	0	0	0
Bis(2-Ethyl Hexyl) Phthalate	1,015	1,015	1,015	908,275	908,275	908,275
Bromomethane	0	0	0	0	0	0
Butyl Benzyl Phthalate	0	0	0	19,225	19,225	19,225
Carbon Tetrachloride	0	0	0	19,825	19,825	19,825
Chlorobenzene	0	0	0	0	0	0
p-Chloro-m-Cresol	0	0	0	0	0	0
Chloroethane	0	0	0	0	0	0
Chloroform	1,612	1,612	1,612	36,500	36,500	36,500
Chloromethane	0	0	0	0	0	0
2-Chloronapthalene	0	0	0	425	425	425
Di-N-Butyl Phthalate	0	0	0	24,450	24,450	24,450
1,2-Dichlorobenzene	0	0	0	12,950	12,950	12,950
1,3-Dichlorobenzene	0	0	0	0	0	0
1,4-Dichlorobenzene	0	0	0	12,950	12,950	12,950
1,1-Dichloroethane	0	0	0	0	0	0
1,2-Dichloroethane	0	0	0	0	0	0
1,1-Dichloroethylene	0	0	0	0	0	0

* All units in lbs/year.

Hazardous Constituents	Gum and Wood Chemicals and Related Oils			Industrial and Commercial Laundries		
	Raw	Current	After PSES	Raw	Current	After PSES
Trans-1,2-Dichloro-ethylene	0	0	0	0	0	0
1,2-Dichloropropane	0	0	0	0	0	0
Dichlorodifluoro-methane	0	0	0	0	0	0
2,4-Dichlorophenol	0	0	0	975	975	975
Diethyl Phthalate	0	0	0	3,575	3,575	3,575
2,4-Dimethylphenol	0	0	0	16,400	16,400	16,400
Dimethyl Phthalate	0	0	0	300	300	300
Di-N-Octyl Phthalate	0	0	0	20,325	20,325	20,325
Ethyl Benzene	50,640	50,640	50,640	439,600	439,600	439,600
Hexachloro-1,3-Butadiene	0	0	0	0	0	0
Hexachloroethane	0	0	0	0	0	0
Methylene Chloride	15,407	15,407	15,407	30,550	30,550	30,550
Naphthalene	0	0	0	284,925	284,925	284,925
N-Nitrosodimethyl Amine	0	0	0	0	0	0
Nitrobenzene	0	0	0	0	0	0
PCB	0	0	0	0	0	0
Pentachlorophenol	0	0	0	1,175	1,175	1,175
Phenol	16,482	16,482	16,482	24,675	24,675	24,675
1,1,2,2-Tetrachloro-ethane	0	0	0	0	0	0
Tetrachloroethylene	0	0	0	67,375	67,375	67,375
Toluene	26,156	26,156	26,156	154,700	154,700	154,700
Tribromomethane	0	0	0	0	0	0

SAIC

Hazardous Constituents	Gum and Wood Chemicals and Related Oils			Industrial and Commercial Laundries		
	Raw	Current	After PSES	Raw	Current	After PSES
1,2,4-Trichloro-benzene	0	0	0	0	0	0
1,1,1-Trichloro-ethane	490	490	490	78,475	78,475	78,475
1,1,2-Trichloro-ethane	0	0	0	0	0	0
Trichloroethylene	0	0	0	6,675	6,675	6,675
Trichlorofluoro-methane	0	0	0	50	50	50
2,4,6-Trichloro-phenol	0	0	0	0	0	0
Vinyl Chloride	0	0	0	0	0	0
SUBTOTAL	112,399	112,399	112,399	2,168,700	2,168,700	2,168,700
Other Toxic Organics	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL TOXIC ORGANICS	112,399	112,399	112,399	2,168,700	2,168,700	2,168,700
Other Hazardous Organics	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL HAZARDOUS ORGANICS	112,399	112,399	112,399	2,168,700	2,168,700	2,168,700

SAIC

Hazardous Constituents	Ink Manufacture and Formulation			Inorganic Chemicals Manufacturing		
	Raw	Current	After PSES	Raw	Current	After PSES
Toxic Metals						
Antimony and Compounds	3	3	3	61,726	61,726	61,726
Arsenic and Compounds	0	0	0	708	708	708
Cadmium and Compounds	1	1	1	46,892	11,733	11,733
Chromium and Compounds	1,391	1,391	1,391	1,694,072	74,391	74,391
Cyanide	6	6	6	56,095	56,095	56,095
Lead and Compounds	5,692	5,692	5,692	423,630	20,314	20,314
Mercury and Compounds	4	4	4	2,459	425	425
Nickel and Compounds	2	2	2	27,609	2,472	2,472
Selenium and Compounds	0	0	0	1,023	110	110
Silver and Compounds	0	0	0	53	53	53
Other Hazardous Metals	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL HAZARDOUS METALS	7,099	7,099	7,099	2,321,267	228,027	228,027
Copper and Compounds	837	837	837	106,921	78,697	78,697
Zinc and Compounds	145	145	145	546,566	15,387	15,387
Other Toxic Metals	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL TOXIC METALS	8,081	8,081	8,081	2,974,754	322,111	322,111

* All units in lbs/year.

Hazardous Constituents	Ink Manufacture and Formulation			Inorganic Chemicals Manufacturing		
	Raw	Current	After PSES	Raw	Current	After PSES
Toxic Organics						
Acrolein	0	0	0	0	0	0
Benzene	6	6	6	0	0	0
Bis(2-Chloro-ethoxy) Methane	0	0	0	0	0	0
Bis(2-Chloroethyl) Ether	0	0	0	0	0	0
Bis(2-Ethyl Hexyl) Phthalate	283	283	283	0	0	0
Bromomethane	0	0	0	0	0	0
Butyl Benzyl Phthalate	0	0	0	0	0	0
Carbon Tetrachloride	0	0	0	0	0	0
Chlorobenzene	1	1	1	0	0	0
p-Chloro-m-Cresol	0	0	0	0	0	0
Chloroethane	0	0	0	0	0	0
Chloroform	0	0	0	0	0	0
Chloromethane	0	0	0	0	0	0
2-Chloronapthalene	0	0	0	0	0	0
Di N-Butyl Phthalate	3	3	3	0	0	0
1,2-Dichlorobenzene	0	0	0	0	0	0
1,3-Dichlorobenzene	0	0	0	0	0	0
1,4-Dichlorobenzene	0	0	0	0	0	0
1,1-Dichloroethane	0	0	0	0	0	0
1,2-Dichloroethane	0	0	0	0	0	0
1,1-Dichloroethylene	0	0	0	0	0	0

* All units in lbs/year.

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Hazardous Constituents	Ink Manufacture and Formulation			Inorganic Chemicals Manufacturing		
	Raw	Current	After PSES	Raw	Current	After PSES
Trans-1,2-Dichloro-ethylene	0	0	0	0	0	0
1,2-Dichloropropane	0	0	0	0	0	0
Dichlorodifluoro-methane	0	0	0	0	0	0
2,4-Dichlorophenol	0	0	0	0	0	0
Diethyl Phthalate	0	0	0	0	0	0
2,4-Dimethylphenol	0	0	0	0	0	0
Dimethyl Phthalate	0	0	0	0	0	0
Di-N-Octyl Phthalate	2	2	2	0	0	0
Ethyl Benzene	16	16	16	0	0	0
Hexachloro-1,3-Butadiene	0	0	0	0	0	0
Hexachloroethane	0	0	0	0	0	0
Methylene Chloride	21	21	21	0	0	0
Naphthalene	0	0	0	0	0	0
N-Nitrosodimethyl Amine	0	0	0	0	0	0
Nitrobenzene	0	0	0	0	0	0
PCB	0	0	0	0	0	0
Pentachlorophenol	1	1	1	0	0	0
Phenol	1	1	1	0	0	0
1,1,2,2-Tetrachloro-ethane	0	0	0	0	0	0
Tetrachloroethylene	20	20	20	0	0	0
Toluene	52	52	52	0	0	0
Tribromomethane	0	0	0	0	0	0

* All units in lbs/year.

SAIC

Hazardous Constituents	Ink Manufacture and Formulation			Inorganic Chemicals Manufacturing		
	Raw	Current	After PSES	Raw	Current	After PSES
1,2,4-Trichloro- benzene	0	0	0	0	0	0
1,1,1-Trichloro- ethane	3	3	3	0	0	0
1,1,2-Trichloro- ethane	0	0	0	0	0	0
Trichloroethylene	20	20	20	0	0	0
Trichlorofluoro- methane	0	0	0	0	0	0
2,4,6-Trichloro- phenol	0	0	0	0	0	0
Vinyl Chloride	0	0	0	0	0	0
SUBTOTAL	429	429	429	0	0	0
Other Toxic Organics	7	7	7	N/A	N/A	N/A
TOTAL TOXIC ORGANICS	436	436	436	0	0	0
Other Hazardous Organics	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL HAZARDOUS ORGANICS	436	436	436	0	0	0

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Hazardous Constituents	Iron and Steel Manufacture and Forming			Leather Tanning and Finishing		
	Raw	Current	After PSES	Raw	Current	After PSES
Toxic Metals						
Antimony and Compounds	21,793	5,235	5,235	0	0	0
Arsenic and Compounds	56,276	14,235	14,235	0	0	0
Cadmium and Compounds	46,690	843	843	227	169	169
Chromium and Compounds	1,688,112	11,250	11,250	11,151,726	757,899	757,899
Cyanide	1,734,835	159,072	159,072	0	0	0
Lead and Compounds	2,588,733	7,990	7,990	78,896	63,270	63,270
Mercury and Compounds	422	8	8	34	24	24
Nickel and Compounds	2,488,303	14,425	14,425	6,286	5,057	5,057
Selenium and Compounds	14,600	1,202	1,202	0	0	0
Silver and Compounds	2,720	345	345	0	0	0
Other Hazardous Metals	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL HAZARDOUS METALS	8,642,484	214,605	214,605	11,237,169	826,419	826,419
Copper and Compounds	1,848,514	5,662	5,662	9,051	7,462	7,462
Zinc and Compounds	11,257,861	21,110	21,110	41,868	33,360	33,360
Other Toxic Metals	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL TOXIC METALS	21,748,859	241,377	241,377	11,288,088	867,241	867,241

SAIC

Hazardous Constituents	Iron and Steel Manufacture and Forming Raw	Current	After PSES	Leather Tanning and Finishing Raw	Current	After PSES
Toxic Organics						
Acrolein	0	0	0	0	0	0
Benzene	540,015	99,138	99,138	518	369	369
Bis(2-Chloro-ethoxy) Methane	0	0	0	0	0	0
Bis(2-Chloroethyl) Ether	0	0	0	0	0	0
Bis(2-Ethyl Hexyl) Phthalate	0	0	0	4,189	3,421	3,421
Bromomethane	0	0	0	0	0	0
Butyl Benzyl Phthalate	832	0	0	0	0	0
Carbon Tetrachloride	0	0	0	0	0	0
Chlorobenzene	0	0	0	1	1	1
p-Chloro-m-Cresol	9,258	1,488	1,488	0	0	0
Chloroethane	0	0	0	0	0	0
Chloroform	5,695	2,098	2,098	298	251	251
Chloromethane	0	0	0	0	0	0
2-Chloronapthalene	0	0	0	5	4	4
Di-N-Butyl Phthalate	0	0	0	81	72	72
1,2-Dichlorobenzene	0	0	0	16,674	13,239	13,239
1,3-Dichlorobenzene	0	0	0	164	115	115
1,4 Dichlorobenzene	0	0	0	3,565	2,800	2,800
1,1-Dichloroethane	5	5	5	0	0	0
1,2-Dichloroethane	0	0	0	151	151	151
1,1 Dichloroethylene	0	0	0	3	3	3

* All units in lbs/year.

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Hazardous Constituents	Iron and Steel Manufacture and Forming			Leather Tanning and Finishing		
	Raw	Current	After PSES	Raw	Current	After PSES
Trans-1,2-Dichloroethylene	0	0	0	1,803	1,445	1,445
1,2-Dichloropropane	0	0	0	0	0	0
Dichlorodifluoromethane	0	0	0	0	0	0
2,4-Dichlorophenol	3,025	35	35	132	110	110
Diethyl Phthalate	0	0	0	32	29	29
2,4-Dimethylphenol	107,689	9,950	9,950	739	664	664
Dimethyl Phthalate	0	0	0	6,629	5,241	5,241
Di-N-Octyl Phthalate	0	0	0	0	0	0
Ethyl Benzene	46,288	7,932	7,932	9,745	8,000	8,000
Hexachloro-1,3-Butadiene	0	0	0	0	0	0
Hexachloroethane	0	0	0	0	0	0
Methylene Chloride	0	0	0	291	271	271
Naphthalene	463,515	49,575	49,575	13,534	10,083	10,083
N-Nitrosodimethyl Amine	0	0	0	0	0	0
Nitrobenzene	0	0	0	23,869	18,872	18,872
PCB	0	0	0	0	0	0
Pentachlorophenol	2,424	798	798	17,051	12,137	12,137
Phenol	4,417,700	297,520	297,520	288,34[illegible]	227,278	227,278
1,1,2,2-Tetrachloroethane	0	0	0	43	43	43
Tetrachloroethylene	15	15	15	6,420	5,116	5,116
Toluene	385,730	49,572	49,572	7,294	5,861	5,861
Tribromomethane	0	0	0	0	0	0

* All units in lbs/year.

Hazardous Constituents	Iron and Steel Manufacture and Forming			Leather Tanning and Finishing		
	Raw	Current	After PSES	Raw	Current	After PSES
1,2,4-Trichloro-benzene	0	0	0	13	11	11
1,1,1-Trichloro-ethane	28	28	28	114	102	102
1,1,2-Trichloro-ethane	0	0	0	9	8	8
Trichloroethylene	1,612	1,608	1,608	1,273	1,029	1,029
Trichlorofluoro-methane	0	0	0	0	0	0
2,4,6-Trichloro-phenol	1,542	498	498	59,663	45,318	45,318
Vinyl Chloride	0	0	0	0	0	0
SUBTOTAL	5,985,373	320,260	320,260	462,644	362,044	362,044
Other Toxic Organics	225,084	39,640	39,640	N/A	N/A	N/A
TOTAL TOXIC ORGANICS	6,210,457	359,900	359,900	462,644	362,044	362,044
Other Hazardous Organics	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL HAZARDOUS ORGANICS	6,210,457	359,900	359,900	462,644	362,044	362,044

Hazardous Constituents	Nonferrous Metals Forming			Nonferrous Metals Manufacturing		
	Raw	Current	After PSES	Raw	Current	After PSES
Toxic Metals						
Antimony and Compounds	36	26	26	15,506	516	516
Arsenic and Compounds	56	56	56	23,244	594	594
Cadmium and Compounds	1,921	151	151	30,99[illegible]	102	102
Chromium and Compounds	244,810	453	453	15,894	135	135
Cyanide	[illegible]2,657	328	328	401	401	401
Lead and Compounds	11,916	740	740	146,949	198	198
Mercury and Compounds	0	0	0	63	12	12
Nickel and Compounds	184,771	2,393	2,393	17,665	385	385
Selenium and Compounds	552	65	65	1,270	76	76
Silver and Compounds	23	18	18	250	110	110
Other Hazardous Metals	N/A	N/A	N/A	628	406	406
TOTAL HAZARDOUS METALS	446,742	4,230	4,230	25[illegible],863	2,935	2,935
Copper and Compounds	125,185	3,305	3,305	17,376	742	742
Zinc and Compounds	131,133	4,218	4,218	[illegible],548,308	789	789
Other Toxic Metals	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL TOXIC METALS	703,060	11,753	11,753	[illegible],817,547	4,466	4,466

Hazardous Constituents	Nonferrous Metals Forming			Nonferrous Metals Manufacturing		
	Raw	Current	After PSES	Raw	Current	After PSES
Toxic Organics						
Acrolein	N/A	N/A	N/A	0	0	0
Benzene	N/A	N/A	N/A	19	19	19
Bis(2-Chloro-ethoxy) Methane	N/A	N/A	N/A	0	0	0
Bis(2-Chloroethyl) Ether	N/A	N/A	N/A	0	0	0
Bis(2-Ethyl Hexyl) Phthalate	N/A	N/A	N/A	4,753	697	697
Bromomethane	N/A	N/A	N/A	0	0	0
Butyl Benzyl Phthalate	N/A	N/A	N/A	289	39	39
Carbon Tetrachloride	N/A	N/A	N/A	68	65	65
Chlorobenzene	N/A	N/A	N/A	12	9	9
P-Chloro-m-Cresol	N/A	N/A	N/A	1,131	55	55
Chloroethane	N/A	N/A	N/A	0	0	0
Chloroform	N/A	N/A	N/A	226	219	219
Chloromethane	N/A	N/A	N/A	0	0	0
2-Chloronapthalene	N/A	N/A	N/A	0	0	0
Di-N-Butyl Phthalate	N/A	N/A	N/A	75	75	75
1,2-Dichlorobenzene	N/A	N/A	N/A	0	0	0
1,3-Dichlorobenzene	N/A	N/A	N/A	1	1	1
1,4-Dichlorobenzene	N/A	N/A	N/A	2	2	2
1,1-Dichloroethane	N/A	N/A	N/A	3	2	2
1,2-Dichloroethane	N/A	N/A	N/A	22	20	20
1,1-Dichloroethylene	N/A	N/A	N/A	66	66	66

* All units in lbs/year.

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Hazardous Constituents	Nonferrous Metals Forming Raw	Nonferrous Metals Forming Current	Nonferrous Metals Forming After PSES	Nonferrous Metals Manufacturing Raw	Nonferrous Metals Manufacturing Current	Nonferrous Metals Manufacturing After PSES
Trans-1,2-Dichloro-ethylene	N/A	N/A	N/A	17	17	17
1,2-Dichloropropane	N/A	N/A	N/A	0	0	0
Dichlorodifluoro-methane	N/A	N/A	N/A	0	0	0
2,4-Dichlorophenol	N/A	N/A	N/A	719	30	30
Diethyl Phthalate	N/A	N/A	N/A	7	7	7
2,4-Dimethylphenol	N/A	N/A	N/A	0	0	0
Dimethyl Phthalate	N/A	N/A	N/A	45	45	45
Di-N-Octyl Phthalate	N/A	N/A	N/A	34	34	34
Ethyl Benzene	N/A	N/A	N/A	7	7	7
Hexachloro-1,3-Butadiene	N/A	N/A	N/A	0	0	0
Hexachloroethane	N/A	N/A	N/A	183	183	183
Methylene Chloride	N/A	N/A	N/A	718	685	685
Naphthalene	N/A	N/A	N/A	1,037	167	167
N-Nitrosodimethyl Amine	N/A	N/A	N/A	0	0	0
Nitrobenzene	N/A	N/A	N/A	3	3	3
PCB	N/A	N/A	N/A	6	6	6
Pentachlorophenol	N/A	N/A	N/A	11	0	0
Phenol	N/A	N/A	N/A	9,253	57	57
1,1,2,2-Tetrachloro-ethane	N/A	N/A	N/A	0	0	0
Tetrachloroethylene	N/A	N/A	N/A	563	36	36
Toluene	N/A	N/A	N/A	8	8	8
Tribromomethane	N/A	N/A	N/A	7	7	7

* All units in lbs/year.

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Hazardous Constituents	Nonferrous Metals Forming			Nonferrous Metals Manufacturing		
	Raw	Current	After PSES	Raw	Current	After PSES
1,2,4-Trichloro- benzene	N/A	N/A	N/A	4	4	4
1,1,1-Trichloro- ethane	N/A	N/A	N/A	187	2	2
1,1,2-Trichloro- ethane	N/A	N/A	N/A	16	16	16
Trichloroethylene	N/A	N/A	N/A	50	47	47
Trichlorofluoro- methane	N/A	N/A	N/A	1	1	1
2,4,6-Trichloro- phenol	N/A	N/A	N/A	1,188	23	23
Vinyl Chloride	N/A	N/A	N/A	0	0	0
SUBTOTAL	0	0	0	20,731	2,654	2,654
Other Toxic Organics	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL TOXIC ORGANICS	0	0	0	20,731	2,654	2,654
Other Hazardous Organics	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL HAZARDOUS ORGANICS	0	0	0	20,731	2,654	2,654

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Hazardous Constituents	Organic Chemicals Manufacturing (ITD)			Organic Chemicals Manufacturing (ISDB)		
	Raw	Current	After PSES	Raw	Current	After PSES
Toxic Metals						
Antimony and Compounds	4,456	4,247	1,953	0	0	0
Arsenic and Compounds	3,195	2,960	374	1,610,298	1,491,857	189,506
Cadmium and Compounds	4,499	4,185	906	0	0	0
Chromium and Compounds	91,647	81,968	2,559	1,893,158	1,693,218	52,861
Cyanide	1,852,332	1,764,303	320	1,631,496	1,553,962	282
Lead and Compounds	205,176	178,137	749	1,610,298	1,398,086	5,878
Mercury and Compounds	56	53	14	0	0	0
Nickel and Compounds	10,191	9,675	1,196	1,611,451	1,529,859	189,117
Selenium and Compounds	78,345	71,249	1,573	1,610,298	1,464,448	32,331
Silver and Compounds	1,786	1,689	738	1,610,298	1,522,841	665,397
Other Hazardous Metals	589	586	571	1,610,298	1,538,975	80,514
TOTAL HAZARDOUS METALS	2,252,272	2,119,052	10,953	13,187,595	12,193,246	1,215,886
Copper and Compounds	518,784	468,962	1,784	1,830,396	1,654,612	6,924
Zinc and Compounds	72,734	71,410	2,819	1,610,303	1,580,990	62,411
Other Toxic Metals	0	0	0	0	0	0
TOTAL TOXIC METALS	2,843,790	2,659,424	15,557	16,628,294	15,428,848	1,285,221

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Hazardous Constituents	Organic Chemicals Manufacturing (TTB)			Organic Chemicals Manufacturing (ISDB)		
	Raw	Current	After PSES	Raw	Current	After PSES
Toxic Organics						
Acrolein	1,658,891	1,579,304	244	52	50	0
Benzene	363,019	352,533	594	2,345,107	2,277,445	3,837
Bis(2-Chloro- ethoxy) Methane	0	0	0	0	0	0
Bis(2-Chloroethyl) Ether	0	0	0	0	0	0
Bis(2-Ethyl Hexyl) Phthalate	36,854	32,029	669	1,610,303	1,488,027	286
Bromomethane	0	0	0	851	813	1
Butyl Benzyl Phthalate	396	387	330	1,610,298	1,478,255	1,341,915
Carbon Tetrachloride	38,278	34,633	120	214,104	192,811	668
Chlorobenzene	2,725	2,342	87	4	3	1
p-Chloro-m-Cresol	0	0	0	0	0	0
Chloroethane	16,936	15,173	111	0	0	0
Chloroform	13,156	12,487	393	1,819,043	1,726,542	54,339
Chloromethane	17,519	16,475	231	29,835	26,968	393
2-Chloronapthalene	53	53	0	0	0	0
Di-N-Butyl Phthalate	272	269	246	1	1	0
1,2-Dichlorobenzene	1,259	1,090	90	291	252	4
1,3-Dichlorobenzene	1,042	906	90	0	0	0
1,4-Dichlorobenzene	798	696	90	0	0	0
1,1-Dichloroethane	18,202	16,475	361	0	0	0
1,2-Dichloroethane	37,516	35,974	616	0	0	0
1,1-Dichloroethylene	7,517	6,784	212	0	0	0

* All units in lbs/year.

Hazardous Constituents	Organic Chemicals Manufacturing (ITD)			Organic Chemicals Manufacturing (ISDB)		
	Raw	Current	After PSES	Raw	Current	After PSES
Trans-1,2-Dichloroethylene	664	610	118	0	0	0
1,2-Dichloropropane	222,815	201,709	469	0	0	0
Dichlorodifluoromethane	0	0	0	0	0	0
2,4-Dichlorophenol	259	237	94	0	0	0
Diethyl Phthalate	1,676	1,502	404	7	7	2
2,4-Dimethylphenol	1,428,163	1,224,205	158	0	0	0
Dimethyl Phthalate	1,125	1,006	235	0	0	0
Di-N-Octyl Phthalate	0	0	0	0	0	0
Ethyl Benzene	256,189	246,519	394	1,657,043	1,594,497	2,548
Hexachloro-1,3-Butadiene	0	0	0	0	0	0
Hexachloroethane	0	0	0	0	0	0
Methylene Chloride	8,439	8,198	373	208,309	179,037	9,207
Naphthalene	73,291	71,142	463	1,610,298	1,563,082	10,151
N-Nitrosodimethyl Amine	0	0	0	0	0	0
Nitrobenzene	119,488	108,504	137	0	0	0
PCB	0	0	0	0	0	0
Pentachlorophenol	117	116	75	0	0	0
Phenol	4,884,051	4,783,110	720	5,480,972	5,367,694	808
1,1,2,2-Tetrachloroethane	0	0	0	2	2	0
Tetrachloroethylene	565	524	182	208,132	193,029	67,044
Toluene	779,123	767,668	1,350	2,875,877	2,833,595	4,983
Tribromomethane	0	0	0	0	0	0

* All units in lbs/year

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Hazardous Constituents	Organic Chemicals Manufacturing (ITD)			Organic Chemicals Manufacturing (ISDB)		
	Raw	Current	After PSES	Raw	Current	After PSES
1,2,4-Trichloro-benzene	11,298	9,731	97	0	0	0
1,1,1-Trichloro-ethane	328	315	175	0	0	0
1,1,2-Trichloro-ethane	173,245	157,540	141	302,522	275,098	246
Trichloroethylene	11,193	10,303	190	0	0	0
Trichlorofluoro-methane	0	0	0	0	0	0
2,4,6-Trichloro-phenol	209	196	119	0	0	0
Vinyl Chloride	13,411	13,033	242	20,333	19,760	367
SUBTOTAL	10,200,082	9,713,778	10,615	19,992,464	19,216,968	1,496,800
Other Toxic Organics	3,176,359	3,128,609	3,363	15,128,363	14,218,687	368,576
TOTAL TOXIC ORGANICS	13,376,441	12,842,387	13,978	35,120,827	33,435,655	1,865,376
Other Hazardous Organics	N/A	N/A	N/A	30,684,157	29,325,096	2,195,055
TOTAL HAZARDOUS ORGANICS	13,376,441	12,842,387	13,978	65,804,984	62,760,751	4,060,431

SAIC

Hazardous Constituents	Organic Chemicals Mfg., Plas., Resins & Syn Fibers (TSDB) Raw	Current	After PSES	Organic Chemicals Mfg., Plas., Resins & Syn Fibers (ITD) Raw	Current	After PSES
Toxic Metals						
Antimony and Compounds	0	0	0	2,290	2,278	370
Arsenic and Compounds	0	0	0	3,226	3,204	80
Cadmium and Compounds	0	0	0	2,187	2,172	177
Chromium and Compounds	257,062	257,062	14,783	16,408	15,963	918
Cyanide	2,132	2,131	10	8,359	8,356	38
Lead and Compounds	0	0	0	20,71[illegible]	20,489	280
Mercury and Compounds	0	0	0	70	70	5
Nickel and Compounds	0	0	0	60,016	59,795	1,246
Selenium and Compounds	0	0	0	1,483	1,193	299
Silver and Compounds	0	0	0	1,039	1,032	139
Other Hazardous Metals	6,299	6,299	5,144	371	371	303
TOTAL HAZARDOUS METALS	265,493	265,492	19,937	116,160	114,923	3,855
Copper and Compounds	0	0	0	55,879	35,281	534
Zinc and Compounds	36,395	35,998	1,706	45,729	44,609	2,114
Other Toxic Metals	0	0	0	0	0	0
TOTAL TOXIC METALS	301,888	301,490	21,643	217,768	214,813	6,503

SAIC

Hazardous Constituents	Organic Chemicals Mfs. Plas., Resins & Syn Fibers (ISOB) Raw	Current	After PSES	Organic Chemicals Mfs. Plas., Resins & Syn Fibers (IID) Raw	Current	After PSES
Toxic Organics						
Acrolein	5	5	0	66,415	64,622	58
Benzene	618,498	590,567	10,614	12,179	11,629	209
Bis(2-Chloro-ethoxy) Methane	0	0	0	0	0	0
Bis(2-Chloroethyl) Ether	0	0	0	0	0	0
Bis(2-Ethyl Hexyl) Phthalate	0	0	0	3,807	3,564	541
Bromomethane	0	0	0	0	0	0
Butyl Benzyl Phthalate	0	0	0	0	0	0
Carbon Tetrachloride	0	0	0	2,330	2,310	17
Chlorobenzene	0	0	0	0	0	0
p-Chloro-m-Cresol	0	0	0	0	0	0
Chloroethane	0	0	0	0	0	0
Chloroform	0	0	0	245	245	43
Chloromethane	0	0	0	205	205	7
2-Chloronapthalene	0	0	0	0	0	0
Di-N-Butyl Phthalate	0	0	0	0	0	0
1,2-Dichlorobenzene	0	0	0	0	0	0
1,3-Dichlorobenzene	0	0	0	0	0	0
1,4-Dichlorobenzene	0	0	0	0	0	0
1,1-Dichloroethane	0	0	0	13,624	12,483	26
1,2-Dichloroethane	0	0	0	750	748	28
1,1-Dichloroethylene	0	0	0	0	0	0

* All units in lbs/year.

Hazardous Constituents	Organic Chemicals Mfg. Plas., Resins & Syn Fibers (ISDB) Raw	Current	After PSES	Organic Chemicals Mfg. Plas., Resins & Syn Fibers (ITD) Raw	Current	After PSES
Trans-1,2-Dichloro-ethylene	0	0	0	0	0	0
1,2-Dichloropropane	0	0	0	6,027	6,027	58
Dichlorodifluoro-methane	0	0	0	0	0	0
2,4-Dichlorophenol	0	0	0	0	0	0
Diethyl Phthalate	0	0	0	0	0	0
2,4-Dimethylphenol	0	0	0	0	0	0
Dimethyl Phthalate	0	0	0	0	0	0
Di-N-Octyl Phthalate	0	0	0	0	0	0
Ethyl Benzene	618,498	596,805	7,670	15,482	14,939	192
Hexachloro-1,3-Butadiene	0	0	0	0	0	0
Hexachloroethane	0	0	0	0	0	0
Methylene Chloride	0	0	0	106	103	33
Naphthalene	0	0	0	2,269	2,183	47
N-Nitrosodimethyl Amine	0	0	0	0	0	0
Nitrobenzene	0	0	0	672	672	1
PCB	0	0	0	0	0	0
Pentachlorophenol	0	0	0	0	0	0
Phenol	16,857,051	16,253,619	726	4,529,707	4,367,558	195
1,1,2,2-Tetrachloro-ethane	0	0	0	0	0	0
Tetrachloroethylene	0	0	0	0	0	0
Toluene	621,012	396,395	2,322	167,266	68,468	401
Tribromomethane	0	0	0	0	0	0

* All units in lbs/year.

SAIC

Hazardous Constituents	Organic Chemicals Mfs. Plas., Resins & Syn Fibers (ISBB)			Organic Chemicals Mfs. Plas., Resins & Syn Fibers (ITB)		
	Raw	Current	After PSES	Raw	Current	After PSES
1,2,4-Trichloro-benzene	0	0	0	744	736	9
1,1,1-Trichloro-ethane	0	0	0	220	219	25
1,1,2-Trichloro-ethane	0	0	0	2,125	2,125	7
Trichloroethylene	0	0	0	996	994	22
Trichlorofluoro-methane	0	0	0	0	0	0
2,4,6-Trichloro-phenol	0	0	0	0	0	0
Vinyl Chloride	20,333	20,332	108	15,479	15,478	82
SUBTOTAL	18,735,397	17,857,723	21,440	4,779,648	4,575,308	2,001
Other Toxic Organics	34,542	34,542	853	70,040	67,503	85
TOTAL TOXIC ORGANICS	18,769,939	17,892,265	22,293	4,849,688	4,642,811	2,086
Other Hazardous Organics	22,460,906	13,043,436	1,966,267	N/A	N/A	N/A
TOTAL HAZARDOUS ORGANICS	41,230,845	30,935,701	1,928,560	4,849,688	4,642,811	2,086

SAIC

Hazardous Constituents	Paint Manufacture and Formulation			Pesticides Manufacture & Formulation (Manufacture Only TTO)		
	Raw	Current	After PSES	Raw	Current	After PSES
Toxic Metals						
Antimony and Compounds	77	68	68	N/A	0	0
Arsenic and Compounds	176	148	148	N/A	0	0
Cadmium and Compounds	1,246	1,047	1,047	N/A	0	0
Chromium and Compounds	10,794	9,628	9,628	N/A	0	0
Cyanide	193	172	172	N/A	3,049	57
Lead and Compounds	22,201	18,205	18,205	N/A	0	0
Mercury and Compounds	1,353	1,115	1,115	N/A	0	0
Nickel and Compounds	2,015	1,705	1,705	N/A	0	0
Selenium and Compounds	4	3	3	N/A	0	0
Silver and Compounds	0	0	0	N/A	0	0
Other Hazardous Metals	1	1	1	N/A	0	0
TOTAL HAZARDOUS METALS	38,060	32,092	32,092	0	3,049	57
Copper and Compounds	2,791	2,406	2,406	N/A	0	0
Zinc and Compounds	137,328	112,609	112,609	N/A	60,442	86
Other Toxic Metals	173	156	156	N/A	0	0
TOTAL TOXIC METALS	178,352	147,263	147,263	N/A	63,491	143

* All units in lbs/year.

Hazardous Constituents	Paint Manufacture and Formulation			Pesticides Manufacture & Formulation (Manufacture Only TTO)		
	Raw	Current	After PSES	Raw	Current	After PSES
Toxic Organics						
Acrolein	0	0	0	N/A	0	0
Benzene	630	548	548	N/A	1,505,628	90
Bis(2-Chloro-ethoxy) Methane	0	0	0	N/A	0	0
Bis(2-Chloroethyl) Ether	0	0	0	N/A	0	0
Bis(2-Ethyl Hexyl) Phthalate	748	603	603	N/A	0	0
Bromomethane	0	0	0	N/A	160	0
Butyl Benzyl Phthalate	23	23	23	N/A	0	0
Carbon Tetrachloride	16	13	13	N/A	4,569	13
Chlorobenzene	18	18	18	N/A	674,039	67
p-Chloro-m-Cresol	0	0	0	N/A	0	0
Chloroethane	0	0	0	N/A	0	0
Chloroform	39	34	34	N/A	213	3
Chloromethane	0	0	0	N/A	9,806	33
2-Chloronapthalene	0	0	0	N/A	0	0
Di N-Butyl Phthalate	2,323	1,863	1,863	N/A	0	0
1,2-Dichlorobenzene	0	0	0	N/A	8,306	8
1,3-Dichlorobenzene	0	0	0	N/A	0	0
1,4-Dichlorobenzene	0	0	0	N/A	13,369	10
1,1-Dichloroethane	0	0	0	N/A	0	0
1,2-Dichloroethane	7	6	6	N/A	3,308	549
1,1-Dichloroethylene	1	1	1	N/A	0	0

* All units in lbs/year.

Hazardous Constituents	Paint Manufacture and Formulation Raw	Current	After PSES	Pesticides Manufacture & Formulation (Manufacture Only TTD) Raw	Current	After PSES
Trans-1,2-Dichloro-ethylene	6	6	6	N/A	0	0
1,2-Dichloropropane	2	2	2	N/A	0	0
Dichlorodifluoro-methane	0	0	0	N/A	0	0
2,4-Dichlorophenol	11	11	11	N/A	12,596	9
Diethyl Phthalate	23	23	23	N/A	0	0
2,4-Dimethylphenol	0	0	0	N/A	0	0
Dimethyl Phthalate	0	0	0	N/A	0	0
Di-N-Octyl Phthalate	0	0	0	N/A	0	0
Ethyl Benzene	35,753	30,033	30,033	N/A	0	0
Hexachloro-1,3-Butadiene	0	0	0	N/A	0	0
Hexachloroethane	0	0	0	N/A	0	0
Methylene Chloride	30,098	26,366	26,366	N/A	63,250	104
Naphthalene	640	550	550	N/A	0	0
N-Nitrosodimethyl Amine	0	0	0	N/A	0	0
Nitrobenzene	3	3	3	N/A	0	0
PCB	0	0	0	N/A	0	0
Pentachlorophenol	760	760	760	N/A	2	1
Phenol	94	94	94	N/A	40,163	7
1,1,2,2-Tetrachloro-ethane	1	1	1	N/A	0	0
Tetrachloroethylene	420	338	338	N/A	0	0
Toluene	35,175	29,969	29,969	N/A	800,526	65
Tribromomethane	0	0	0	N/A	0	0

* All units in lbs/year.

Hazardous Constituents	Paint Manufacture and Formulation			Pesticides Manufacture & Formulation (Manufacture Only ITD)		
	Raw	Current	After PSES	Raw	Current	After PSES
1,2,4-Trichloro-benzene	0	0	0	N/A	0	0
1,1,1-Trichloro-ethane	188	177	177	N/A	0	0
1,1,2-Trichloro-ethane	6	5	5	N/A	0	0
Trichloroethylene	88	86	86	N/A	0	0
Trichlorofluoro-methane	0	0	0	N/A	0	0
2,4,6-Trichloro-phenol	116	116	116	N/A	0	0
Vinyl Chloride	0	0	0	N/A	0	0
SUBTOTAL	107,189	91,649	91,649	N/A	3,135,935	959
Other Toxic Organics	104	104	104	N/A	8,07[illegible]	49
TOTAL TOXIC ORGANICS	107,293	91,753	91,753	N/A	3,144,006	1,008
Other Hazardous Organics	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL HAZARDOUS ORGANICS	107,293	91,753	91,753	N/A	3,144,006	1,008

Hazardous Constituents	Pesticides Manufacture & Formulation (Formulation Only TTO) Raw	Current	After PSES	Pesticides Manufacture & Formulation (Manufacture Only TSDR) Raw	Current	After PSES
Toxic Metals						
Antimony and Compounds	N/A	0	0	0	0	0
Arsenic and Compounds	N/A	0	0	165	165	3
Cadmium and Compounds	N/A	0	0	0	0	0
Chromium and Compounds	N/A	0	0	244,015	244,015	4,636
Cyanide	N/A	0	0	249	249	5
Lead and Compounds	N/A	0	0	23	23	0
Mercury and Compounds	N/A	0	0	26,773	26,773	509
Nickel and Compounds	N/A	0	0	239,975	239,975	4,559
Selenium and Compounds	N/A	0	0	1	1	0
Silver and Compounds	N/A	0	0	0	0	0
Other Hazardous Metals	N/A	N/A	N/A	1,147	1,147	22
TOTAL HAZARDOUS METALS	0	0	0	512,348	512,348	9,734
Copper and Compounds	N/A	0	0	106,132	106,132	149
Zinc and Compounds	N/A	0	0	9,725	9,725	14
Other Toxic Metals	N/A	0	0	0	0	0
TOTAL TOXIC METALS	N/A	0	0	628,205	628,205	9,897

* All units in lb/yr

SAIC

Hazardous Constituents	Pesticides Manufacture & Formulation (Formulation Only ITD)			Pesticides Manufacture & Formulation (Manufacture Only TSDR)		
	Raw	Current	After PSES	Raw	Current	After PSES
Toxic Organics						
Acrolein	N/A	0	0	0	0	0
Benzene	N/A	0	0	1,194	1,194	0
Bis(2-Chloro- ethoxy) Methane	N/A	0	0	0	0	0
Bis(2-Chloroethyl) Ether	N/A	0	0	0	0	0
Bis(2-Ethyl Hexyl) Phthalate	N/A	0	0	0	0	0
Bromomethane	N/A	0	0	0	0	0
Butyl Benzyl Phthalate	N/A	0	0	0	0	0
Carbon Tetrachloride	N/A	5	0	1,867	1,867	5
Chlorobenzene	N/A	0	0	0	0	0
P Chloro-m-Cresol	N/A	0	0	0	0	0
Chloroethane	N/A	0	0	0	0	0
Chloroform	N/A	0	0	17	17	0
Chloromethane	N/A	0	0	262	262	1
2-Chloronapthalene	N/A	0	0	0	0	0
Di-N-Butyl Phthalate	N/A	0	0	0	0	0
1,2-Dichlorobenzene	N/A	0	0	1,147	1,147	1
1,3-Dichlorobenzene	N/A	0	0	0	0	0
1,4 Dichlorobenzene	N/A	0	0	0	0	0
1,1-Dichloroethane	N/A	0	0	0	0	0
1,2-Dichloroethane	N/A	0	0	5	5	1
1,1 Dichloroethylene	N/A	14	0	0	0	0

* All units in lbs/year.

SAIC

Hazardous Constituents	Pesticides Manufacture & Formulation (Formulation Only ITD)			Pesticides Manufacture & Formulation (Manufacture Only TSDR)		
	Raw	Current	After PSES	Raw	Current	After PSES
Trans-1,2-Dichloro-ethylene	N/A	0	0	0	0	0
1,2-Dichloropropane	N/A	0	0	0	0	0
Dichlorodifluoro-methane	N/A	0	0	0	0	0
2,4-Dichlorophenol	N/A	0	0	9,464	9,464	7
Diethyl Phthalate	N/A	0	0	0	0	0
2,4-Dimethylphenol	N/A	0	0	0	0	0
Dimethyl Phthalate	N/A	0	0	0	0	0
Di-N-Octyl Phthalate	N/A	0	0	0	0	0
Ethyl Benzene	N/A	2	0	109	109	0
Hexachloro-1,3-Butadiene	N/A	0	0	0	0	0
Hexachloroethane	N/A	0	0	0	0	0
Methylene Chloride	N/A	0	0	14,338	14,338	24
Naphthalene	N/A	0	0	0		0
N-Nitrosodimethyl Amine	N/A	0	0	0	0	0
Nitrobenzene	N/A	0	0	0	0	0
PCB	N/A	0	0	0	0	0
Pentachlorophenol	N/A	0	0	0	0	0
Phenol	N/A	0	0	1,411	1,411	0
1,1,2,2-Tetrachloro-ethane	N/A	0	0	0	0	0
Tetrachloroethylene	N/A	0	0	56,947	56,947	5
Toluene	N/A	0	0	632,843	632,843	63
Tribromomethane	N/A	0	0	0	0	0

* All units [illegible]

SAIC

Hazardous Constituents	Pesticides Manufacture & Formulation (Formulation Only ITD)			Petroleum Refining		
	Raw	Current	After PSES	Raw	Current	After PSES
1,2,4-Trichloro-benzene	N/A	0	0	0	0	0
1,1,1-Trichloro-ethane	N/A	315	0	0	0	0
1,1,2-Trichloro-ethane	N/A	0	0	0	0	0
Trichloroethylene	N/A	0	0	0	0	0
Trichlorofluoro-methane	N/A	0	0	0	0	0
2,4,6-Trichloro-phenol	N/A	0	0	78	78	0
Vinyl Chloride	N/A	0	0	0	0	0
SUBTOTAL	N/A	336	0	719,682	719,682	107
Other Toxic Organics	N/A	0	0	461,222	461,222	486
TOTAL TOXIC ORGANICS	N/A	336	0	1,180,904	1,180,904	593
Other Hazardous Organics	N/A	N/A	N/A	61,849,698	61,849,698	2,352,080
TOTAL HAZARDOUS ORGANICS	N/A	336	0	63,030,602	63,030,602	2,352,673

Hazardous Constituents	Petroleum Refining			Pharmaceutical Manufacturing		
	Raw	Current	After PSES	Raw	Current	After PSES
Toxic Metals						
Antimony and Compounds	0	0	0	4,530	4,530	4,530
Arsenic and Compounds	5,041	5,041	5,041	2,920	2,920	2,920
Cadmium and Compounds	0	0	0	2,517	2,517	2,517
Chromium and Compounds	296,020	296,020	296,020	11,779	11,779	11,779
Cyanide	707,424	707,424	707,424	10,008,000	26,271	26,271
Lead and Compounds	5,041	5,041	5,041	11,980	11,980	11,980
Mercury and Compounds	280	280	280	393	393	393
Nickel and Compounds	560	560	560	10,369	10,369	10,369
Selenium and Compounds	53,771	53,771	53,771	3,121	3,121	3,121
Silver and Compounds	0	0	0	3,222	3,222	3,222
Other Hazardous Metals	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL HAZARDOUS METALS	1,068,137	1,068,137	1,068,137	10,058,831	77,102	77,102
Copper and Compounds	5,881	5,881	5,881	57,485	57,485	57,485
Zinc and Compounds	46,770	46,770	46,770	36,545	36,545	36,545
Other Toxic Metals	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL TOXIC METALS	1,120,788	1,120,788	1,120,788	10,152,861	171,132	171,132

SAIC

Hazardous Constituents	Coal, Oil, Petroleum Products ~~Petroleum Refining~~ and Refining Raw	Current	After PSES	Pharmaceutical Manufacturing Raw	Current	After PSES
Toxic Organics						
Acrolein	0	0	0	0	0	0
Benzene	228,807	228,807	228,807	542,726	542,726	542,726
Bis(2-Chloro-ethoxy) Methane	0	0	0	0	0	0
Bis(2-Chloroethyl) Ether	0	0	0	0	0	0
Bis(2-Ethyl Hexyl) Phthalate	560	560	560	15,806	15,806	15,806
Bromomethane	0	0	0	0	0	0
Butyl Benzyl Phthalate	0	0	0	25,169	25,169	25,169
Carbon Tetrachloride	0	0	0	8,155	8,155	8,155
Chlorobenzene	560	560	560	0	0	0
P-Chloro-m-Cresol	0	0	0	0	0	0
Chloroethane	0	0	0	0	0	0
Chloroform	1,960	1,960	1,960	1,962,319	1,962,319	1,962,319
Chloromethane	0	0	0	0	0	0
2-Chloronapthalene	0	0	0	0	0	0
Di-N-Butyl Phthalate	840	840	840	1,913	1,913	1,913
1,2-Dichlorobenzene	0	0	0	1,611	1,611	1,611
1,3-Dichlorobenzene	0	0	0	0	0	0
1,4 Dichlorobenzene	0	0	0	0	0	0
1,1-Dichloroethane	0	0	0	0	0	0
1,2-Dichloroethane	1,680	1,680	1,680	253,296	253,296	253,296
1,1-Dichloroethylene	0	0	0	23,155	23,155	23,155

* All units in lbs/year.

SAIC

Hazardous Constituents	Petroleum Refining			Pharamaceutical Manufacturing		
	Raw	Current	After PSES	Raw	Current	After PSES
Trans-1,2-Dichloro-ethylene	0	0	0	0	0	0
1,2-Dichloropropane	0	0	0	0	0	0
Dichlorodifluoro-methane	0	0	0	0	0	0
2,4-Dichlorophenol	0	0	0	1,007	1,007	1,007
Diethyl Phthalate	1,400	1,400	1,400	6,141	6,141	6,141
2,4-Dimethylphenol	422,606	422,606	422,606	6,242	6,242	6,242
Dimethyl Phthalate	0	0	0	0	0	0
Di-N-Octyl Phthalate	0	0	0	0	0	0
Ethyl Benzene	711,345	711,345	711,345	325,883	325,883	325,883
Hexachloro-1,3-Butadiene	0	0	0	0	0	0
Hexachloroethane	0	0	0	0	0	0
Methylene Chloride	280	280	280	10,537,590	10,537,590	10,537,590
Naphthalene	47,330	47,330	47,330	0	0	0
N-Nitrosodimethyl Amine	0	0	0	1,208	1,208	1,208
Nitrobenzene	0	0	0	0	0	0
PCB	0	0	0	0	0	0
Pentachlorophenol	14,563	14,563	14,563	5,235	5,235	5,235
Phenol	543,871	543,871	543,871	757,976	757,976	757,976
1,1,2,2-Tetrachloro-ethane	0	0	0	2,014	2,014	2,014
Tetrachloroethylene	280	280	280	2,819	2,819	2,819
Toluene	1,740,836	1,740,836	1,740,836	1,236,722	1,236,722	1,236,722
Tribromomethane	0	0	0	0	0	0

* All units in lbs/year.

Hazardous Constituents	Petroleum Refining Raw	Petroleum Refining Current	Petroleum Refining After PSES	Pharmaceutical Manufacturing Raw	Pharmaceutical Manufacturing Current	Pharmaceutical Manufacturing After PSES
1,2,4-Trichloro-benzene	0	0	0	0	0	0
1,1,1-Trichloro-ethane	560	560	560	17,014	17,014	17,014
1,1,2-Trichloro-ethane	0	0	0	2,014	2,014	2,014
Trichloroethylene	0	0	0	6,846	6,846	6,846
Trichlorofluoro-methane	0	0	0	0	0	0
2,4,6-Trichloro-phenol	0	0	0	2,014	2,014	2,014
Vinyl Chloride	0	0	0	0	0	0
SUBTOTAL	3,717,478	3,717,478	3,717,478	16,244,875	16,244,875	16,244,875
Other Toxic Organics	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL TOXIC ORGANICS	3,717,478	3,717,478	3,717,478	16,244,875	16,244,875	16,244,875
Other Hazardous Organics	N/A	N/A	N/A	32,644,458	32,644,458	32,644,458
TOTAL HAZARDOUS ORGANICS	3,717,478	3,717,478	3,717,478	48,889,333	48,889,333	48,889,333

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Hazardous Constituents	Photographic Chemicals and Film Manufacturing Raw	Current	After PSES	Plastics Molding and Forming Raw	Current	After PSES
Toxic Metals						
Antimony and Compounds	566	469	469	31	31	31
Arsenic and Compounds	462	384	384	25	25	25
Cadmium and Compounds	124,557	103,382	103,382	110	110	110
Chromium and Compounds	12,286	10,197	10,197	354	354	354
Cyanide	4,584	3,805	3,805	138	138	138
Lead and Compounds	2,038	1,691	1,691	16,742	16,742	16,742
Mercury and Compounds	87	72	72	0	0	0
Nickel and Compounds	83	69	69	540	540	540
Selenium and Compounds	127	105	105	826	826	826
Silver and Compounds	261,180	26,118	26,118	9	9	9
Other Hazardous Metals	N/A	N/A	N/A	128	128	128
TOTAL HAZARDOUS METALS	405,970	146,292	146,292	18,903	18,903	18,903
Copper and Compounds	7,752	6,434	6,434	979	979	979
Zinc and Compounds	65,708	54,537	54,537	3,931	3,931	3,931
Other Toxic Metals	N/A	N/A	N/A	3	3	3
TOTAL TOXIC METALS	479,430	207,263	207,263	23,816	23,816	23,816

Hazardous Constituents	Photographic Chemicals and Film Manufacturing			Plastics Molding and Forming		
	Raw	Current	After PSES	Raw	Current	After PSES
Toxic Organics						
Acrolein	32	30	30	0	0	0
Benzene	0	0	0	1,924	1,924	1,924
Bis(2-Chloro-ethoxy) Methane	0	0	0	0	0	0
Bis(2-Chloroethyl) Ether	0	0	0	0	0	0
Bis(2-Ethyl Hexyl) Phthalate	29	27	27	25,093	25,093	25,093
Bromomethane	0	0	0	0	0	0
Butyl Benzyl Phthalate	72	67	67	0	0	0
Carbon Tetrachloride	7	7	7	0	0	0
Chlorobenzene	7	7	7	0	0	0
p-Chloro-m-Cresol	24	22	22	3,417	3,417	3,417
Chloroethane	0	0	0	0	0	0
Chloroform	85	80	80	209	209	209
Chloromethane	0	0	0	0	0	0
2-Chloronapthalene	0	0	0	0	0	0
Di-N-Butyl Phthalate	5,275	4,960	4,960	1,051	1,051	1,051
1,2-Dichlorobenzene	0	0	0	0	0	0
1,3-Dichlorobenzene	14	13	13	0	0	0
1,4-Dichlorobenzene	0	0	0	0	0	0
1,1-Dichloroethane	0	0	0	0	0	0
1,2-Dichloroethane	188	177	177	0	0	0
1,1-Dichloroethylene	0	0	0	0	0	0

* All units in lbs/year.

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Hazardous Constituents	Photographic Chemicals and Film Manufacturing			Plastics Molding and Forming		
	Raw	Current	After PSES	Raw	Current	After PSES
Trans-1,2-Dichloro-ethylene	14	13	13	0	0	0
1,2-Dichloropropane	0	0	0	0	0	0
Dichlorodifluoro-methane	0	0	0	0	0	0
2,4-Dichlorophenol	6	6	6	0	0	0
Diethyl Phthalate	82	75	75	0	0	0
2,4-Dimethylphenol	1	1	1	0	0	0
Dimethyl Phthalate	15	14	14	913	913	913
Di-N-Octyl Phthalate	0	0	0	0	0	0
Ethyl Benzene	18	17	17	129	129	129
Hexachloro-1,3-Butadiene	0	0	0	0	0	0
Hexachloroethane	0	0	0	0	0	0
Methylene Chloride	376	353	353	3,623	3,623	3,623
Naphthalene	8	8	8	0	0	0
N-Nitrosodimethyl Amine	0	0	0	0	0	0
Nitrobenzene	0	0	0	0	0	0
PCB	7	7	7	0	0	0
Pentachlorophenol	1,616	1,519	1,519	0	0	0
Phenol	3	3	3	953	953	953
1,1,2,2-Tetrachloro-ethane	0	0	0	0	0	0
Tetrachloroethylene	91	86	86	0	0	0
Toluene	70	66	66	38	38	38
Tribromomethane	0	0	0	0	0	0

(All units in lbs/year.)

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Hazardous Constituents	Photographic Chemicals and Film Manufacturing			Plastics Molding and Forming		
	Raw	Current	After PSES	Raw	Current	After PSES
1,2,4-Trichloro-benzene	0	0	0	161	161	161
1,1,1-Trichloro-ethane	23	21	21	3,770	3,770	3,770
1,1,2-Trichloro-ethane	0	0	0	0	0	0
Trichloroethylene	14	13	13	111	111	111
Trichlorofluoro-methane	15	14	14	0	0	0
2,4,6-Trichloro-phenol	2,316	2,177	2,177	0	0	0
Vinyl Chloride	0	0	0	0	0	0
SUBTOTAL	10,408	9,783	9,783	41,392	41,392	41,392
Other Toxic Organics	N/A	N/A	N/A	72	72	72
TOTAL TOXIC ORGANICS	10,408	9,783	9,783	41,464	41,464	41,464
Other Hazardous Organics	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL HAZARDOUS ORGANICS	10,408	9,783	9,783	41,464	41,464	41,464

Hazardous Constituents	Porcelain Enameling Raw	Porcelain Enameling Current	Porcelain Enameling After PSES	Printing and Publishing Raw	Printing and Publishing Current	Printing and Publishing After PSES
Toxic Metals						
Antimony and Compounds	120,424	10,350	10,350	60	56	56
Arsenic and Compounds	2,156	2,150	2,150	2,992	2,812	2,812
Cadmium and Compounds	14,660	1,785	1,785	30,389	28,028	28,028
Chromium and Compounds	3,218	824	824	21,667	20,110	20,110
Cyanide	0	0	0	37,229	34,772	34,772
Lead and Compounds	76,459	7,320	7,320	63,785	58,563	58,563
Mercury and Compounds	0	0	0	209	198	198
Nickel and Compounds	155,664	14,161	14,161	136,879	130,526	130,526
Selenium and Compounds	18,451	1,584	1,584	0	0	0
Silver and Compounds	0	0	0	46,061	44,445	44,445
Other Hazardous Metals	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL HAZARDOUS METALS	391,032	38,174	38,174	341,271	319,510	319,510
Copper and Compounds	10,897	9,026	9,026	58,889	54,560	54,560
Zinc and Compounds	171,022	16,603	16,603	397,328	386,375	386,375
Other Toxic Metals	76	76	76	N/A	N/A	N/A N/A
TOTAL TOXIC METALS	576,027	63,879	63,879	292,488	260,445	0

Hazardous Constituents	Porcelain Enameling			Printing and Publishing		
	Raw	Current	After PSES	Raw	Current	After PSES
Toxic Organics						
Acrolein	0	0	0	0	0	0
Benzene	0	0	0	169	157	157
Bis(2-Chloro-ethoxy) Methane	0	0	0	0	0	0
Bis(2-Chloroethyl) Ether	0	0	0	3,688	3,426	3,426
Bis(2-Ethyl Hexyl) Phthalate	259	217	217	3,884	3,563	3,563
Bromomethane	0	0	0	0	0	0
Butyl Benzyl Phthalate	0	0	0	0	0	0
Carbon Tetrachloride	0	0	0	14	13	13
Chlorobenzene	0	0	0	0	0	0
p-Chloro-m-Cresol	0	0	0	910	845	845
Chloroethane	0	0	0	0	0	0
Chloroform	59	49	49	4,065	3,776	3,776
Chloromethane	0	0	0	0	0	0
2-Chloronapthalene	0	0	0	0	0	0
Di-N-Butyl Phthalate	59	49	49	0	0	0
1,2-Dichlorobenzene	0	0	0	0	0	0
1,3-Dichlorobenzene	0	0	0	0	0	0
1,4-Dichlorobenzene	0	0	0	0	0	0
1,1-Dichloroethane	0	0	0	43	40	40
1,2-Dichloroethane	0	0	0	14	13	13
1,1-Dichloroethylene	0	0	0	0	0	0

* All unit in lbs/year.

Hazardous Constituents	Porcelain Enameling Raw	Porcelain Enameling Current	Porcelain Enameling After PSES	Printing and Publishing Raw	Printing and Publishing Current	Printing and Publishing After PSES
Trans-1,2-Dichloroethylene	24	20	20	0	0	0
1,2-Dichloropropane	0	0	0	0	0	0
Dichlorodifluoromethane	0	0	0	0	0	0
2,4-Dichlorophenol	0	0	0	0	0	0
Diethyl Phthalate	282	237	237	0	0	0
2,4-Dimethylphenol	0	0	0	0	0	0
Dimethyl Phthalate	0	0	0	0	0	0
Di-N-Octyl Phthalate	129	109	109	0	0	0
Ethyl Benzene	0	0	0	5,386	5,004	5,004
Hexachloro-1,3-Butadiene	0	0	0	0	0	0
Hexachloroethane	0	0	0	0	0	0
Methylene Chloride	59	49	49	5,216	4,846	4,846
Naphthalene	0	0	0	3,688	3,426	3,426
N-Nitrosodimethyl Amine	0	0	0	0	0	0
Nitrobenzene	0	0	0	0	0	0
PCB	0	0	0	0	0	0
Pentachlorophenol	0	0	0	0	0	0
Phenol	0	0	0	4,540	4,540	4,540
1,1,2,2-Tetrachloroethane	0	0	0	29	27	27
Tetrachloroethylene	0	0	0	0	0	0
Toluene	212	178	178	4,323	4,016	4,016
Tribromomethane	24	20	20	0	0	0

Hazardous Constituents	Porcelain Enameling			Printing and Publishing		
	Raw	Current	After PSES	Raw	Current	After PSES
1,2,4-Trichloro-benzene	0	0	0	0	0	0
1,1,1-Trichloro-ethane	0	0	0	402	373	373
1,1,2-Trichloro-ethane	82	69	69	0	0	0
Trichloroethylene	47	40	40	1,573	1,461	1,461
Trichlorofluoro-methane	0	0	0	0	0	0
2,4,6-Trichloro-phenol	0	0	0	0	0	0
Vinyl Chloride	0	0	0	0	0	0
SUBTOTAL	1,236	1,037	1,037	37,944	35,526	35,526
Other Toxic Organics	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL TOXIC ORGANICS	1,236	1,037	1,037	37,944	35,526	35,526
Other Hazardous Organics	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL HAZARDOUS ORGANICS	1,236	1,037	1,037	37,944	35,526	35,526

Hazardous Constituents	Pulp and Paper Mills Raw	Pulp and Paper Mills Current	Pulp and Paper Mills After PSES	Rubber Manufacturing Raw	Rubber Manufacturing Current	Rubber Manufacturing After PSES
Toxic Metals						
Antimony and Compounds	0	0	0	0	0	0
Arsenic and Compounds	0	0	0	0	0	0
Cadmium and Compounds	0	0	0	0	0	0
Chromium and Compounds	62,378	62,378	62,378	1,150	1,150	1,150
Cyanide	34,373	34,373	34,373	0	0	0
Lead and Compounds	99,315	99,315	99,315	0	0	0
Mercury and Compounds	995	995	995	0	0	0
Nickel and Compounds	24,335	24,335	24,335	4,300	4,300	4,300
Selenium and Compounds	0	0	0	0	0	0
Silver and Compounds	0	0	0	0	0	0
Other Hazardous Metals	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL HAZARDOUS METALS	221,396	221,396	221,396	5,450	5,450	5,450
Copper and Compounds	82,108	82,108	82,108	0	0	0
Zinc and Compounds	618,415	616,239	616,239	452,925	452,925	452,925
Other Toxic Metals	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL TOXIC METALS	921,919	919,713	919,743	458,375	458,375	458,375

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Hazardous Constituents	Pulp and Paper Mills			Rubber Manufacturing		
	Raw	Current	After PSES	Raw	Current	After PSES
Toxic Organics						
Acrolein	0	0	0	0	0	0
Benzene	5,628	5,628	5,628	0	0	0
Bis(2-Chloro-ethoxy) Methane	0	0	0	0	0	0
Bis(2-Chloroethyl) Ether	0	0	0	0	0	0
Bis(2-Ethyl Hexyl) Phthalate	112,093	112,093	112,093	0	0	0
Bromomethane	0	0	0	0	0	0
Butyl Benzyl Phthalate	61,234	61,234	61,234	0	0	0
Carbon Tetrachloride	0	0	0	0	0	0
Chlorobenzene	697	697	697	0	0	0
p-Chloro-m-Cresol	0	0	0	0	0	0
Chloroethane	0	0	0	0	0	0
Chloroform	423,969	423,969	423,969	0	0	0
Chloromethane	0	0	0	0	0	0
2-Chloronapthalene	0	0	0	0	0	0
Di-N-Butyl Phthalate	7,900	7,900	7,900	0	0	0
1,2-Dichlorobenzene	0	0	0	0	0	0
1,3-Dichlorobenzene	0	0	0	0	0	0
1,4-Dichlorobenzene	0	0	0	0	0	0
1,1-Dichloroethane	0	0	0	0	0	0
1,2-Dichloroethane	203	203	203	0	0	0
1,1-Dichloroethylene	0	0	0	0	0	0

* All units in lbs/year.

Hazardous Constituents	Pulp and Paper Mills			Rubber Manufacturing		
	Raw	Current	After PSES	Raw	Current	After PSES
Trans-1,2-Dichloro-ethylene	0	0	0	0	0	0
1,2-Dichloropropane	0	0	0	0	0	0
Dichlorodifluoro-methane	0	0	0	0	0	0
2,4-Dichlorophenol	387	387	387	0	0	0
Diethyl Phthalate	41,973	41,973	41,973	0	0	0
2,4-Dimethylphenol	0	0	0	0	0	0
Dimethyl Phthalate	0	0	0	0	0	0
Di-N-Octyl Phthalate	0	0	0	0	0	0
Ethyl Benzene	722,060	722,060	722,060	2,275	2,275	2,275
Hexachloro-1,3-Butadiene	0	0	0	0	0	0
Hexachloroethane	0	0	0	0	0	0
Methylene Chloride	5,126	5,126	5,126	0	0	0
Naphthalene	2,728	2,728	2,728	0	0	0
N-Nitrosodimethyl Amine	0	0	0	0	0	0
Nitrobenzene	0	0	0	0	0	0
PCB	1,119	1,119	1,119	0	0	0
Pentachlorophenol	124,245	0	0	0	0	0
Phenol	107,366	107,366	107,366	0	0	0
1,1,2,2-Tetrachloro-ethane	0	0	0	0	0	0
Tetrachloroethylene	1,518	1,518	1,518	0	0	0
Toluene	64,344	64,344	64,344	31,000	31,000	31,000
Tribromomethane	0	0	0	0	0	0

* All units in lbs/year.

Hazardous Constituents	Pulp and Paper Mills Raw	Pulp and Paper Mills Current	Pulp and Paper Mills After PSES	Rubber Manufacturing Raw	Rubber Manufacturing Current	Rubber Manufacturing After PSES
1,2,4-Trichloro-benzene	0	0	0	0	0	0
1,1,1-Trichloro-ethane	43,005	43,005	43,005	0	0	0
1,1,2-Trichloro-ethane	0	0	0	0	0	0
Trichloroethylene	5,138	5,138	5,138	0	0	0
Trichlorofluoro-methane	61	61	61	0	0	0
2,4,6-Trichloro-phenol	45,518	45,518	45,518	0	0	0
Vinyl Chloride	0	0	0	0	0	0
SUBTOTAL	1,776,312	1,652,067	1,652,067	33,275	33,275	33,275
Other Toxic Organics	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL TOXIC ORGANICS	1,776,312	1,652,067	1,652,067	33,275	33,275	33,275
Other Hazardous Organics	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL HAZARDOUS ORGANICS	1,776,312	1,652,067	1,652,067	33,275	33,275	33,275

Hazardous Constituents	Textile Mills			Timber Products Processing		
	Raw	Current	After PSES	Raw	Current	After PSES
Toxic Metals						
Antimony and Compounds	4,471	4,471	4,471	99	99	99
Arsenic and Compounds	8,465	8,465	8,465	2,234	2,234	2,234
Cadmium and Compounds	1,274	1,274	1,274	31	31	31
Chromium and Compounds	74,522	74,522	74,522	2,198	2,198	2,198
Cyanide	9,991	9,991	9,991	0	0	0
Lead and Compounds	21,116	21,116	21,116	263	263	263
Mercury and Compounds	9,884	9,884	9,884	157	157	157
Nickel and Compounds	29,550	29,550	29,550	1,482	1,482	1,482
Selenium and Compounds	4,436	4,436	4,436	103	103	103
Silver and Compounds	11,208	11,208	11,208	43	43	43
Other Hazardous Metals	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL HAZARDOUS METALS	174,917	174,917	174,917	6,610	6,610	6,610
Copper and Compounds	125,415	125,415	125,415	10,969	3,449	3,449
Zinc and Compounds	251,041	251,041	251,041	18,907	5,861	5,861
Other Toxic Metals	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL TOXIC METALS	551,373	551,373	551,373	36,486	15,920	15,920

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Hazardous Constituents	Textile Mills Raw	Textile Mills Current	Textile Mills After PSES	Timber Products Processing Raw	Timber Products Processing Current	Timber Products Processing After PSES
Toxic Organics						
Acrolein	4,356	4,356	4,356	0	0	0
Benzene	3,614	3,614	3,614	2,819	2,819	2,819
Bis(2-Chloro-ethoxy) Methane	0	0	0	0	0	0
Bis(2-Chloroethyl) Ether	0	0	0	0	0	0
Bis(2-Ethyl Hexyl) Phthalate	78,346	78,346	78,346	292	292	292
Bromomethane	0	0	0	0	0	0
Butyl Benzyl Phthalate	3,616	3,616	3,616	0	0	0
Carbon Tetrachloride	0	0	0	0	0	0
Chlorobenzene	10,100	10,100	10,100	0	0	0
p-Chloro-m-Cresol	432	432	432	0	0	0
Chloroethane	0	0	0	0	0	0
Chloroform	28,572	28,572	28,572	137	137	137
Chloromethane	0	0	0	0	0	0
2-Chloronaphthalene	0	0	0	0	0	0
Di-N-Butyl Phthalate	4,110	4,110	4,110	0	0	0
1,2-Dichlorobenzene	4,160	4,160	4,160	0	0	0
1,3-Dichlorobenzene	5,992	5,992	5,992	0	0	0
1,4-Dichlorobenzene	3,350	3,350	3,350	0	0	0
1,1-Dichloroethane	213	213	213	0	0	0
1,2-Dichloroethane	162	162	162	0	0	0
1,1-Dichloroethylene	1,127	1,127	1,127	0	0	0

* All units in lbs/year.

Hazardous Constituents	Textile Mills			Timber Products Processing		
	Raw	Current	After PSES	Raw	Current	After PSES
Trans-1,2-Dichloro-ethylene	1,693	1,693	1,693	0	0	0
1,2-Dichloropropane	1,359	1,359	1,359	0	0	0
Dichlorodifluoro-methane	0	0	0	0	0	0
2,4-Dichlorophenol	910	910	910	3,530	988	988
Diethyl Phthalate	4,670	4,670	4,670	0	0	0
2,4-Dimethylphenol	2,601	2,601	2,601	0	0	0
Dimethyl Phthalate	2,797	2,797	2,797	0	0	0
Di-N-Octyl Phthalate	14	14	14	0	0	0
Ethyl Benzene	307,049	307,049	307,049	743	743	743
Hexachloro-1,3-Butadiene	0	0	0	0	0	0
Hexachloroethane	0	0	0	0	0	0
Methylene Chloride	60,571	60,571	60,571	444	444	444
Naphthalene	53,749	53,749	53,749	0	0	0
N-Nitrosodimethyl Amine	0	0	0	0	0	0
Nitrobenzene	0	0	0	0	0	0
PCB	1	1	1	0	0	0
Pentachlorophenol	5,500	5,500	5,500	35,914	10,345	10,345
Phenol	20,710	20,710	20,710	27,30[illegible]	7,644	7,644
1,1,2,2-Tetrachloro-ethane	420	420	420	0	0	0
Tetrachloroethylene	63,879	63,879	63,879	0	0	0
Toluene	66,197	66,197	66,197	2,905	0	0
Tribromomethane	0	0	0	0	0	0

* All units in lbs/year.

Hazardous Constituents	Textile Mills			Timber Products Processing		
	Raw	Current	After PSES	Raw	Current	After PSES
1,2,4-Trichloro-benzene	0	0	0	0	0	0
1,1,1-Trichloro-ethane	28,940	28,940	28,940	0	0	0
1,1,2-Trichloro-ethane	0	0	0	0	0	0
Trichloroethylene	44,831	44,831	44,831	0	0	0
Trichlorofluoro-methane	1,072	1,072	1,072	0	0	0
2,4,6-Trichloro-phenol	1,392	1,392	1,392	416	116	116
Vinyl Chloride	48	48	48	0	0	0
SUBTOTAL	816,553	816,553	816,553	74,501	23,528	23,528
Other Toxic Organics	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL TOXIC ORGANICS	816,553	816,553	816,553	74,501	23,528	23,528
Other Hazardous Organics	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL HAZARDOUS ORGANICS	816,553	816,553	816,553	74,501	23,528	23,528

Hazardous Constituents	TOTAL TTD RAW	TOTAL TTD CURRENT	TOTAL TTD AFTER PSES	TOTAL TSDB RAW	TOTAL TSDB CURRENT	TOTAL TSDB AFTER PSES
Toxic Metals						
Antimony and Compounds	368,098	221,685	217,483	361,352	215,160	215,160
Arsenic and Compounds	166,139	66,575	60,867	1,770,181	1,552,433	249,920
Cadmium and Compounds	837,895	189,856	184,583	831,209	183,499	183,499
Chromium and Compounds	64,568,116	2,851,472	2,451,483	66,565,542	4,660,026	2,519,915
Cyanide	31,792,538	3,165,294	1,490,001	31,574,260	2,954,464	1,390,068
Lead and Compounds	9,031,870	1,641,068	1,137,902	11,026,950	3,449,009	1,143,453
Mercury and Compounds	27,488	15,789	15,685	54,135	42,439	16,175
Nickel and Compounds	30,232,184	1,619,872	1,552,838	32,013,393	3,320,226	1,744,068
Selenium and Compounds	182,852	142,[illegible]77	71,980	1,713,279	1,534,540	102,422
Silver and Compounds	379,925	130,587	128,743	1,987,398	1,650,707	793,263
Other Hazardous Metals	1,717	1,492	1,409	1,623,803	1,552,253	86,268
TOTAL HAZARDOUS METALS	137,588,822	10,046,267	7,212,971	149,521,502	21,114,756	8,444,211
Copper and Compounds	27,379,591	4,266,000	1,901,157	27,450,268	4,211,320	1,905,684
Zinc and Compounds	39,214,787	4,136,340	3,964,773	40,753,725	5,587,570	4,023,906
Other Toxic Metals	252	235	235	252	235	235
TOTAL TOXIC METALS	204,183,452	18,448,842	13,079,136	217,725,747	40,913,881	14,374,036

Hazardous Constituents	TOTAL ITD RAW	TOTAL ITD CURRENT	TOTAL ITD AFTER PSES	TOTAL ISDB RAW	TOTAL ISDB CURRENT	TOTAL ISDB AFTER PSES
Toxic Organics						
Acrolein	1,729,958	1,648,576	4,696	4,445	4,441	4,386
Benzene	2,142,346	3,099,834	1,230,936	4,732,027	4,099,249	1,244,494
Bis(2-Chloro-ethoxy) Methane	230	23	23	230	23	23
Bis(2-Chloroethyl) Ether	4,226	3,480	3,480	4,226	3,480	3,480
Bis(2-Ethyl Hexyl) Phthalate	1,324,213	1,207,712	1,173,329	2,893,855	2,660,146	1,172,405
Bromomethane	0	160	0	851	813	1
Butyl Benzyl Phthalate	137,967	136,062	136,005	1,747,869	1,613,930	1,477,590
Carbon Tetrachloride	90,655	71,920	30,553	265,018	225,086	31,076
Chlorobenzene	14,666	687,835	11,608	11,972	11,484	11,472
P-Chloro-m-Cresol	781,758	82,918	82,918	781,758	82,918	82,918
Chloroethane	16,936	15,173	111	0	0	0
Chloroform	2,486,366	2,475,514	2,463,008	4,292,035	4,189,128	2,516,908
Chloromethane	17,724	26,486	271	30,097	27,230	394
2 Chloronapthalene	10,468	1,481	1,428	10,415	1,428	1,428
Di-N-Butyl Phthalate	130,817	85,332	85,307	130,546	85,064	85,063
1,2 Dichlorobenzene	168,855	54,633	45,335	499,469	377,071	45,294
1,3-Dichlorobenzene	11,656	7,471	6,655	10,614	6,565	6,565
1,4-Dichlorobenzene	49,255	36,009	22,044	610,387	583,874	22,147
1,1-Dichloroethane	35,547	29,666	1,095	4,721	708	708
1,2-Dichloroethane	363,665	302,706	263,869	325,404	262,681	262,677
1,1-Dichloroethylene	51,547	33,224	26,638	44,032	26,440	26,426

† All units in lbs/year.

SAIC

Hazardous Constituents	TOTAL ITD RAW	TOTAL ITD CURRENT	TOTAL ITD AFTER PSES	TOTAL ISDB RAW	TOTAL ISDB CURRENT	TOTAL ISDB AFTER PSES
Trans-1,2-Dichloro-ethylene	10,666	4,456	3,964	10,002	3,846	3,846
1,2-Dichloro-propane	230,203	209,097	1,888	1,361	1,361	1,361
Dichlorodifluoro-methane	0	0	0	0	0	0
2,4-Dichlorophenol	12,574	17,453	4,723	21,779	14,084	4,627
Diethyl Phthalate	84,616	62,783	61,685	82,947	61,288	61,283
2,4-Dimethylphenol	2,552,119	1,739,434	515,387	1,123,956	515,229	515,229
Dimethyl Phthalate	36,293	12,864	12,093	35,168	11,858	11,858
Di-N-Octyl Phthalate	21,241	20,544	20,544	21,241	20,544	20,544
Ethyl Benzene	2,933,117	2,873,040	2,612,166	4,937,096	4,802,993	2,621,798
Hexachloro-1,3-Butadiene	0	0	0	0	0	0
Hexachloroethane	183	183	183	183	183	183
Methylene Chloride	12,310,067	11,965,655	11,894,614	12,524,169	12,087,479	11,903,335
Naphthalene	993,804	530,914	458,087	2,528,518	2,020,647	467,716
N-Nitrosodimethyl Amine	1,208	1,208	1,208	1,208	1,208	1,208
Nitrobenzene	144,342	128,085	19,047	24,182	18,909	18,909
PCB	1,137	1,137	1,137	1,781	1,781	1,143
Pentachlorophenol	1,439,257	184,321	184,279	1,439,140	184,203	184,203
Phenol	16,167,871	11,673,435	2,047,593	20,663,772	23,475,543	2,048,219
1,1,2,2-Tetrachloro-ethane	2,891	2,543	2,543	2,893	2,545	2,543
Tetrachloroethylene	4,081,609	3,042,789	3,042,447	4,403,576	3,349,694	3,109,575
Toluene	5,816,176	6,070,811	4,430,713	9,054,529	8,291,692	4,436,227
Tribromomethane	31	27	27	31	27	27

* All units in lbs/year.

SAIC

Hazardous Constituents	TOTAL ITD RAW	TOTAL ITD CURRENT	TOTAL ITD AFTER PSES	TOTAL ISDB RAW	TOTAL ISDB CURRENT	TOTAL ISDB AFTER PSES
1,2,4-Trichloro-benzene	65,511	27,469	4,439	40,985	4,518	4,311
1,1,1-Trichloro-ethane	11,187,117	8,652,375	8,651,726	11,186,569	8,651,841	8,651,526
1,1,2-Trichloro-ethane	187,030	162,734	3,217	314,182	278,167	3,315
Trichloroethylene	4,874,316	3,803,526	3,792,438	4,862,107	3,792,209	3,792,209
Trichlorofluoro-methane	1,199	1,198	1,198	1,129	1,198	1,128
2,4,6 Trichloro-phenol	216,540	107,585	107,508	216,409	107,467	107,389
Vinyl Chloride	28,938	28,559	372	40,714	40,140	523
SUBTOTAL	72,969,213	61,330,429	43,464,524	97,939,658	82,202,413	44,969,680
Other Toxic Organics	3,471,666	3,244,006	43,320	18,991,211	17,856,412	412,297
TOTAL TOXIC ORGANICS	76,440,879	64,574,435	43,507,844	116,930,869	100,058,825	45,381,977
Other Hazardous Organics	N/A	N/A	N/A	150,310,316	148,951,255	37,490,648
TOTAL HAZARDOUS ORGANICS	76,440,879	64,571,415	43,507,844	267,241,185	249,010,080	82,872,625

SAIC

APPENDIX C

POLLUTANT PHYSICAL PROPERTIES DATA BASE

Record#	CAS_NO	CHEMNAME	MOLE_WT	PVAP	H_CONST	DIFF_WAT	DIFF_AIR	VP_COEF_A	VP_COEF_B	VP_COEF_C	EMAX	KS
1	109-88-3	TOLUENE	92.40	30.0000000	0.006680000	0.0000860	0.0870000	6.954	1344.800	219.480	0.000020400	30.60
2	91-20-3	NAPHTHALENE	128.20	0.2300000	0.001180000	0.0000075	0.0590000	7.010	1733.710	201.860	0.000011800	42.50
3	108-95-2	PHENOL	94.10	0.3400000	0.000000454	0.0000091	0.0820000	7.133	1516.790	174.950	0.000026900	7.60
4	107-02-8	ACROLEIN	56.10	244.2000000	0.000056600	0.0000122	0.1050000	2.390	0.000	0.000	0.000002170	22.00
5	75-09-2	METHYLENE CHLORIDE	85.00	438.0000000	0.003190000	0.0000117	0.1010000	7.409	1325.900	252.600	0.000006110	55.00
6	67-66-3	CHLOROFORM	119.40	208.0000000	0.003390000	0.0000100	0.1040000	6.493	929.440	196.030	0.000000817	3.70
7	79-34-5	TETRACHLOROETHANE(1,1,2,2)	168.00	6.5000000	0.000380000	0.0000079	0.0710000	6.631	1228.100	179.900	0.000001720	9.10
8	107-06-2	DICHLOROETHANE(1,2)	99.00	80.0000000	0.001200000	0.0000099	0.1040000	7.025	1272.300	222.900	0.000000583	2.10
9	127-18-4	TETRACHLOROETHYLENE	165.83	19.0000000	0.029000000	0.0000082	0.0720000	6.980	1386.920	217.530	0.000001720	9.10
10	108-90-7	CHLOROBENZENE	112.60	11.8000000	0.003930000	0.0000087	0.0730000	6.978	1431.050	217.550	0.000000108	0.04
11	71-43-2	BENZENE	78.10	95.2000000	0.005500000	0.0000098	0.0880000	6.905	1211.033	220.790	0.000005280	13.60
12	95-50-1	DICHLOROBENZENE(1,2) (-o)	147.00	1.5000000	0.001940000	0.0000079	0.0690000	0.176	0.000	0.000	0.000000694	4.40
13	56-23-5	CARBON TETRACHLORIDE	153.80	113.0000000	0.030000000	0.0000088	0.0780000	6.934	1242.430	230.000	0.000000417	1.00
14	1336-36-3	POLYCHLORINATED BIPHENYLS	290.00	0.0000000	0.000400000	0.0000100	0.1040000	0.000	0.000	0.000	0.000000000	0.00
15	71-55-6	TRICHLOROETHANE(1,1,1)	133.40	123.0000000	0.004920000	0.0000088	0.0780000	8.643	2136.600	302.800	0.000000972	4.73
16	100-41-4	ETHYLBENZENE	106.20	10.0000000	0.006440000	0.0000078	0.0750000	6.975	1424.255	213.210	0.000001890	3.20
17	75-01-4	VINYL CHLORIDE	62.50	2660.0000000	0.086000000	0.0000123	0.1060000	3.425	0.000	0.000	0.000000000	0.00
18	98-95-3	NITROBENZENE	123.10	0.3000000	0.000013100	0.0000086	0.0760000	7.115	1746.600	201.800	0.000003060	4.80
19	106-46-7	DICHLOROBENZENE(1,4) (-p)	147.00	1.2000000	0.001600000	0.0000079	0.0690000	0.079	0.000	0.000	0.000001780	2.78
20	87-68-3	HEXACHLOROBUTADIENE	260.80	0.1500000	0.025600000	0.0000062	0.0561000	-0.824	0.000	0.000	0.000000000	0.00
21	79-01-6	TRICHLOROETHYLENE	131.40	75.0000000	0.009100000	0.0000091	0.0790000	6.518	1018.600	192.700	0.000001080	4.43
22	75-69-4	TRICHLOROFLUOROMETHANE	137.40	796.0000000	0.058300000	0.0000097	0.0870000	6.884	1043.004	236.880	0.000000000	0.00
23	111-44-4	BIS(2-CHLOROETHYL)ETHER	143.00	1.4000000	0.000013000	0.0000075	0.0692000	0.000	0.000	0.000	0.000003110	31.59
24	117-81-7	BIS(2-ETHYLHEXYL)PHTHALATE	390.60	0.0000002	0.000000300	0.0000037	0.0351000	0.000	0.000	0.000	0.000000986	0.11
25	75-25-2	BROMOFORM	252.77	5.6000000	0.000584000	0.0000101	0.0820000	0.000	0.000	0.000	0.000000108	0.44
26	74-83-9	BROMOMETHANE	94.95	1250.0000000	0.221000000	0.0000146	0.1140000	0.000	0.000	0.000	0.000000083	0.28
27	85-68-7	BUTYL BENZYL PHTHALATE	312.39	0.0000000	0.010800000	0.0000048	0.0458000	0.000	0.000	0.000	0.000003110	2.40
28	59-50-7	CHLORO(-p)CRESOL(-m)	142.60	0.0035000	0.000000164	0.0000076	0.0709000	0.000	0.000	0.000	0.000000986	5.41
29	75-00-3	CHLOROETHANE	64.52	1200.0000000	0.009100000	0.0000115	0.2710000	6.980	1030.010	238.610	0.000000083	0.91
30	74-87-3	CHLOROMETHANE	50.49	3830.0000000	0.008140000	0.0000150	0.1300000	0.000	0.000	0.000	0.000000083	1.40
31	91-58-7	CHLORONAPHTHALENE-2	162.51	0.0170000	0.018000000	0.0000074	0.0653000	0.000	0.000	0.000	0.000000083	0.01
32	117-84-0	DI-N-OCTYL PHTHALATE	390.62	0.0000000	0.137000000	0.0000041	0.0409000	0.000	0.000	0.000	0.000000083	0.02
33	84-74-2	DIBUTYLPHTHALATE	278.30	0.0000100	0.000000280	0.0000079	0.0438000	6.639	1744.200	113.590	0.000003960	1.91
34	541-73-1	DICHLOROBENZENE(1,3)(-m)	147.01	2.2800000	0.003610000	0.0000079	0.0690000	0.000	0.000	0.000	0.000001780	2.80
35	75-71-8	DICHLORODIFLUOROMETHANE	120.92	5000.0000000	0.401000000	0.0000100	0.0001040	0.000	0.000	0.000	0.000000083	0.37
36	75-34-3	DICHLOROETHANE(1,1)	99.00	234.0000000	0.005540000	0.0000105	0.0914000	0.000	0.000	0.000	0.000000083	0.13
37	75-35-4	DICHLOROETHYLENE(1,1)	97.00	630.1000000	0.015000000	0.0000110	0.0935000	0.000	0.000	0.000	0.000000083	0.59
38	156-54-2	DICHLOROETHYLENE(1,2)	96.95	200.0000000	0.031900000	0.0000110	0.0935000	6.965	1141.900	231.900	0.000000083	0.29
39	120-83-2	DICHLOROPHENOL(2,4)	163.01	0.1000000	0.000004800	0.0000076	0.0709000	0.000	0.000	0.000	0.000006940	7.50
40	78-87-5	DICHLOROPROPANE(1,2)	112.99	40.0000000	0.002300000	0.0000087	0.0782000	6.980	1380.100	22.800	0.000004720	12.00
41	84-66-2	DIETHYL PHTHALATE	222.00	0.0000000	0.011100000	0.0000058	0.0542000	0.000	0.000	0.000	0.000000753	1.28
42	131-11-3	DIMETHYL PHTHALATE	194.20	0.0001870	0.000002150	0.0000063	0.0568000	4.522	700.310	51.420	0.000000611	0.11
43	105-67-9	DIMETHYLPHENOL(2,4)	122.16	0.0573000	0.000921000	0.0000084	0.0712000	0.000	0.000	0.000	0.000002970	2.30
44	67-72-1	HEXACHLOROETHANE	237.00	0.6500000	0.000002490	0.0000068	0.0024900	0.000	0.000	0.000	0.000000986	14.02
45	87-86-5	PENTACHLOROPHENOL	266.40	0.0009900	0.000002800	0.0000061	0.0560000	0.000	0.000	0.000	0.000036100	38.00
46	120-82-1	TRICHLOROBENZENE(1,2,4)	181.50	0.1800000	0.001420000	0.0000077	0.0676000	0.000	0.000	0.000	0.000000083	0.07
47	79-00-5	TRICHLOROETHANE(1,1,2)	133.40	25.0000000	0.000742000	0.0000088	0.0780000	6.951	1314.410	209.200	0.000000972	4.73
48	88-06-2	TRICHLOROPHENOL(2,4,6)	197.46	0.0073000	0.000017700	0.0000075	0.0661000	0.000	0.000	0.000	0.000000108	1.50

TECHNICAL REPORT DATA

(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA-450/4-89-013b	2.	3. RECIPIENT'S ACCESSION NO.
4. TITLE AND SUBTITLE Background Document for the Surface Impoundment Modeling System (SIMS)		5. REPORT DATE September 1989
		6. PERFORMING ORGANIZATION CODE
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		14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

EPA Project Officer: David C. Misenheimer

16. ABSTRACT

This document presents a brief description of the operation and design of surface impoundments and background information on the development of the Surface Impoundments Modeling System (SIMS). The SIMS was developed with funding from the U.S. Environmental Protection Agency's (EPA) Control Technology Center (CTC) and with project management provided by EPA's Technical Support Division of the Office of Air Quality Planning and Standards. SIMS is based on emission models developed by the Emission Standards Division (ESD) during the evaluation of surface impoundments located in treatment, storage, and disposal facilities (TSDF). This technical document discusses these emission models, surface impoundment design and operation, default parameter development, and the emission estimation procedure. Another document entitled, SIMS User's Manual, EPA-450/4-89-013a, presents a complete reference for all features and commands in the SIMS PC program.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS *(This Report)*	21. NO. OF PAGES
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