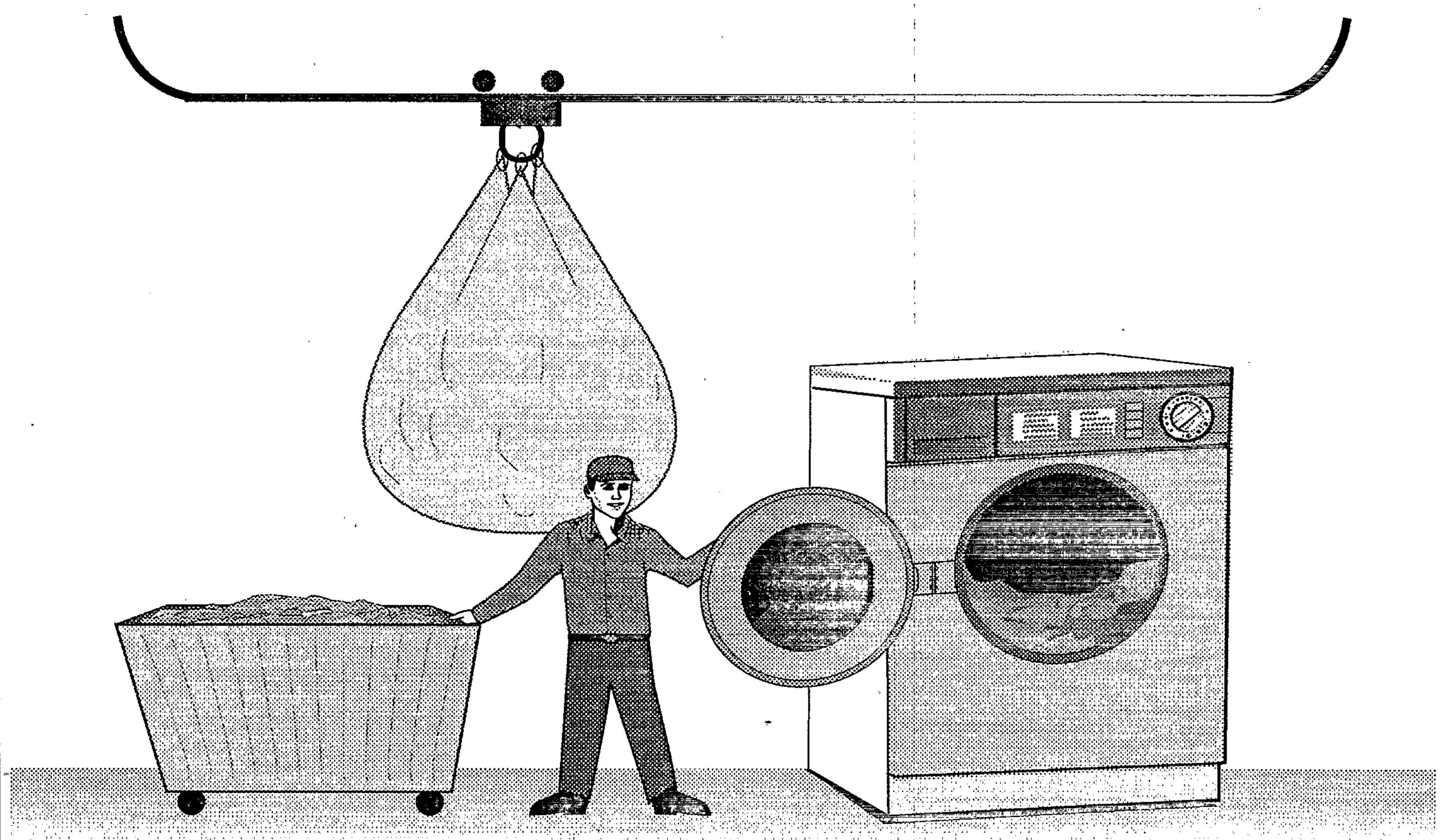
United States
Environmental Protection
Agency

Office of Water
(4303)

EPA 821-R-97-009
November 1997

EPA

Water Quality Benefits Analysis for Proposed Pretreatment Standards for Existing and New Sources for the Industrial Laundries Point Source Category



Water Quality Benefits Analysis for Proposed Pretreatment Standards for Existing and New Sources for the Industrial Laundries Point Source Category

Executive Summary

Overview of the Industrial Laundry Industry and its Effluent Discharges

From a detailed technical and economic survey of the industrial laundry industry, the U.S. Environmental Protection Agency (EPA) estimates that the industry contains 1,747 facilities that discharge water and are thus potentially subject to regulation. Of these 1,747 facilities, 1,606 would be required to comply with standards because they process one million pounds or more of laundry or 255,000 pounds or more of shop towels or printer towels per year. EPA estimates that all of these facilities are indirect dischargers (i.e., they discharge their effluent to publicly-owned treatment works (POTWs)) and thus would be subject to Pretreatment Standards for Existing Sources (PSES).

Currently, industrial laundry facilities nationwide discharge to POTWs 4.9 million pounds per year of priority and nonconventional pollutants (excluding Chemical Oxygen Demand, Total Organic Carbon, and Total Petroleum Hydrocarbons measured as Silica Gel Treated n-Hexane Extractable Material (SGT-HEM)), and 35.9 million pounds of oil and grease measured as n-Hexane Extractable Material (HEM). Of the 35.9 million pounds of HEM, 13.2 million pounds are SGT-HEM (see Table ES-1 for loadings of all pollutants). Discharges of priority and nonconventional pollutants into freshwater and estuarine ecosystems may alter aquatic habitats, adversely affect aquatic biota, and adversely impact human health through the consumption of contaminated fish and water. Furthermore, these pollutants may interfere with POTW operations through contamination of sewage sludge, thereby restricting the method of disposal, or through inhibition of the microbes present in activated sewage sludge. Many of the pollutants of concern from industrial laundries have at least one toxic effect (human health carcinogen and/or non-cancer toxicant, or aquatic toxicant). In addition, many of these pollutants bioaccumulate in aquatic organisms and persist in the environment.

For this rulemaking, EPA evaluated the environmental benefits of controlling the pollutant discharges from industrial laundry facilities to POTWs through national analyses of four primary treatment options: organics control (OC) only, dissolved air flotation (DAF-IL), chemical precipitation (CP-IL), and a combined option with either DAF or CP for all wastewater (Combo-IL).

Benefits of the Proposed Rule

EPA estimates that the proposed standards would significantly reduce pollutant discharges to POTWs, as shown by the loadings estimates in Table ES-1 for five categories of pollutants. Reductions in industrial laundry pollutant discharges to POTWs would result in a number of benefits to society, including: improved quality of freshwater, estuarine, and marine ecosystems; increased survivability and diversity of aquatic life and terrestrial wildlife; reduced risks to human health through consumption of fish or water taken from affected waterways; reduced cost of disposal or use of municipal sewage sludge that is affected by industrial laundry pollutant discharges; and, reduced occurrence of biological inhibition of activated sludge at POTWs.

Table ES-1. Summary of Estimated Pollutant Loadings from Industrial Laundries to POTWs					
Regulatory Option	Priority and Nonconventional Pollutants* (million lb/yr)	HEM (million lb/yr)**	SGT-HEM (million lb/yr)	Other Conventional Pollutants (million lb/yr)***	Other Nonconventional Pollutants (million lb/yr)****
	National Estimates	National Estimates	National Estimates	National Estimates	National Estimates
Baseline	4.9	35.9	13.2	176	346
DAF-IL	2.9	15.9	2.6	137	252
CP-IL	2.9	15.2	2.4	139	258
Combo-IL	3.1	15.9	2.6	139	258

* Excludes Total Organic Carbon (TOC), Total Petroleum Hydrocarbons measured as Silica Gel Treated n-Hexane Extractable Material (SGT-HEM), and Chemical Oxygen Demand (COD).
** Includes the pounds of SGT-HEM.
*** Includes Biological Oxygen Demand (BOD) and Total Suspended Solids (TSS).
**** Includes Chemical Oxygen Demand (COD) and Total Organic Carbon (TOC).

Human Health Benefits

EPA analyzed the following measures of health-related benefits from the proposed rule: reduced cancer risk from fish consumption, measured as annual avoided cancer cases; and, reduced occurrence of in-waterway pollutant concentrations in excess of human health-based ambient water quality criteria (AWQC) or in excess of documented toxic effect levels for those chemicals for which EPA has not published water quality criteria. Note that this second measure includes both cancer and non-cancer effects. In doing this, EPA examined industrial laundry discharges alone, not accounting for any other discharges to receiving waters.

For 139 industrial laundry facilities that responded to the detailed questionnaire, EPA predicted steady-state, in-stream pollutant concentrations by assuming complete immediate mixing with no loss from the system. (Because of incomplete information on the POTWs to which some of the sample facilities discharge, EPA was unable to include in the benefits analysis 33 of the 172 facilities surveyed.) These 139 facilities discharge to 118 POTWs that in turn discharge to 113 water bodies (88 rivers/streams, 21 bays/estuaries, and 4 lakes).

EPA then extrapolated the environmental assessment results for the sample facilities to the entire population of industrial laundry facilities nationwide (approximately 1,606 facilities discharging to 1,178 POTWs discharging to 1,133 waterbodies). For this extrapolation, each sample facility received a sample weight based on the varying number of additional facilities of the same approximate size engaged in similar activities under similar economic conditions.

EPA then estimated the change in aggregate cancer risk through consumption of fish in waterbodies where the identified POTWs discharge. EPA predicted pollutant concentrations in fish by using the in-stream concentration from POTW effluent where industrial laundry discharges are expected to pass through and pollutant-specific bioconcentration factors. EPA used data on licensed fishing populations by state and county, presence of fish advisories, fishing activity rates, and average household size to estimate the exposed population of recreational and subsistence anglers and their families that would benefit from reduced pollutant concentrations in fish. EPA used fish consumption rates for recreational and subsistence anglers to estimate exposure levels. Based on these data, EPA estimated the change in cancer risk among these populations.

For combined recreational and subsistence angler household populations, EPA projects that the treatment options would eliminate approximately 0.04 cancer cases per year from a baseline of about 0.1 cases estimated at the current discharge level (see Table ES-2).

Table ES-2. Estimated Annual Avoided Cancer Cases from Freshwater Fish Consumption	
Regulatory Option	**Number of Avoided Cases (National Estimates)**
Baseline	--
CP-IL	0.04
DAF-IL	0.04
Combo-IL	0.04

EPA also evaluated reduced occurrence of in-waterway pollutant concentrations in excess of human-health based ambient water quality criteria (AWQC). At current discharge levels, in-stream concentrations of two pollutants --bis(2-ethylhexyl)phthalate and tetrachloroethene -- are projected to exceed human health criteria (developed for consumption of water and organisms) in nine receiving streams nationwide (see Table ES-3) for a total of 17 exceedences. The proposed PSES regulated discharge levels would eliminate the occurrence of pollutant concentrations in excess of the human health-based AWQCs in 7 of 9 affected streams.

Table ES-3. Discharge Reaches with Pollutant Concentrations Exceeding AWQC Limits for Protection of Human Health, and Reductions Achieved by Regulatory Options	
	Number of Reaches with Concentrations Exceeding Health-Based AWQCs (National Basis)
Regulatory Option	**Water and Organisms**
Baseline	9
CP-IL	2
DAF-IL	2
Combo-IL	2

Ecological Benefits Valued on the Basis of Enhanced Recreational Fishing Opportunities

EPA analyzed one measure of ecological benefits from the proposed regulation: reduced occurrence of in-waterway pollutant concentrations in excess of acute and chronic exposure AWQCs that protect aquatic life. EPA used the findings from the analysis of reduced occurrence of pollutant concentrations in excess of both EPA's ecological and human health AWQCs to assess improvements in recreational fishing habitats and, in turn, to estimate a monetary value for the enhanced recreational fishing opportunities.

To assess aquatic life benefits, EPA estimated the effect of facility discharges of regulated pollutants on pollutant concentrations in affected waterways. EPA compared the estimated concentrations, on a baseline and post-compliance basis, with the Agency's AWQCs for acute and chronic exposure impacts to aquatic life. Pollutant concentrations in excess of these values indicate potential impacts to aquatic life. EPA's analysis found that 78 stream reaches exceed chronic AWQC values at baseline discharge levels for a total of 93 exceedences (see Table ES-4). Under three options, EPA estimates that the proposed regulation would eliminate concentrations in excess of the chronic AWQC values for aquatic life in 66 affected reaches. EPA predicts that no pollutants under current or proposed discharge levels would exceed acute AWQC.

EPA expects that society will value improvements in aquatic species habitat, resulting from the reduction of pollutant concentrations in excess of the chronic AWQC values, by a number of mechanisms. For this analysis, EPA estimated a partial monetary value of ecological improvements based on the value of enhanced recreational fishing opportunities. Specifically, the elimination of pollutant concentrations exceeding AWQC limits for protection of aquatic species and human health is expected to generate benefits to recreational anglers. Such benefits are expected to manifest as increases in the value of the fishing experience per day fished or the number of days anglers subsequently choose to fish the cleaner waterways. These benefits, however, do not include all of the benefits that are associated with improvements in aquatic life. For example, recreational benefits do not capture the benefit of increased assimilative capacity of a receiving waterbody, improvements in the taste and odor of the instream flow, or improvements to other recreational activities such as swimming and wildlife observation that may be enhanced by improved water quality.

Table ES-4. Discharge Reaches with Pollutant Concentrations Exceeding *Chronic* AWQC Limits for Protection of Aquatic Species, and Reductions Achieved by Regulatory Options

Regulatory Option	Number of Pollutants Estimated to Exceed Chronic AWQC Limits	Number of Reaches with Concentrations Exceeding Chronic AWQC Limits	Total Exceedences of Chronic AWQC Limits
Baseline	3	78	93
CP-IL	2	12	19
DAF-IL	2	12	19
Combo-IL	2	12	19
None of the *acute* AWQC limits were estimated to be exceeded in the baseline.			

Benefits from Reduced Cost of Sewage Sludge Disposal and Reduced Incidence of Inhibition

EPA expects that reduced effluent discharges from the industrial laundry industry would also yield economic productivity benefits. For this analysis, EPA estimated productivity benefits for two benefit categories: reduced pollutant contamination of effluent discharged by industrial laundry facilities to sewage treatment systems and associated savings in sewage sludge use or disposal costs; and, a reduction in biological inhibition of activated sludge. For the former category, EPA examined the following: (1) whether industrial laundry baseline discharges would prevent POTWs from being able to meet the metal concentration limits required for certain lower cost sewage sludge use/disposal practices — beneficial land application and surface disposal; and (2) whether limitations on the selection of management practices would be removed under regulatory options.

EPA has promulgated regulations establishing standards for sewage when it is applied to the land, disposed of at dedicated sites (surface disposal), and incinerated (40 CFR Part 503). For land application, the regulations include three sets of pollutant concentration limits for ten metals: (1) Pollutant Ceiling Limits, which all land-applied sewage sludge must meet with certain limitations, (2) Cumulative Pollutant Loading Limits (which limit the cumulative amount of metal which may be applied to the soil) and (3) more stringent Pollutant Concentration Limits, which provide more favorable terms for land application of sewage sludge.

EPA estimated sewage sludge concentrations of ten metals for sample facilities under baseline and post-regulatory options discharge levels. EPA compared these concentrations with the relevant metal concentration limits for the following sewage sludge management options: Land Application-High (Concentration Limits), Land Application-Low (Ceiling Limits), and Surface Disposal. In the baseline case, EPA estimated that concentrations of one pollutant (lead) at ten POTWs would fail the Land Application-High limits while meeting the Land Application-Low limits. EPA estimated that no POTWs would fail any of the Surface Disposal limits. Under all three regulatory options, EPA estimated that all ten POTWs would meet the Land Application-High limits. EPA expects that an estimated 6,200 dry metric tons (TDMT) of annual disposal of sewage sludge would newly qualify for beneficial use under the Land Application-High limits as a result of the industrial laundry regulation. By meeting the more stringent Land Application-High Criteria, EPA expects that POTWs will benefit by reduced record-keeping costs and generally greater flexibility in management of sewage sludge.

EPA estimated inhibition of POTW operations by comparing predicted POTW influent concentrations to available inhibition levels for 45 pollutants (not including oil and grease). At current discharge levels, EPA estimates POTW concentrations of lead exceed biological inhibition criteria at two POTWs. Under all treatment options, inhibition problems are eliminated.

EPA based the POTW inhibition and sludge values upon engineering and health estimates contained in guidance or guidelines published by EPA and other sources because the values used in this analysis are not, in general, regulatory values. EPA did not base the proposed pretreatment discharge standards directly on this approach. However, the values and methodology used in this analysis are helpful in identifying potential benefits for POTW operations and sludge disposal that may result from the compliance with proposed pretreatment discharge requirements.

Discussions with POTW Operators and Pre-Treatment Coordinators

To understand the frequency and characteristics of problems to POTWs resulting from industrial laundry discharges, EPA spoke to POTW pre-treatment coordinators in EPA's regional offices and in states and to individual POTW operators. Several pre-treatment coordinators and operators recommended other sources to call for more information on the subject. In these conversations, EPA discussed 40 POTWs that receive discharges from industrial laundries. Of these 40 POTWs, 11 were described as encountering some difficulty resulting from industrial laundry discharges while 29 reported having no problems from industrial laundry discharges. Problems encountered by POTWs include oil and grease, which may clog pipes and pump stations, inhibit activated sludge, and otherwise inhibit POTW operations; metals, which may also inhibit activated sludge; and pH fluctuations, which can injure POTW workers and deteriorate concrete pipes and manholes.

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1. INTRODUCTION

1.1 Description of the Industrial Laundry Industry

The industrial laundry industry comprises approximately 1,747 facilities which wash light, non-industrial items (e.g., linens from hotels, hospitals, and restaurants) and/or heavy, industrial items (e.g., printer rags, shop towels, and mats). For this proposed regulation, EPA is considering only 1,606 facilities with annual production greater than or equal to one million pounds or shop and printer towel annual production greater than or equal to 255,000 pounds. The industrial laundry facilities are all indirect dischargers (i.e., each facility discharges to a Publicly Owned Treatment Works (POTW) as opposed to directly discharging to a waterbody). Currently, approximately 87 percent of the facilities do not have any wastewater treatment in place. Of the facilities with some treatment in place, some segregate what they perceive as "heavy" items from "light" items and only treat the wastewater generated from washing the heavy items.

At current discharge levels, industrial laundry facilities discharge 4.9 million pounds per year of priority and nonconventional pollutants (excluding chemical oxygen demand, total organic carbon, and total petroleum hydrocarbons measured as Silica Gel Treated n-Hexane Extractable Material (SGT-HEM)) and 35.9 million pounds per year of oil and grease measured as n-Hexane Extractable Material (HEM), including 13.2 million pounds per year of SGT-HEM.

1.2 Purpose of the Environmental Assessment Document

The purpose of this Environmental Assessment is to estimate the environmental impact of industrial laundry discharges on waterbodies and POTWs under both current conditions and conditions corresponding to three regulatory options. First, EPA established a baseline of environmental effects by modeling current pollutant discharges from industrial laundries. Then, EPA modeled changes in pollutant loadings corresponding to the implementation of various regulatory options to estimate how environmental effects would change with the regulation of industrial laundry discharges.

The four types of environmental impacts quantified by EPA in this Environmental Assessment are:

- estimates of the occurrence of pollutant concentrations in excess of EPA Ambient Water Quality Criteria (AWQC) for protection of human health and aquatic species in waterways (streams, lakes, and bays and estuaries) receiving discharges (via POTWs) from industrial laundries;

- estimates of the occurrence of POTW inhibition problems resulting from industrial laundries' discharges;

- estimates of the inability of POTWs to use preferable sewage sludge management or disposal methods, i.e., beneficial land application or surface disposal, because of metals discharges from industrial laundries; and

- estimates of the number of cancer cases attributable to pollutant-tainted fish in waterways receiving discharges (via POTWs) from industrial laundries.

1.3 Treatment Options Considered for the Industrial Laundry Industry

For this rulemaking, EPA evaluated the environmental benefits of controlling the pollutant discharges from industrial laundry facilities to POTWs through national analyses of the primary treatment options: organics control only, dissolved air flotation (DAF-IL), chemical precipitation (CP-IL), and a combined option with either DAF or CP for all wastewater (Combo-IL). Since EPA determined that the organics control only option did not remove a greater amount of the organics than the other options, EPA did not perform a separate environmental assessment for this.

1.4 Organization of the Environmental Assessment Document

EPA organized this document into five major sections. The first section, which includes this sub-section, provides a brief description of the industrial laundry industry and the regulatory treatment options being considered. The second section provides information on the pollutants found in industrial laundry discharges. The third section describes the methodology used to estimate environmental impacts, including extrapolation of sample sets to the national level and estimates of water quality impacts. The fourth section describes data sources for industrial laundry facilities and for POTWs. The fifth section presents the results of the environmental assessment. Two appendices provide further detail on statistical methods and on chemical-specific data used.

2. CHARACTERIZATION OF POLLUTANTS IN INDUSTRIAL LAUNDRY DISCHARGES

The extent of human and ecological exposure and risk from environmental releases of toxic chemicals depends on chemical-specific properties, the mechanism and media of release, and site-specific environmental conditions. Chemical-specific properties include toxicological effects on living organisms, hydrophobicity/lipophilicity, reactivity, and persistence.

The methodology EPA used in assessing the fate and toxicity of pollutants associated with industrial laundry discharges consists of three steps: (1) chemical identification; (2) compilation of physical-chemical and toxicity data; and (3) categorization assessment. These steps are described in detail below. A summary of the major assumptions and limitations associated with this methodology is also presented.

2.1 Chemical Identification

From October 1992 through April 1997, EPA conducted sampling of industrial laundry facilities located nationwide to determine the presence or absence of priority, conventional, and nonconventional pollutants in the industrial laundry discharges. The Agency collected samples of raw wastewater during eight sampling episodes. EPA used these data and applicable criteria to select 72 pollutants for regulation from the 315 pollutants initially identified as pollutants of concern. EPA was able to assess the potential fate and toxicity of 67 of these pollutants, including 31 priority pollutants (18 priority organics and 13 priority metals), 35 nonconventional pollutants (24 nonconventional organics and 11 nonconventional metals), and one bulk nonconventional pollutant (total petroleum hydrocarbons, measured as SGT-HEM). Exhibit 1 presents the potential fate and toxicity, based on known characteristics of each chemical, of 67 pollutants of concern. Although potential fate and toxicity data are not available for the three conventional and two bulk nonconventional pollutants (also listed in Exhibit 1), these pollutants are associated with adverse water quality impacts, as described further below.

2.2 Compilation of Physical-Chemical and Toxicity Data

The chemical-specific data needed to conduct the fate and toxicity evaluation for this study include aquatic life criteria or toxic effect data for native aquatic species, human health reference doses (RfDs) and cancer potency slope factors (SFs), EPA maximum contaminant levels (MCLs) for drinking water protection, and bioconcentration factors (BCFs) for native aquatic species.

Sources of the above data include EPA ambient water quality criteria documents and updates, EPA's ASsessment Tools for the Evaluation of Risk (ASTER) and the associated AQUatic Information REtrieval System (AQUIRE) and Environmental Research Laboratory-Duluth fathead minnow database, EPA's Integrated Risk Information System (IRIS), EPA's Health Effects Assessment Summary Tables (HEAST), EPA's 1991 and 1993 Superfund Chemical Data Matrix (SCDM), EPA's 1989 Toxic Chemical Release Inventory Screening Guide, Syracuse Research Corporation's CHEMFATE and BIODEG databases, EPA and other government reports, scientific literature, and other primary and secondary data sources. To ensure that the examination is as comprehensive as possible, EPA took alternative measures to compile data for chemicals for which physical-chemical property and/or toxicity data are not presented in the sources listed above. To the extent possible, EPA estimated values for the chemicals using the quantitative structure-activity relationship (QSAR) model incorporated in ASTER, or for some physical-chemical properties, utilized published linear regression correlation equations.

2.2.1 Aquatic Life Data

EPA obtained ambient criteria or toxic effect concentration levels for the protection of aquatic life primarily from EPA's ambient water quality criteria documents and ASTER. For several pollutants, EPA has published ambient water quality criteria for the protection of both freshwater and marine aquatic life from acute and chronic effects. The acute value represents a maximum allowable 1-hour average concentration of a pollutant at any time that protects aquatic life from lethality. The chronic value represents the average allowable concentration of a toxic pollutant over a four-day period at which a diverse genera of aquatic organisms and their uses should not be unacceptably affected, provided that these levels are not exceeded more than once every three years.

For pollutants for which no water quality criteria have been developed, EPA used values from published aquatic toxicity test data or estimated values from the ASTER QSAR model. In selecting values from the literature, EPA preferred measured concentrations from flow-through studies under typical pH and temperature conditions. In addition, the test organism must be a North American resident species of fish or invertebrate. The hierarchies used by EPA to select the appropriate acute and chronic values are listed below in descending order of priority.

Acute Aquatic Life Values

- National acute water quality criteria;
- Lowest reported acute test values (96-hour LC_{50} for fish and 48-hour EC_{50}/LC_{50} for daphnids);
- Lowest reported LC_{50} test value of shorter duration, adjusted to estimate a 96-hour exposure period;
- Lowest reported LC_{50} test value of longer duration, up to a maximum of two weeks exposure; and,
- Estimated 96-hour LC_{50} from the ASTER QSAR model.

Chronic Aquatic Life Values

- National chronic water quality criteria;
- Lowest reported maximum allowable toxic concentration (MATC), lowest observable effect concentration (LOEC), or no observable effect concentration (NOEC);
- Lowest reported chronic growth or reproductive toxicity test concentration; and,
- Estimated chronic toxicity concentration from a measured acute to chronic ratio for a less sensitive species; a quantitative structure-activity relationship (QSAR) model; or a default acute to chronic ratio of 10:1.

Chronic Toxicity Values for Total Petroleum Hydrocarbons (TPH)

Because total petroleum hydrocarbons do not constitute a definitive chemical category, but instead include many organic compounds with varying physical, chemical, and toxicological properties, it is difficult for EPA to establish a numerical criterion which would be applicable to all types of petroleum hydrocarbons. Given this difficulty and the chronic toxic potential of petroleum hydrocarbons, EPA recommends using an application factor of 0.01 and the 96-hr LC_{50} for a sensitive resident species for individual petrochemical components (U.S. EPA, 1987b). EPA compiled lethal toxicities of various petroleum products to aquatic organisms (U.S. EPA, 1976). A wide range of toxic effect levels for a variety of petroleum products is reported for all types of organisms evaluated (i.e., fish, crustacea, larvae and eggs, gastropods, bivalves, invertebrates, and flora). The most sensitive categories of organisms, the marine larvae and benthic invertebrates, appear to be intolerant of petroleum products, particularly the water-soluble compounds, at concentrations ranging from 0.1 ppm to 25 ppm and 1 ppm to 6,100 ppm, respectively. Although most of the reported data are for marine organisms, Nelson-Smith (1973) states that within a range of limits, "toxicities are much the same in salt as in freshwater".

In keeping with the established hierarchy of selecting the lowest reported 24 to 96-hr LC_{50} for a North American resident species of fish or invertebrate, EPA selected the 96-hr LC_{50} value of 5.6 mg/L for soluble hydrocarbons to freshwater finfish as representative of TPH toxicity in industrial laundries. EPA then calculated the chronic aquatic life value of 56 μg/L by applying an application factor of 0.01.

Bioconcentration Factor Data

Bioconcentration factor (BCF) data are available from numerous data sources, including EPA ambient water quality criteria documents and EPA's ASTER. Because measured BCF values are not available for several chemicals, methods are used to estimate this parameter based on the octanol/water partition coefficient or solubility of the chemical. Such methods are detailed in Lyman et al. (1990). Multiple values are reviewed, and a representative value is selected according to the following guidelines:

- Resident U.S. fish species are preferred over invertebrates or estimated values.
- Edible tissue or whole fish values are preferred over nonedible or viscera values.
- Estimates derived from octanol/water partition coefficients are preferred over estimates based on solubility or other estimates, unless the estimate comes from EPA Criteria Documents.

The most conservative value (i.e., the highest BCF) is selected among comparable candidate values.

Exhibit B-1 in Appendix B provides a listing, by pollutant, of acute and chronic aquatic life values and BCF data used in these analyses. Freshwater chronic and acute AWQC limits were available for 65 and 59 pollutants, respectively, and salt water chronic and acute AWQC limits were available for 11 and 19 pollutants, respectively.

2.2.2 Human Health Data

Human health toxicity data include chemical-specific reference doses (RfDs) for non-cancer effects, and potency slope factors (SFs) for carcinogenic effects. EPA obtained RfDs and SFs first from EPA's Integrated Risk Information System (IRIS), and secondarily from EPA's Health Effects Assessment Summary Tables (HEAST). The RfD is an estimate of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious non-cancer health effects over a lifetime (U.S. EPA, 1989a). A chemical with a low RfD is more toxic than a chemical with a high RfD. Non-cancer effects include systemic effects (e.g., immunological, neurological, circulatory, or respiratory toxicity), reproductive toxicity, and developmental toxicity. EPA recommends a threshold level assessment approach for these systemic and other effects because several protective mechanisms must be overcome prior to the appearance of an adverse non-cancer effect. In contrast, EPA assumes that cancer growth can be initiated from a single cellular event, and therefore should not be subject to a threshold level assessment approach. The SF is an upper bound estimate of the probability of cancer per unit intake of a chemical over a lifetime (U.S. EPA, 1989a). A chemical with a large SF has greater potential to cause cancer than a chemical with a small SF.

For this analysis, human health criteria values are developed for two exposure routes: (1) ingesting the pollutant via contaminated aquatic organisms only (carcinogens and noncarcinogens), and (2) ingesting the pollutant via both water and contaminated aquatic organisms (noncarcinogens only). The equations for developing the values are presented below.

For Non-cancer Protection (ingestion of organisms only)

$$HH_{oo} = \frac{RfD \cdot CF}{IR_f \cdot BCF}$$

where:

HH_{oo}	=	human health value (µg/L),
RfD	=	reference dose (mg/day),
IR_f	=	fish ingestion rate (kg/day),
BCF	=	bioconcentration factor (L/kg), and
CF	=	conversion factor for units (1,000 µg/mg).

For Carcinogenic Protection (ingestion of organisms only)

$$HH_{oo} = \frac{BW \cdot RL \cdot CF}{SF \cdot IR_f \cdot BCF}$$

where:

HH_{oo}	=	human health value (µg/L),
BW	=	body weight (kg),
RL	=	risk level,
SF	=	cancer slope factor $(mg/kg\text{-}day)^{-1}$,
IR_f	=	fish ingestion rate (kg/day),
BCF	=	bioconcentration factor (L/kg), and
CF	=	conversion factor for units (1,000 µg/mg).

For Non-cancer Protection (ingestion of water and organisms)

$$HH_{wo} = \frac{RfD \cdot CF}{IR_w + (IR_f \cdot BCF)}$$

where:

HH_{wo}	=	human health value (µg/L),
RfD	=	reference dose (mg/day),
IR_w	=	water ingestion rate (L/day),
IR_f	=	fish ingestion rate (kg/day),
BCF	=	bioconcentration factor (L/kg), and
CF	=	conversion factor for units (1,000 µg/mg).

The values for ingesting water and organisms are derived by assuming an average daily ingestion rate of 2 L of water, an average daily fish consumption rate of 6.5 g, and an average adult body weight of 70 kg (U.S. EPA, 1991). Protective concentration levels for carcinogens are developed in terms of non-threshold lifetime risk level. EPA chose to develop criteria at a risk level of 10^{-6} for this analysis. This risk level indicates a probability of one additional case of cancer for every 1,000,000 persons exposed.

The hierarchy used to select the most appropriate human health criteria values is listed below in descending order of priority:

- Calculated human health criteria values using EPA's Integrated Risk Information System (IRIS) reference doses (RfDs) or slope factors (SFs) used in conjunction with adjusted three percent lipid BCF values derived from *Ambient Water Quality Criteria Documents* (U.S. EPA, 1980); three percent is the mean lipid content of fish tissue reported in the study from which the average daily fish consumption rate of 6.5 g/day was derived;

- Calculated human health criteria values using current IRIS RfDs or SFs and representative BCF values for common North American species of fish or invertebrates or estimated BCF values;

- Calculated human health criteria values using RfDs or SFs from EPA's Health Effects Assessment Summary Tables (HEAST) used in conjunction with adjusted three percent lipid BCF values derived from *Ambient Water Quality Criteria Documents* (U.S. EPA, 1980);

- Calculated human health criteria values using current RfDs or SFs from HEAST and representative BCF values for common North American species of fish or invertebrates or estimated BCF values;

- Criteria guidance from the *Ambient Water Quality Criteria Documents* (U.S. EPA, 1980); and,

- Calculated human health values using RfDs or SFs from data sources other than IRIS or HEAST.

This hierarchy is based on Section 2.4.6 of the *Technical Support Document for Water Quality-based Toxics Control* (U.S. EPA, 1991), which recommends using the most current risk information from IRIS when estimating human health risks. In cases where chemicals have both RfDs and SFs from the same level of the hierarchy, EPA calculated human health values for both types of toxicity effects. Exhibit B-2 in Appendix B provides a listing, by pollutant, of human health risk values used in these analyses.

For the pollutant arsenic, 30 states have adopted a less stringent human health criteria value for arsenic ingestion via both water and contaminated aquatic organisms. For those states, the state criteria values were used in this analysis. (See Exhibit B-2 for a list of the states and their criteria.)

Other chemical designations related to potential adverse human health effects include EPA assignment of a concentration limit for protection of drinking water, and EPA identification as a hazardous air pollutant (HAP) in wastewater, or a pollutant regulated under the Resource Conservation and Recovery Act (RCRA). EPA establishes drinking water criteria and standards, such as the maximum contaminant level (MCL), under authority of the Safe Drinking Water Act (SDWA). Current MCLs are available from IRIS. A set of 189 hazardous air pollutants are identified in the Clean Air Act. The Office of Air Quality Planning and Standards (OAQPS) has reduced the set of 189 pollutants to produce a draft list of 111 pollutants that are considered to be hazardous air pollutants when present in wastewater (McDonald, 1994). OAQPS eliminated pollutants that are inorganic, do not persist in water (short half-life), or have a Henry's Law constant less than 0.1 atm/mole fraction (approximately 2 x 10^{-6} atm-m^3/mol). RCRA pollutants are listed in Appendix VIII to that regulation.

2.3 Categorization Assessment

The objective of this generalized evaluation of fate and toxicity potential is to place chemicals into groups with qualitative descriptors of potential environmental behavior and impact. EPA based these groups on categorization schemes derived for:

- Acute aquatic toxicity (highly, moderately, or slightly toxic); and
- Bioaccumulation potential (high, moderate, slight, or no significant potential).

These categorization schemes identify the relative aquatic toxicity and bioaccumulation potential for each chemical associated with industrial laundry discharges. This evaluation also identifies chemicals which: (1) are known or probable human carcinogens; (2) are systemic human health toxicants; (3) have EPA human health drinking water standards; (4) are tentatively designated as HAPs in wastewater by OAQPS; and (5) are RCRA pollutants. The results of this analysis can provide a qualitative indication of potential risk posed by the release of these chemicals. Actual risk depends on the magnitude, frequency, and duration of pollutant loading; site-specific environmental conditions; proximity and number of human and ecological receptors; and relevant exposure pathways. The following discussion outlines the categorization schemes. Ranges of parameter values defining the categories are also presented.

2.3.1 Acute Aquatic Toxicity

Key Parameter: Acute aquatic life criteria, LC_{50}, or other benchmark (AT) (µg/L)

Using acute criteria or lowest reported acute test results (generally 96-hour and 48-hour durations for fish and invertebrates, respectively), EPA grouped chemicals according to their relative short-term effects on aquatic life.

Categorization Scheme:

$AT < 100$	Highly toxic
$100 \leq AT \leq 1000$	Moderately toxic
$AT > 1000$	Slightly toxic

This scheme, used as a rule-of-thumb guidance by EPA's Office of Pollution Prevention and Toxics (OPPT) for Premanufacture Notice (PMN) evaluations, is used to indicate chemicals that could potentially cause lethality to aquatic life downstream of discharges.

2.3.2 Bioaccumulation Potential

Key Parameter: Bioconcentration Factor (BCF) (L/kg)

$$BCF = \frac{Equilibrium\ chemical\ concentration\ in\ organism\ (mg/kg,\ wet\ weight)}{Mean\ chemical\ concentration\ in\ water\ (mg/L)}$$

BCF is a good indicator of a chemical's potential to accumulate in aquatic biota through uptake across an external surface membrane.

Categorization Scheme:

$BCF > 500$	High potential
$50 \leq BCF \leq 500$	Moderate potential
$5 \leq BCF < 50$	Slight potential
$BCF < 5$	No significant potential

This scheme is used to identify chemicals that may be present in fish or shellfish tissues at higher levels than in surrounding water. These chemicals may accumulate in the food chain and increase pollutant exposure of higher trophic level populations, including people consuming their sport catch or commercial seafood.

Based on available physical-chemical properties and aquatic life and human health toxicity data for the 72 evaluated pollutants, EPA identified that 17 of these pollutants exhibit moderate to high toxicity to aquatic life; 39 are human non-cancer toxicants; 8 are classified as known or probable human carcinogens; 17 are designated as hazardous air pollutants (HAP) in wastewater; and 26 are RCRA pollutants. The Agency also determined that 23 of the 72 evaluated pollutants have a moderate to high potential to bioaccumulate in aquatic biota (potentially accumulating in the food chain and causing increased risk to higher trophic level organisms and to exposed human populations via fish and shellfish consumption).

Although EPA did not evaluate the potential fate and toxicity of the three conventional pollutants and two bulk nonconventional pollutants, the discharge of conventional pollutants (biochemical oxygen demand (BOD 5-day), total suspended solids (TSS), and oil and grease (OG)) and nonconventional pollutants (chemical oxygen demand (COD) and total organic carbon (TOC)) can have adverse effects on human health and the environment. For example, habitat degradation can result from increased suspended particulate matter that reduces light penetration and primary productivity, or from accumulation of particles that alter benthic spawning grounds and feeding habitats. Oil and grease can have a lethal effect on fish by coating gill surfaces and causing asphyxia, depleting oxygen levels as a result of excessive biological oxygen demand, and inhibiting stream reaeration due to the creation of a surface film. Oil and grease can also have detrimental effects on waterfowl by destroying the buoyancy and insulation of their feathers. High COD and BOD levels can deplete oxygen concentrations, which can result in mortality or other adverse effects on fish.

Exhibit 1: Potential Fate and Toxicity of Pollutants of Concern										
Type	Chemical Name	CAS Number	Aquatic Toxicity Category	Bioaccumulation Category	Carcinogenic Effect	Non-Cancer Health Effect	Drinking Water Criterion	Hazardous Air Pollutant in Wastewater	RCRA Pollutant	Priority Pollutant
C	Biological Oxygen Demand (5-day)		*	Unknown						
C	Chemical Oxygen Demand		*	Unknown						
C	Total Organic Carbon		*	Unknown						
C	Total Petroleum Hydrocarbons		Unknown	Unknown						
C	Total Recoverable Oil and Grease		*	Unknown						
C	Total Suspended Solids		*	Unknown						
Me	Aluminum	7429905	Moderate	Moderate			SM			
Me	Antimony	7440360	High	Insignificant		✓	M		✓	✓
Me	Arsenic	7440382	Moderate	Slight	✓	✓	M		✓	✓
Me	Barium	7440393	Slight	Unknown		✓	M		✓	
Me	Beryllium	7440417	Moderate	Slight	✓	✓	M		✓	✓
Me	Boron	7440428	Unknown	Unknown		✓				
Me	Cadmium	7440439	High	Moderate		✓	M		✓	✓
Me	Chromium	7440473	Slight	Slight		✓	M		✓	✓
Me	Cobalt	7440484	Slight	Unknown						
Me	Copper	7440508	High	Moderate			TT			✓
Me	Iron	7439896	Unknown	Unknown			SM			
Me	Lead	7439921	High	Slight		✓	TT		✓	✓
Me	Manganese	7439965	Unknown	Unknown		✓	SM			
Me	Mercury	7439976	High	High		✓	M		✓	✓
Me	Molybdenum	7439987	Unknown	Unknown		✓				
Me	Nickel	7440020	Slight	Slight		✓	M		✓	✓
Me	Selenium	7782492	High	Insignificant		✓	M		✓	✓
Me	Silver	7440224	High	Insignificant		✓	SM		✓	✓
Me	Thallium	7440280	Slight	Moderate			M		✓	✓
Me	Tin	7440315	Unknown	Unknown		✓				
Me	Titanium	7440326	Unknown	Unknown						
Me	Vanadium	7440622	Slight	Unknown		✓				
Me	Yttrium	7440655	Unknown	Unknown						
Me	Zinc	7440666	Moderate	Slight		✓	SM			✓
O	Benzoic acid	65850	Slight	Slight		✓				
O	Benzyl alcohol	100516	Slight	Insignificant		✓				
O	Bis(2-ethylhexyl) phthalate	117817	Moderate	Moderate	✓	✓	M	✓		✓
O	Butanone, 2-	78933	Slight	Insignificant		✓		✓	✓	
O	Butyl benzyl phthalate	85687	Slight	Moderate		✓			✓	✓
O	Chlorobenzene	108907	Slight	Slight		✓	M	✓	✓	✓
O	Chloroform	67663	Slight	Insignificant	✓	✓	M			✓
O	Cresol, p-	106445	Slight	Slight		✓		✓	✓	
O	Cymene, p-	99876	Slight	High						
O	Decane, n-	124185	Slight	High						
O	Di-n-butyl phthalate	84742	Moderate	Moderate		✓		✓	✓	✓

Exhibit 1: Potential Fate and Toxicity of Pollutants of Concern

Type	Chemical Name	CAS Number	Aquatic Toxicity Category	Bioaccumulation Category	Carcinogenic Effect	Non-Cancer Health Effect	Drinking Water Criterion	Hazardous Air Pollutant in Wastewater	RCRA Pollutant	Priority Pollutant
O	Di-n-octyl phthalate	117840	Moderate	High		✓			✓	✓
O	Dichloroethene, trans-1,2-	156605	Slight	Insignificant		✓	M		✓	✓
O	Diphenylhydrazine, 1,2-	122667	Moderate	Slight	✓			✓	✓	✓
O	Docosane, n-	629970	Slight	High						
O	Dodecane, n-	112403	Slight	High						
O	Eicosane, n-	112958	Slight	High						
O	Ethylbenzene	100414	Slight	Slight		✓	M	✓		✓
O	Hexacosane, n-	630013	Slight	Unknown						
O	Hexadecane, n-	544763	Slight	High						
O	Hexanoic acid	142621	Slight	Slight						
O	Isophorone	78591	Slight	Insignificant	✓	✓		✓		✓
O	Methylphenol, 4-chloro-3-	59507	Slight	Moderate						✓
O	Methylene chloride	75092	Slight	Insignificant	✓	✓	M	✓	✓	✓
O	Methylnaphthalene, 2-	91576	Moderate	High						
O	Naphthalene	91203	Slight	Slight		✓		✓	✓	✓
O	Octacosane, n-	630024	Slight	Unknown						
O	Octadecane, n-	593453	Slight	High						
O	Pentamethylbenzene	700129	Moderate	High						
O	Pentanone, 4-methyl-2-	108101	Slight	Insignificant		✓		✓		
O	Phenol	108952	Slight	Insignificant		✓		✓	✓	✓
O	Propanone, 2-	67641	Slight	Insignificant		✓				
O	Terpineol, alpha-	98555	Slight	Unknown						
O	Tetrachloroethene	127184	Slight	Slight	✓	✓	M	✓	✓	✓
O	Tetracosane, n-	646311	Slight	High						
O	Tetradecane, n-	629594	Slight	High						
O	Toluene	108883	Slight	Slight		✓	M	✓	✓	✓
O	Triacontane, n-	638686	Slight	Unknown						
O	Trichloroethane, 1,1,1-	71556	Slight	Slight		✓	M			✓
O	Trichloroethene	79016	Slight	Slight			M	✓	✓	✓
O	Xylene, m-	108383	Slight	Moderate		✓	M	✓		
O	Xylene, o- and p-	136777612	Slight	Moderate		✓	M	✓		

C: Conventional or bulk nonconventional pollutant.
Me: Metal pollutant.
O: Organic pollutant.
M: Maximum Contaminant Level (MCL) established for health-based effect. Chloroform is part of the Total Trihalomethanes category; m-, o-, and p-xylenes are in Total Xylenes.
SM: Secondary Maximum Contaminant Level (SMCL) established for taste or aesthetic effect.
TT: Treatment technology action level established.
*: Can indirectly cause toxicity by promoting algal blooms, decreasing oxygen content, coating fish gills, etc.
✓: Pollutant has indicated characteristic.
See Section 2.3 for category definitions (slight, moderate, etc.).

2.4 Assumptions and Limitations

The major assumptions and limitations associated with the data compilation and categorization schemes are summarized in the following two sections.

2.4.1 Data Compilation

- If data are readily available from electronic databases, other primary and secondary sources are not searched.
- Many of the data are estimated and therefore can have a high degree of associated uncertainty.
- For some chemicals, neither measured nor estimated data are available for key categorization parameters. In addition, chemicals identified for this study do not represent a complete set of wastewater constituents. As a result, this study is an incomplete assessment of industrial laundry wastewater.

2.4.2 Categorization Schemes

- Receiving waterbody characteristics, magnitude of pollutant loadings, exposed populations, and potential exposure routes are not considered.
- Placement into groups is based on order-of-magnitude data breaks for several categorization schemes. Combined with data uncertainty, this may lead to an overstatement or understatement of the characteristics of a chemical.
- Data derived from laboratory tests may not accurately reflect conditions in the field.
- Available aquatic toxicity and bioconcentration test data may not represent the most sensitive species.

3. METHODOLOGY

3.1 Sample Set Data Analysis and National Extrapolation

EPA based the analyses in this Environmental Assessment on data from 172 industrial laundry facilities that it surveyed as the basis for the economic, engineering, and environmental analyses being performed in support of the industrial laundry regulation. EPA estimates that these 172 facilities represent 1,606 industrial laundry facilities nationwide. All sample facilities are indirect dischargers (e.g., each facility discharges to a POTW as opposed to directly discharging to a waterbody). EPA evaluated impacts of industrial laundry discharges on POTW operations, human health, and aquatic life under baseline discharge conditions and under the three treatment technology options. Because of incomplete information on the POTWs to which some of the sample facilities discharge, EPA deleted 33 facilities from the analysis. EPA used the procedure for addressing item level nonresponse, outlined in *Steps to Generate National Estimates of Means and Totals* (SAIC, 1996), to adjust the sample weights for the remaining facilities in each affected stratum. The sample weight adjustment has the effect of assigning the sample mass for a lost observation(s) to the remaining observations in the affected stratum. As a result, EPA performed analyses on 139 sample facilities discharging to 118 POTWs.

Appendix A provides further detail on the simple linear weighting technique and the differential weighting technique used to extrapolate results estimated for the sample facilities to the population level.

3.2 Estimated Water Quality Impacts

EPA estimated water quality impacts of indirect dischargers on POTW operations and their receiving waterways by using various modeling techniques. EPA quantified the releases of 72 pollutants of concern under both current (baseline) conditions and the three treatment technology options. EPA then evaluated site-specific potential aquatic life and human health impacts resulting from current and proposed pollutant releases. EPA compared projected water concentrations for each pollutant to EPA water quality criteria, or to toxic effect levels (i.e., lowest reported or estimated toxic concentration) for pollutants for which no water quality criteria have been developed. EPA also made estimates of cancer cases attributable to the consumption of contaminated fish. The analyses of impacts of industrial laundry discharges on POTW operations include estimates of the occurrence of biological inhibition and estimates of limitations on the ability of POTWs to adopt most favorable practices for use or disposal of sewage sludge. EPA performed these analyses for the stratified random sample set of 139 industrial laundry facilities discharging to 118 POTWs that, in turn, discharge to 113 waterbodies (88 rivers/streams, 21 bays/estuaries, and 4 lakes). As described above, EPA extrapolated the results of this analysis to the entire population of industrial laundry facilities nationwide (approximately 1,606 facilities discharging to 1,178 POTWs, which in turn discharge to 1,133 waterbodies)[1].

3.2.1 Impact of Indirect Discharging Facilities on Waterways

EPA used four different equations to model the impacts of indirect industrial laundry discharges on receiving waterways. For POTWs that discharge into streams or rivers, EPA used a simple stream dilution model that does not account for fate processes other than complete immediate mixing. The facility-specific data (i.e., pollutant loading, operating days, and facility flow) used in this equation are derived from sources described in Sections 4.1 and 4.2 of this report. One of three receiving stream flow conditions (the lowest 1-day average flow with a recurrence interval of 10 years (1Q10), the lowest consecutive 7-day average flow with a recurrence interval of 10 years (7Q10),

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[1] The extrapolation results in the 92 freshwater sites representing 1,009 freshwater sites nationwide and the 21 marine sites representing 124 marine sites nationwide. It is important to note that the sample weights used in this extrapolation are based on engineering and economic characteristics of the industrial laundry sample facility, not on the type of waterbody to which the receiving POTW discharges. Therefore, although the 1,178 POTWs are discharging to 1,133 waterbodies, the actual distribution of freshwater and marine waterbodies may vary from the numbers predicted in the extrapolation.

and the harmonic mean flow) is used, depending on the type of criterion or toxic effect level intended for comparison. The 1Q10 and 7Q10 flows are used in comparisons of instream concentrations with acute and chronic aquatic life criteria or toxic effect levels, respectively, as recommended in the *Technical Support Document for Water Quality-based Toxics Control* (U.S. EPA, 1991). The harmonic mean flow, defined as the inverse mean of reciprocal daily arithmetic mean flow values, is used in comparisons of instream concentrations with human health criteria or toxic effect levels based on lifetime exposure. EPA recommends the long-term harmonic mean flow as the design flow instead of the arithmetic mean flow for assessing potential long-term human health impacts because instream pollutant concentration is a function of, and inversely proportional to, the streamflow downstream of the discharge.

The event frequency represents the number of times an exposure event occurs during a specified time period. For assessing impacts on aquatic life, EPA set the event frequency equal to the facility operating days. The calculated instream concentration is thus the average concentration on days the facility is discharging wastewater. For assessing long-term human health impacts, EPA set the event frequency at 365 days. The calculated instream concentration is thus the average concentration on all days of the year. Although this leads to a lower calculated concentration because of the additional dilution from days when the facility is not operating, it is consistent with the conservative assumption that the target population is present to consume drinking water every day and contaminated fish throughout an entire lifetime.

$$C_{is} = \frac{L \cdot (1 - TMT)}{(OD \cdot PF) + (EF \cdot SF)}$$

where:

C_{is}	=	instream pollutant concentration (µg/L),
L	=	facility pollutant loading (µg/yr),
TMT	=	POTW treatment removal efficiency (unitless),
OD	=	facility operating days (days/yr),
PF	=	POTW flow (L/day),
EF	=	event frequency (days/yr), and
SF	=	receiving stream flow (L/day).

For POTWs that discharge into relatively small lakes, EPA used the following simple steady-state model which takes into account pollutant degradation and the hydraulic residence time of the lake:

$$C_{lake} = \frac{C_i}{(1 + T_w \cdot k)}$$

where:

$$T_w = \frac{V}{Q}$$

and where:

C_{lake}	=	steady-state lake concentration of pollutant (µg/L),
C_i	=	steady-state inflow concentration of pollutant (µg/L),
T_w	=	mean hydraulic residence time (yr),
k	=	first-order pollutant decay rate (yr^{-1}),
V	=	lake volume (m^3), and
Q	=	mean total inflow rate (m^3/yr).

For hydrologically complex waters such as bays and estuaries, EPA used alternative means to predict pollutant concentrations that are suitable for comparison with ambient criteria or toxic effect levels for facilities discharging to these types of waterbodies. The first choice is to employ site-specific critical dilution factors (CDFs) to predict the concentration at the edge of a mixing zone. The second choice is to use estuarine dissolved concentration potentials (DCPs).

EPA obtained site-specific CDFs from a survey of States and Regions conducted by EPA's Office of Pollution Prevention and Toxics (*Mixing Zone Dilution Factors for New Chemical Exposure Assessments*, U.S. EPA, 1992a). The dilution model for estimating estuary concentrations by using a CDF is presented below.

$$C_{es} = \frac{L \cdot (1-TMT)}{EF \cdot PF \cdot CDF}$$

where:

C_{es}	=	estuary pollutant concentration (µg/L),
L	=	facility pollutant loading (µg/yr),
TMT	=	POTW treatment removal efficiency (unitless),
EF	=	event frequency (days/yr),
PF	=	POTW flow (L/day), and
CDF	=	critical dilution factor (unitless).

EPA used acute CDFs to evaluate acute aquatic life effects and chronic CDFs to evaluate chronic aquatic life or adverse human health effects. EPA assumed that the drinking water intake and fishing location are at the edge of the chronic mixing zone. EPA set the event frequency equal to the facility operating days for comparison with aquatic life criteria or toxic effect levels, and equal to 365 days for comparison with human health criteria or toxic effect levels.

The National Oceanic and Atmospheric Administration (NOAA) has developed DCPs to predict pollutant concentrations in various salinity zones for each estuary in NOAA's National Estuarine Inventory (NEI). A DCP represents the concentration of a nonreactive dissolved substance under well-mixed, steady-state conditions given an annual load of 10,000 tons. DCPs account for the effects of flushing by considering the freshwater inflow rate, and dilution by considering the total estuarine volume. DCPs reflect the predicted estuary-wide response, and, therefore, may not be indicative of concentrations at the edge of much smaller mixing zones. The dilution model used for estimating pollutant concentrations using a DCP is presented below.

$$C_{es} = \frac{L \cdot (1-TMT) \cdot DCP}{BL \cdot CF}$$

where:

C_{es}	=	estuary pollutant concentration (µg/L),
L	=	facility pollutant loading (kg/yr),
TMT	=	POTW treatment removal efficiency (unitless),
DCP	=	dissolved concentration potential (µg/L),
BL	=	benchmark load (10,000 tons/yr), and
CF	=	conversion factor (907.2 kg/ton).

EPA compared projected waterway pollutant concentrations to EPA water quality criteria or toxic effect levels for the protection of aquatic life and human health to determine potential water quality impacts. EPA determined water quality excursions by dividing the projected waterway pollutant concentration by the EPA water quality criteria or toxic effect levels for the protection of aquatic life and human health. A value greater than one indicates an excursion.

3.2.2 Impact of Indirect Discharging Facilities on POTW Operations

Analysis of Biological Inhibition

Inhibition of POTW operations occurs when high levels of toxics, such as metals or cyanide, kill bacteria that are required for the wastewater treatment process. EPA analyzed inhibition of POTW operations by comparing calculated POTW influent concentrations with available inhibition levels. Excursions are indicated by a value greater than one. POTW influent concentrations are estimated as:

$$C_{pi} = \frac{L}{OD \cdot PF}$$

where:

C_{pi}	=	POTW influent concentration (µg/L),
L	=	facility pollutant loading (µg/yr),
OD	=	facility operating days (days/yr), and
PF	=	POTW flow (L/day).

Analysis of Sludge Disposal Practices

EPA also analyzed the effects of industrial laundry discharges on POTW operations by comparing the estimated concentrations of metals in sewage sludge with the published metals concentration limits for preferable sewage sludge disposal or use practices. In particular, EPA examined: (1) whether industrial laundry baseline discharges would prevent POTWs from being able to meet the metals concentration limits required for certain more favorable and lower cost sewage sludge use/disposal practices, i.e., beneficial land application and surface disposal; and (2) whether limitations on the selection of management practices would be removed under regulatory options. EPA estimated sewage sludge concentrations of ten metals for sample facilities under baseline and post-regulatory option discharge levels. EPA compared these concentrations with the relevant metals concentration limits for the following sewage sludge management options: Land Application-High (Concentration Limits), Land Application-Low (Ceiling Limits), and Surface Disposal. Metal concentrations in sewage sludge are estimated as:

$$C_{sp} = \frac{L \cdot TMT \cdot PART \cdot SGF}{OD \cdot PF}$$

where:

C_{sp}	=	sewage sludge pollutant concentration (mg/kg),
L	=	facility pollutant loading (µg/yr),
TMT	=	POTW treatment removal efficiency (unitless),
$PART$	=	pollutant-specific sludge partition factor (unitless),
SGF	=	sludge generation factor (mg/kg per µg/L),
OD	=	facility operating days (days/yr), and
PF	=	POTW flow (L/day).

EPA derived the facility-specific data to evaluate POTW operations from the sources described in Sections 4.1 and 4.2. For industrial laundry facilities that discharge to the same POTW, EPA summed the individual loadings before the POTW influent and sewage sludge concentrations were calculated.

The partition factor is a chemical-specific value that represents the fraction of the load that is expected to partition to sewage sludge during wastewater treatment. For predicting sewage sludge generation, EPA used 1988 data on volume of sewage sludge produced (Federal Register, February 19, 1993, p. 9257) and volume of wastewater treated (1988 Needs Survey, Table C-3), resulting in a sludge generation factor of 7.4 mg/kg per µg/L:

$$\frac{28.736\ x\ 10^9 gal/day}{5{,}357{,}200\ DMT/yr} \cdot \frac{365\ day}{1\ yr} \cdot \frac{1\ DMT}{1000\ kg} \cdot \frac{3.79\ L}{1\ gal} \cdot \frac{1\ mg\ chemical}{1000\ \mu g\ chemical} = \frac{7.4\ mg\ chemical/kg\ sludge}{1\ \mu g\ chemical/L\ wastewater}$$

For every 1 µg/L of pollutant removed from wastewater and partitioned to sewage sludge, the concentration in sewage sludge is 7.4 mg/kg dry weight.

Documented Impacts of Industrial Laundry Discharges on POTWs

To understand the frequency and characteristics of problems to POTWs resulting from industrial laundry discharges, EPA obtained information from discussions with EPA regional staff and POTW operators. Of 37 POTWs that receive discharges from industrial laundries and were contacted by EPA, 11 POTW operators described their facilities as encountering some difficulty resulting from industrial laundry discharges, while the remaining 26 reported no problems from industrial laundry discharges.

3.2.3 Estimating Cancer Risk from Consumption of Chemically Contaminated Fish

The analysis of reduced annual occurrence of cancer in exposed populations via the fish consumption pathway involves three analytic steps: (1) estimating, from reduced pollutant contamination of fish, the reduced lifetime risk of developing cancer for an individual within the exposed population; (2) estimating the size of the population that would be expected to benefit from reduced pollutant contamination of fish; and (3) calculating the annual change in the number of cancer events in the exposed population.

The estimated marginal risk to an individual of developing cancer is based on the quantity of carcinogenic chemicals that IL facilities discharge to waterways, the bioaccumulation of discharged chemicals in fish tissue, the cancer-related effects of the discharged chemicals, and the rate of consumption of chemically contaminated fish. For each sample IL facility and the waterway to which it discharges, EPA calculated baseline and post-compliance marginal cancer risk for two population classes that differ based on fish consumption rates: recreational anglers and subsistence anglers.

As described in Section 3.2.1, for all IL chemicals for which a quantitative relationship between ingestion rate and annual probability of developing cancer has been estimated, EPA calculated the pollutant concentrations for each IL facility, using a simplified waterway dilution model. Then, two different risk values were estimated for subsistence fishing households and recreational fishing households. The risks differ in the assumed consumption rates and exposure durations of the respective populations. Persons living in subsistence fishing households were assumed to consume 140 grams per day (0.14 kg/day) of fish over 70 years of exposure. The risks to recreational fishing households were estimated based on consumption of 30 grams of fish per day (0.030 kg/day) over a 30-year period and 6.5 grams per day (0.0065 kg/day) over a 40-year period. To estimate the annual increased risk of cancer in recreation and subsistence anglers and their families, the lifetime risk values were then divided by 70 years (an estimate of lifetime). The marginal annual risk of developing cancer from exposure to more than one IL pollutant was assumed to be the sum of the marginal annual risks from all pollutants.

Estimating the Population Expected to Benefit from Reduced Contamination of Fish

The population exposed to chemically contaminated fish and thus expected to benefit from reduced IL discharges includes recreational and subsistence anglers who fish IL reaches, as well as members of such anglers' households.[2] A "reach" is defined as a specific length of river, lake shoreline, or marine coastline, and an "IL reach" is a reach to which an IL facility discharges.[3] The geographical area from which anglers would travel to fish a reach is assumed to include only those counties that abut a given reach.[4] Estimating the number of persons fishing a reach involved the

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[2] The exposed, and thus potentially benefitting, population would also include a category of "all other individuals" who consume freshwater and estuarine fish. Although these individuals are expected to have a much lower average daily consumption rate, they nevertheless would likely receive some benefit from reduced exposure to pollutants through fish consumption. This analysis omits this consumption category and the associated benefit estimate.

[3] All IL facilities considered in this analysis discharge to POTWs, which in turn discharge to waterways. The relevant IL reach for this analysis is therefore the reach to which the receiving POTW discharges. All analyses of in-waterway concentrations and related impacts are post-POTW and reflect the removal of pollutants at the POTW.

[4] This assumption is based on the finding in the *1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation* that 65 percent of anglers travel less than 50 miles to fish (U.S. Department of the Interior,

following steps:

Estimating the Licensed Fishing Population in Counties Abutting IL Reaches. To estimate the number of anglers fishing an IL reach, EPA first estimated the number of fishing licenses sold in the counties abutting the reach. This number was assumed to approximate the number of anglers residing in the abutting counties. Sample IL facilities were located in 41 states. Due to time and resource constraints, it was not possible to collect fishing license data at the county level for all 41 states. Thus, EPA used the state level data to estimate the number of fishing licenses per county. Total state licenses were apportioned to counties based on the ratio of total population in the county abutting a discharge reach to total state population. Where an IL reach spans more than one county, fishing licenses were summed across all counties abutting the discharge reach.

Estimating the Population of Subsistence Anglers in Counties Abutting IL Reaches. Although fishing licenses may be sold to subsistence anglers, many such anglers do not purchase fishing licenses. Thus, the magnitude of subsistence fishing is not generally known. For this analysis, EPA assumed that subsistence anglers would constitute an *additional* 5 percent of the licensed fishing population.[5]

Estimating the Fraction of the Fishing Population that Fish an IL Reach. EPA assumed that anglers residing within counties abutting a discharge reach are distributed evenly to all reach miles. Thus, the number of anglers who fish an IL reach was estimated by computing the length of the reach as a percentage of total reach miles within corresponding counties and multiplying the estimated ratio by the total fishing population in counties abutting the reach.

Adjusting for Fish Advisories. For IL reaches where fish advisories are in place, EPA assumed that some proportion of anglers would adhere to the advisory and not fish those reaches. Based on the existing studies, EPA assumed that recreational fishing would be 20 percent less on reaches subject to an advisory.[6] EPA further assumed that fish advisories do not affect fishing participation by subsistence anglers; thus, no adjustment was made for this population.

Including Family Members in the Exposed Population Estimates. For each IL reach, EPA multiplied the estimated numbers of recreational and subsistence anglers by the corresponding size of the average household in each state in 1993, based on Current Population Reports (*Statistical Abstract of the US*, 1993). These calculations yielded the household populations of recreational and

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1993).

[5] It is important to estimate recreational and subsistence populations separately because fish consumption rates for subsistence anglers are considerably higher than those for recreational anglers.

[6] For a detailed discussion of estimation of the fraction of anglers adhering to the fish advisories, see the *Regulatory Impact Analysis of Proposed Effluent Limitations Guidelines and Standards for the Metal Products and Machinery Industry (Phase I)* (U.S. EPA, 1995).

subsistence anglers who are estimated to consume fish from the reach.

3.2.4 Assumptions and Caveats

A discussion of the major assumptions and caveats in these analyses follows.

Other Source Contributions

For the analyses described above, EPA attempted to account for "other source contributions" of industrial laundry pollutants to estimate the concentrations of these pollutants at relevant measurement points. Accounting for the discharges from other sources is important because the assessment of gains in these analyses — that is, from reduction of POTW inhibition, improved sewage sludge management practices, and reduced exceedance of AWQC limits — depends on comparisons of estimated pollutant concentration values with applicable thresholds and identifying situations in which threshold criteria are failed in the baseline case but met under a regulatory option. In such an analytic framework, failure to account for other source contributions is likely to lead to an underestimate of the environmental problems that may be ameliorated by the regulation under analysis. EPA attempted to estimate other source contributions to sample POTWs based on discharge information for major manufacturing facilities received by EPA in the Toxics Release Inventory (TRI). However, data limitations prevented the completion of this analysis. For example, only approximately one-third of the pollutants of concern for industrial laundries are reported under TRI. Furthermore, EPA could not assign TRI discharge values to all of the sample-associated POTWs. Thus, background concentrations of each pollutant, both in the receiving stream and in the POTW influent, are set equal to zero.

Differential Sample-Weighting Technique

For locations where only one industrial laundry facility discharged to a POTW, the number of reaches expected to be affected at the national level is simply the sample weight of the facility. However, national estimates could not be extrapolated directly when more than one industrial laundry facility discharged pollutants to a single POTW, because the unit of analysis for estimating national impacts is a POTW, and facility sample weights differ from POTW sample weights. Thus, for those POTWs to which more than one facility discharges, the differential sample-weighting technique was used to account for different sample weights in developing national estimates (see Appendix A).

Waterbody Modeling

EPA made four major assumptions concerning all waterbody modeling, and two major assumptions specific to stream modeling. First, EPA assumed that complete mixing of POTW discharge flow immediately occurs in the waterbody. This mixing results in the calculation of an "average" concentration even though the actual concentration may vary across the width and depth of the waterbody.

Secondly, EPA assumed the pollutant load to the receiving waterbody is continuous and representative of long-term facility operations. This assumption may overestimate long-term risks to human health and aquatic life, but may underestimate potential short-term effects.

Thirdly, EPA did not consider pollutant fate processes such as sediment adsorption and volatilization. This may result in estimated waterbody concentrations that are environmentally conservative (i.e., higher than may actually exist).

Fourth, if data on POTW flow were missing, POTW daily flow rates were set equal to the simple arithmetic mean flow among POTWs associated with sample industrial laundry facilities.

For modeling streams, EPA used 1Q10 and 7Q10 receiving stream flow rates to estimate aquatic life impacts, and harmonic mean flow rates to estimate human health impacts. EPA estimated 1Q10 low flows by using the results of a regression analysis conducted for OPPT of 1Q10 and 7Q10 flows from representative U.S. rivers and streams (Versar, 1992). EPA estimated harmonic mean flows from the mean and 7Q10 flows as recommended in the *Technical Support Document for Water Quality-based Toxics Control* (U.S. EPA, 1991). These flows may not be the same as those used by specific states to assess impacts.

If data on stream flow parameters were missing, EPA set mean and 7Q10 flow values equal to the corresponding median values associated with sample reaches.

Exposure Analyses

AWQC for the protection of human health from consumption of organisms reflect both freshwater and marine organism consumption and thus are used in the analyses for both aquatic and marine discharge locations. However, EPA assumes that salt water would not be used as drinking water, and thus does not analyze the exceedance of human health-based AWQC values for consumption of organisms *and water* for marine discharge locations.

EPA also assumes that the exposure frequency for evaluating human health impacts from drinking water and contaminated fish ingestion is 365 days, which may overestimate long-term risks to human health.

Extrapolation from Sample Set to National Level

The sample set should represent a national group of facilities discharging to waterways and POTWs. However, effluent from an individual facility in the sample set may not have a similar potential environmental impact as effluent from the facilities it is assumed to represent. For example, a facility that discharges to a stream with a very small design flow may be similar to the facilities it represents in all aspects except available dilution in the receiving stream.

Estimation of the Exposed Fishing Population

EPA's estimation of the exposed fishing population relied on state fishing license statistics and census data. If other factors influence the proportion of anglers in the local population, benefits may be overstated or understated. In addition, data limitations hamper the estimate of the number of anglers who actually fish a given IL reach. Estimating the number of anglers fishing IL reaches based on the ratio of IL reach length to the total number of IL reach miles in the county recognizes the effect of the *quantity* of competing fishing opportunities on the likelihood of fishing a given IL reach, but it does not account for the differential *quality* of fishing opportunities. If water quality in substitute sites is distinctly better or worse, the estimates of the exposed populations are likely to be overstated or understated.

Also, subsistence anglers were assumed to account for an additional 5 percent of the fishing population. The magnitude of subsistence fishing in the U.S. or in individual states, however, is not known. As a result, this estimate may understate or overstate the actual number of subsistence anglers.

Finally, to account for the effect of a fish advisory on fishing activity, and therefore on the exposed fishing population, EPA reduced the fishing population at an IL reach under a fish advisory by 20 percent. This could lead to either an overestimate or underestimate of the risk associated with consumption of contaminated fish, because (1) anglers who change locations may simply be switching to other locations where advisories are in place and therefore maintain or increase their current risk, and (2) anglers who continue to fish contaminated waters may change their consumption and preparation habits to reduce the risks from the contaminated fish they consume.

4. DATA SOURCES

The following four sections describe the various data sources used to evaluate water quality impacts.

4.1 Facility-Specific Data

Within EPA's Office of Water, the Engineering and Analysis Division (EAD) provided the Standards and Applied Science Division (SASD) with projected effluent discharge rates for sample industrial laundry facilities, days per year wastewater is discharged by facilities, and pollutant loadings under both current conditions and regulatory options (June, 1997).

The names, locations, and the flow data for the POTWs to which the industrial laundry facilities discharge are obtained from the industrial laundry Screener Questionnaire, Regional EPA Pretreatment Coordinators, EPA's 1992 Needs Survey, EPA's Industrial Facilities Discharge database (IFD), and EPA's Permit Compliance System (PCS). If these sources did not yield information for a facility, EPA took alternative measures to obtain a complete set of receiving POTWs.

EPA used latitude/longitude coordinates (if available) to locate those POTWs that have not been assigned a reach number in IFD. For those facilities for which the POTW receiving the plant discharge could not be positively identified, EPA identified the nearest POTW. The identification of the closest linear distance was based on the latitude/longitude coordinates of the industrial laundry facility or the city in which it was located. EPA identified the corresponding reach in IFD, and obtained POTW flow from the Needs Survey or PCS.

4.2 Waterbody-Specific Data

4.2.1 Streams and Rivers

For the 88 streams and rivers modeled, 1Q10, 7Q10, and mean flow data were needed. As described in Section 3.2.1, the 1Q10 and 7Q10 flows are used to estimate instream concentrations, which are then compared with acute and chronic aquatic life criteria or toxic effect levels, respectively. The mean flow data are used to estimate the harmonic mean flow, defined as the inverse mean of reciprocal daily arithmetic mean flow values. The harmonic mean flow is used to estimate instream concentrations which are then compared with human health criteria or toxic effect levels based on lifetime exposure.

EPA obtained 7Q10 and mean flow data from either the W.E. Gates study data or from measured streamflow data, both of which are contained in EPA's GAGE file. The W.E. Gates study contains calculated average and low flow statistics based on the best available flow data and on drainage areas for reaches throughout the United States. The GAGE file also includes average and low flow statistics based on measured data from United States Geological Survey (USGS) gaging stations. If data on stream flow parameters were missing, EPA set 7Q10 and mean flow values equal to the corresponding median values associated with the sample reaches. To estimate 1Q10 flows, EPA used the results of a regression analysis conducted for OPPT of 1Q10 and 7Q10 flows from representative U.S. rivers and streams (Versar, 1992). EPA estimated harmonic mean flows from the mean and 7Q10 flows as recommended in the *Technical Support Document for Water Quality-based Toxics Control* (U.S. EPA, 1991).

For two sample facilities, the POTW outfall pipe was located near the end of the discharge reach (i.e., within 25 percent of the discharge reach length from the downstream reach). Therefore, EPA used the downstream reach flow characteristics when comparing estimated in-stream concentrations to AWQC protective of aquatic species.

4.2.2 Lakes

For relatively small lakes, data on hydraulic residence time (the amount of time water remains in a lake) were needed. For relatively large lakes, Critical Dilution Factors (CDFs), which describe dilution in a portion of a lake, were required. The sample industrial laundry facilities discharged indirectly to four lake reaches: one on Lake Onondaga, one on Lake Erie, and two on Lake Michigan. For Lake Onondaga, the average hydraulic residence time of 94 days was obtained from Russell Nemecek (315-435-6600) in Onondaga County. For Lake Erie, CDFs were readily available. Given the size of Lake Michigan and the use of CDFs for Lake Erie, use of a hydraulic residence time was not appropriate; however, CDFs were not readily available for the two sample reaches on Lake Michigan. Therefore, the seven chronic CDFs which were available for reaches discharging to Lake Michigan (1, 1, 4, 4, 10, 10, 4) were arithmetically averaged (U.S. EPA, 1992a, p. A-4) for the two reaches being modeled.

4.2.3 Estuaries and Bays

Twenty-one (21) bays and estuaries received indirect discharges from sample industrial laundry facilities. To estimate the pollutant concentrations in 18 of these complex water bodies, a dilution model that predicts pollutant concentrations in the chronic and acute mixing zones based on site-specific critical dilution factors (CDFs) was used (U.S. EPA, 1992a and Versar, 1994). For four of the 18 bays/estuaries, both acute and chronic CDFs were available. For three New York bays/estuaries, acute and chronic CDFs were estimated by arithmetically averaging available values for nearby New Jersey sites discharging to the Arthur Kill (acute: 1.5, 4.0, 5.0; chronic: 5; 20; 10) and Upper New York Bay (acute: 8.0; chronic: 22.9).

For the remaining 11 sample reaches, chronic CDFs could not be identified or approximated, and thus sample weights were adjusted according to the item level nonresponse methodology (SAIC, 1996). Four of the 11 bays/estuaries had available acute CDFs. For two bays/estuaries in Florida, acute CDFs were extrapolated from another Florida bay; for four bays/estuaries in California, acute CDFs were extrapolated from another California bay; and for one bay in Hawaii, the acute CDF was assumed to be ten.

For three sample bays/estuaries, dissolved concentration potential factors (DCPs) were available from the National Estuarine Atlas of the Strategic Assessment Branch of NOAA's Ocean Assessments Division. EPA then used a dilution model that predicts pollutant concentrations in the estuarine environment using a site-specific DCP factor.

4.3 Information Used to Evaluate POTW Operations

When data on POTW flow rates were missing, POTW daily flow rates were calculated by applying the following steps:

1. Identify whether the POTW with missing information is a minor or major discharger, based on the PCS database.[7] All POTWs associated with the sample industrial laundries which were missing daily flow rate data were classified as minor dischargers in the PCS database.

2. Calculate arithmetic mean flow among minor/major POTWs associated with the sample industrial laundry facilities. The estimated arithmetic mean flow for minor POTWs associated with the sample industrial laundries is 2.2 million liters per day (MLD).

3. Set POTW flow rate equal to the relevant arithmetic mean flow. Since all POTWs missing flow data were classifed as minor dischargers, their flow rates were all set equal to the arithmetic mean flow rate for minor POTWs, 2.2 MLD.
   To evaluate POTW operations, EPA also required removal efficiency rates, inhibition values,

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[7] According to the PCS classification, municipal dischargers are considered "major" if they discharge more than 1 million gallons per day.

and sewage sludge regulatory levels. EPA obtained POTW removal efficiency rates from several sources. EPA developed rates from POTW removal data and pilot-plant studies or used the removal rate of a similar pollutant when data were not available. Use of the selected removal rates assumes that the evaluated POTWs are well-operated and have at least secondary treatment in place.

EPA obtained inhibition values from *Guidance Manual for Preventing Interference at POTWs* (U.S. EPA, 1987a) and from *CERCLA Site Discharges to POTWs: Guidance Manual* (U.S. EPA, 1990). EPA used the most conservative values for activated sludge. For pollutants with no specific inhibition value, a value based on compound type (e.g., aromatics) was used.

For the ten metals regulated in sewage sludge, EPA used the sewage sludge regulatory levels from the Federal Register 40 CFR Part 257 et al., Standards for the Use or Disposal of Sewage Sludge; Final Rules (February 19, 1993) and from the Federal Register 59(38):9095-9099 (February 25, 1994) and 60(206):54,764-54,770 (October 25, 1995). EPA used pollutant limits established for the final use or disposal of sewage sludge when the sewage sludge is applied to agricultural and non-agricultural land or is applied to a dedicated surface disposal site. EPA obtained sludge partition factors from the *Report to Congress on the Discharge of Hazardous Wastes to Publicly Owned Treatment Works (Domestic Sewage Study)* (U.S. EPA, 1986).

Exhibit B-3 in Appendix B provides a listing of POTW treatment removal efficiency rates, inhibition values, and sewage sludge regulatory levels used in the evaluation of POTW operations.

4.4 Chemical Pollutant Decay Data

As presented in Section 3.2, modeling of pollutant discharges to lakes requires an estimate of the pollutant decay rate in water. For the 24 inorganic pollutants of concern, a decay rate of zero was conservatively assumed. Due to a lack of readily available data for ten organic pollutants and the six conventional pollutants, a decay rate of zero was also assumed. For the remaining 32 organic pollutants, decay rates due to abiotic hydrolysis or biodegradation were used. For six pollutants, decay rates were readily available from the literature. For the remaining 26 organic chemicals, decay rates were calculated from data on half-lives or were estimated. Details of these calculations are given below. All of the decay rates used are summarized in Exhibit C-1 in Appendix C.

4.4.1 Estimated Decay Rates

Decay rates were estimated for the following four organic chemicals: 4-chloro-3-methylphenol, 2-methylnaphthalene, p-cymene, and pentamethylbenzene.

According to the Hazardous Substances Data Base (1994), Tabak et al. (1981) studied settled domestic wastewater containing ten parts per million (ppm) of 4-chloro-3-methylphenol. The researchers found that 100 percent of this pollutant biodegraded within 14 days. To estimate the decay rate (k) from this information, a remaining concentration of 0.0001 ppm (one one-thousandth of one percent of the initial concentration) was assumed:

$$0.0001\ ppm = 10\ ppm \cdot e^{-k \cdot 14\ days}$$

$$k = 0.8\ day^{-1} = 0.03\ hr^{-1}$$

For 2-methylnaphthalene, EPA assumed the same decay rate as for naphthalene, based on structural similarity. For p-cymene, EPA assumed the same decay rate as for p-xylene, again based on structural similarity. Likewise, for pentamethylbenzene, EPA assumed the same rate as for benzene (Lyman et al., 1990) based on structural similarity.

4.4.2 Decay Rates Calculated from Half-Life Data

For 22 chemicals, as noted in Exhibit C-1, the high and low estimates of half-lives presented in Howard et al., 1991, were converted to decay rates, assuming first-order decay. They then were arithmetically averaged to obtain an average decay rate:

$$rate_{high} = \frac{-\ln 0.5}{t_{high}} \quad and \quad rate_{low} = \frac{-\ln 0.5}{t_{low}}$$

$$rate_{avg} = \frac{rate_{high} + rate_{low}}{2}$$

5. RESULTS

At current discharge levels, industrial laundry facilities discharge 4.9 million pounds per year of priority and nonconventional pollutants (excluding chemical oxygen demand, total organic carbon, and total petroleum hydrocarbons measured as Silica Gel Treated n-Hexane Extractable Material (SGT-HEM)) and 35.9 million pounds per year of oil and grease measured as n-Hexane Extractable Material (HEM), including 13.2 million pounds per year of SGT-HEM. The three regulatory options under analysis considerably reduce these loadings to POTWs. Exhibit 2 summarizes the estimated industrial laundry discharges in these three pollutant categories, as well as for other conventional and bulk nonconventional pollutants, on both sample and national level bases for the regulatory options under analysis.

Exhibit 2. Summary of Estimated Pollutant Loadings from Industrial Laundries on a Sample and National Basis					
Regulatory Option	**Priority and Nonconventional Pollutants*(lb/yr)**	**HEM (lb/yr)**	**SGT-HEM (lb/yr)**	**Biological Oxygen Demand and Total Suspended Solids (lb/yr)**	**Chemical Oxygen Demand and Total Organic Carbon (lb/yr)**
	Sample Estimates	**Sample Estimates**	**Sample Estimates**	**Sample Estimates**	**Sample Estimates**
Baseline	608,854	4,128,803	1,577,973	21,760,532	43,952,456
Combo-IL	403,213	1,802,227	335,772	17,425,878	33,358,162
DAF-IL	376,020	1,802,227	335,772	17,168,792	32,743,837
CP-IL	376,997	1,727,221	306,010	17,422,713	33,329,832
	National Estimates	**National Estimates**	**National Estimates**	**National Estimates**	**National Estimates**
Baseline	4,858,790	35,873,675	13,242,020	176,053,618	345,694,475
Combo-IL	3,130,211	15,880,076	2,646,313	139,050,357	258,345,334
DAF-IL	2,876,415	15,880,076	2,646,313	136,600,985	252,435,412
CP-IL	2,918,186	15,180,783	2,414,526	139,043,890	258,294,321
* Excludes Total Organic Carbon, Total Petroleum Hydrocarbons measured as Silica Gel Treated n-Hexane Extractable Material, and Chemical Oxygen Demand.					

5.1 Reduced Occurrence of Pollutant Concentrations in Excess of AWQC Limits for Protection of Human Health

To assess reduced human health risk from the three regulatory options, the instances in which pollutant concentrations exceeded AWQC limits for one or more pollutants in the baseline and in which AWQC limits for all pollutants were met in the post-regulatory option cases were identified. At current discharge levels, in-waterway concentrations of two industrial laundry pollutants — tetrachloroethene and bis(2-ethylhexyl)phthalate — were estimated to exceed AWQC limits for human health from *consumption of water and organisms* in two sample reaches. As shown in Exhibit 3, all three options were estimated to eliminate the occurrence of tetrachloroethene concentrations in excess of AWQC in all reaches. All three options also reduced bis(2-ethylhexyl)phthalate concentrations below AWQCs in one reach.

In addition, pollutant concentrations in excess of AWQC values for human health for *consumption of organisms only* were estimated. No pollutant concentrations were found to exceed the AWQCs for organism consumption under baseline discharges. Note that the AWQC limit exceedances for *organism consumption only* form a subset of the AWQC limit exceedances for *water and organism* consumption.

The findings from the analysis of discharge reaches affected by sample facility discharges were extrapolated to national estimates using facility sample weights, as described in Section 3.1. As shown in Exhibit 3, in-waterway, baseline concentrations of three industrial laundry pollutants were estimated to exceed AWQC limits for human health for consumption of water and organisms in nine reaches nationwide. All three regulatory options eliminated the occurrence of tetrachloroethene concentrations in excess of AWQC limits in all reaches. All three regulatory options also eliminated instances of bis(2-ethylhexyl)phthalate concentrations exceeding AWQC limits in seven reaches.

Exhibit 3: Discharge Reaches with Pollutant Concentrations Exceeding AWQC Limits for Protection of Human Health, and Reductions Achieved by Regulatory Options

Regulatory Option	Number of Reaches with Concentrations Exceeding Health-Based AWQCs (Sample Basis)		Number of Reaches with Concentrations Exceeding Health-Based AWQCs (National Basis)	
	Water and Organisms	Organisms Only	Water and Organisms	Organisms Only
Baseline				
Streams (No.)	2	0	9	0
Pollutants (No.)	2 (BEHP, Perc)	0	2 (BEHP, Perc)	0
Total Excursions	3	0	17	0
Combo-IL				
Streams (No.)	1	0	2	0
Pollutants (No.)	1 (BEHP)	0	1 (BEHP)	0
Total Excursions	1	0	2	0
DAF-IL				
Streams (No.)	1	0	2	0
Pollutants (No.)	1 (BEHP)	0	1 (BEHP)	0
Total Excursions	1	0	2	0
CP-IL				
Streams (No.)	1	0	2	0
Pollutants (No.)	1 (BEHP)	0	1 (BEHP)	0
Total Excursions	1	0	2	0

Note: BEHP is bis(2-ethylhexyl)phthalate and Perc is tetrachloroethene (perchloroethene).

5.2 Reduced Incidence of Cancer from Consumption of Fish

EPA calculated the cancer cases associated with the pollutant discharges from each facility by multiplying the annual marginal cancer risk value for the two population classes (i.e., recreational angler households and subsistence angler households) by the estimated size of each population class living near the facility. Summing the values for the recreational and subsistence fishing household classes yielded the total number of cancer cases associated with the sample facility discharges. Because these cancer event values apply to *sample* facilities, EPA extrapolated the sample results to the total IL population by multiplying the result obtained for each sample facility by its sample weight and summing the results. These values were calculated for the baseline and post-compliance cases. The *difference* is the number of cancer cases estimated to be avoided annually.

Exhibit 4 indicates the number of cancer cases associated with the IL regulation. For combined recreational and subsistence angler populations, EPA estimated that all three options would eliminate approximately 0.04 cancer cases per year from a baseline value of approximately 0.1 cases, representing a reduction of about 40 percent.

Exhibit 4: Number of Cancer Cases from Fish Consumption on a National Basis	
Regulatory Option	**Number of Cancer Cases**
Baseline	0.1
Combo-IL	0.06
DAF-IL	0.06
CP-IL	0.06
Carcinogenic Pollutants: Arsenic, Beryllium, Bis (2-ethylhexyl)phthalate, Chloroform, Isophorone, Methylene chloride, Tetrachloroethene, 1,2 - Diphenylhydrazine	

5.3 Reduced Occurrence of Pollutant Concentrations in Excess of AWQC Limits for Protection of Aquatic Species

The estimated elimination of concentrations in excess of the AWQC values for protection of aquatic species provides a quantitative measure of ecological benefits stemming from the regulatory options analyzed. As shown in Exhibit 5, pollutant concentrations at baseline discharge levels were predicted to exceed *chronic* exposure criteria for protection of aquatic species on nine sample reaches. These exceedances are caused by three pollutants: lead, silver, and total petroleum hydrocarbons (TPH). All three regulatory options reduced the concentrations of lead to values below the chronic AWQC limit; however, on three reaches, the concentrations of silver and TPH remained above AWQC limits under all three regulatory options. In this analysis, none of the *acute* AWQC limits were exceeded in the baseline.

Exhibit 5 also summarizes the results extrapolated to the national level. At baseline discharge levels, 78 reaches nationwide were estimated to exceed chronic AWQC limits for aquatic life due to industrial laundry discharges. The exceedances for lead were eliminated by all three regulatory options in all 78 reaches. Exceedances of AWQC for silver and TPH were removed in 66 streams under all three regulatory options.

Exhibit 5: Discharge Reaches with Pollutant Concentrations Exceeding *Chronic* AWQC Limits for Protection of Aquatic Species, and Reductions Achieved by Regulatory Options		
Regulatory Option	**Number of Reaches with Concentrations Exceeding Chronic AWQC Limits**	
	Sample Basis	**National Basis**
Baseline		
Streams (No.)	9	78
Pollutants (No.)	3 (Pb, Ag, TPH)	3 (Pb, Ag, TPH)
Total Excursions	11	93
Combo-IL		
Streams (No.)	3	12
Pollutants (No.)	2 (Ag, TPH)	2 (Ag, TPH)
Total Excursions	4	19
DAF-IL		
Streams (No.)	3	12
Pollutants (No.)	2 (Ag, TPH)	2 (Ag, TPH)
Total Excursions	4	19
CP-IL		
Streams (No.)	3	12
Pollutants (No.)	2 (Ag, TPH)	2 (Ag, TPH)
Total Excursions	4	19
None of the *acute* AWQC limits were estimated to be exceeded in the baseline. Pb is lead, Ag is silver, and TPH is total petroleum hydrocarbons.		

5.4 Analysis of Biological Inhibition at POTWs

The effects of industrial laundry discharges on POTW operations were evaluated for 45 pollutants with inhibition criteria under baseline and post-regulatory option discharge levels. At current discharge levels, estimated POTW concentrations of one metal, lead, exceeded biological inhibition criteria at one of the 118 POTWs associated with sample industrial laundry facilities. As shown in Exhibits 6 and 7, these incidents were removed under all three regulatory options.

Sample-level results were extrapolated to the national level by summing over the weights of the industrial laundry facilities that discharge to the affected POTWs. As shown in Exhibits 6 and 8, for the baseline analysis, estimated POTW influent concentrations of lead exceeded biological inhibition criteria at two POTWs; inhibition criteria were not exceeded under any of the regulatory options. Exhibits 7 and 8 also present the flow rates (in million liters per day) of the POTWs with exceedance events.

Basis for Biological Inhibition Analysis

Number of Facilities: 139 Number of POTWs: 118 Number of Pollutants: 45

Exhibit 6: Summary of Estimated POTW Inhibition Problems on a Sample Basis (National Basis)			
Regulatory Option	**Number of POTWs Estimated to be Affected by Inhibition Problems**	**Number of Pollutants Estimated to Cause an Inhibition Problem**	**Total Number of Exceedance Events Across All POTWs and Pollutants**
Baseline	1 (2)	1 (1)	1 (2)
Combo-IL	0 (0)	0 (0)	0 (0)
DAF-IL	0 (0)	0 (0)	0 (0)
CP-IL	0 (0)	0 (0)	0 (0)

Basis for Biological Inhibition Analysis

Number of Facilities: 139 Number of POTWs: 118 Number of Pollutants: 45

Exhibit 7: Number of POTWs and Associated POTW Flow Estimated to be Affected by Biological Inhibition Problems on a Sample Basis

Pollutant	Baseline		Combo-IL		DAF-IL		CP-IL	
	No.	Flow (ML/day)	No.	Flow (ML/day)	No.	Flow (ML/day)	No.	Flow (ML/day)
Lead	1	0.454	0	0	0	0	0	0
Total number of exceedance events:	1		0		0		0	

Exhibit 8: Number of POTWs and Associated POTW Flow Estimated to be Affected by Biological Inhibition Problems on a National Basis

Pollutant	Baseline		Combo-IL		DAF-IL		CP-IL	
	No.	Flow (ML/day)	No.	Flow (ML/day)	No.	Flow (ML/day)	No.	Flow (ML/day)
Lead	2	0.9	0	0	0	0	0	0
Total number of exceedance events:	2		0		0		0	

5.5 Analysis of Sludge Disposal Practices

Sewage sludge concentrations of ten metals were estimated for sample facilities under baseline and post-regulatory option discharge levels. These concentrations were compared with the relevant metals concentration limits for the following sewage sludge management options: Land Application-High (Concentration Limits), Land Application-Low (Ceiling Limits), and Surface Disposal. In the baseline case, concentrations of one pollutant, lead, at two sample POTWs were estimated to fail the Land Application-High limits while meeting the Land Application-Low limits. No POTWs were estimated to fail any of the Surface Disposal limits. Under all three regulatory options, these two POTWs were estimated to meet all Land Application-High limits. As a result of the metals discharge reductions, the previously affected POTWs that would meet all Land Application-Low limits are candidates for being able to shift their sewage sludge management options to the more preferable beneficial land application methods permitted under the Land Application-High limits. The summary of limitations on adoption of preferable sewage sludge disposal methods in the baseline case and alternative regulatory options is presented in Exhibits 9, 10, and 11.

After extrapolating the sample results to the national level, it was estimated that baseline concentrations of lead would fail to meet Land Application-High limits for sludge disposal at ten POTWs. Under all three regulatory options, these ten POTWs were estimated to meet all Land Application-High limits for lead. An estimated 6,200 dry metric tons (DMT) of annual disposal of sewage sludge would be expected to newly qualify for beneficial use under the Land Application-High limits as a result of these options (see Exhibits 9, 10, and 12).

Exhibit 9: Summary of Estimated Shifts in Sewage Sludge Use or Disposal Practices a Sample Basis (National Basis)

Shift Category	Regulatory Option	Number of POTWs	Associated Sewage Sludge Quantity (DMT/Year)
Upgrade from Land Application-Low limits to Land Application-High limits as a result of the indicated regulatory option.	Combo-IL	2 (10)	757 (6,200)
	DAF-IL	2 (10)	757 (6,200)
	CP-IL	2 (10)	757 (6,200)

Basis for Sludge Contamination Analysis

Number of Facilities: 139 Number of POTWs: 118 Number of Pollutants: 10

Exhibit 10: Summary of Estimated Sewage Sludge Contamination Problems on a Sample Basis (National Basis)			
Regulatory Option	**Number of POTWs Estimated to Exceed Land Application Limits**	**Number of Pollutants Estimated to Exceed Land Application Limits**	**Total Number of Exceedance Events Across All POTWs and Pollutants**
Baseline	2 (10)	1 (Pb)	2 (10)
Combo-IL	0 (0)	0	0 (0)
DAF-IL	0 (0)	0	0 (0)
CP-IL	0 (0)	0	0 (0)

Basis for Sludge Contamination Analysis

Number of Facilities: 139 Number of POTWs: 118 Number of Pollutants: 10

Exhibit 11: Number of POTWs and Associated Sludge Production Estimated to Exceed Land Application Limits on a Sample Basis								
Pollutant	**Baseline**		**Combo-IL**		**DAF-IL**		**CP-IL**	
	No.	Weight (metric tons)	No.	Weight (metric tons)	No.	Weight (metric tons)	No.	Weight (metric tons)
Lead	2	757	0	0	0	0	0	0
Total number of exceedance events:	2	---	0		0		0	

Exhibit 12: Number of POTWs and Associated Sludge Production Estimated to Exceed Land Application Limits on a National Basis								
Pollutant	**Baseline**		**Combo-IL**		**DAF-IL**		**CP-IL**	
	No.	Weight (metric tons)	No.	Weight (metric tons)	No.	Weight (metric tons)	No.	Weight (metric tons)
Lead	10	6,200	0	0	0	0	0	0
Total number of exceedance events:	10	---	0		0		0	

5.6 Analysis of Baseline Closures

To estimate the potential impact on benefit results of baseline closures of industrial laundries, EPA analyzed a separate case in which the baseline closures were removed from the environmental assessment. First, EPA removed observations corresponding to the facilities identified as potential baseline closures from the data sets supporting the analysis. Then, EPA estimated the benefits of the proposed regulation in the same categories as presented in Sections 5.1 through 5.5. Removing the baseline closures from the assessment did not materially change the estimated benefits for the following reasons:

1. Human Health Benefits. At current discharge levels, EPA estimated that in-waterway concentrations of IL pollutants discharged by the facilities identified as potential baseline closures do not exceed human health-based AWQCs.

2. Recreational Benefits. At current discharge levels, the estimated in-waterway concentrations of pollutants discharged by the IL facilities identified as potential baseline closures do not exceed AWQC limits for protection of aquatic species.

3. POTW benefits. At current discharge levels, EPA estimated that (1) influent concentrations at the POTWs receiving discharges from the baseline closures were below the POTW inhibition values for all of the IL pollutants; (2) sewage sludge generated by the POTWs associated with the IL facilities identified as potential baseline closures met Land Application-High pollutant limits.

5.7 Efforts to Document POTW Problems from Industrial Laundry Discharges and to Develop Case Studies of Such Problems

To understand the frequency and characteristics of problems to POTWs resulting from industrial laundry discharges, EPA spoke to POTW pre-treatment coordinators in EPA's regional offices and in states and to individual POTW operators. Several pre-treatment coordinators and operators recommended other sources to call for more information on the subject. In these conversations, which occurred in early 1997, EPA discussed 40 POTWs that receive discharges from industrial laundries. Of these 40 POTWs, 11 were described as encountering some difficulty resulting from industrial laundry discharges either currently or in the recent past. This information is summarized by EPA region in Exhibit 13.

Exhibit 13: Summary of POTWs with and without Problems with Industrial Laundries, by Region		
EPA Region	**Number of POTWs known to encounter problems from industrial laundry discharges**	**Number of POTWs known to *not* encounter problems from industrial laundry discharges**
III	2	2
IV	2	11
V	0	1
VI	1	2
VIII	1	7
IX	2	6
X	3	0

Based on these conversations, it appears that POTWs are most interested in EPA conducting a good study of industrial laundries that clearly describes what problems the laundries pose to POTWs, as well as to the environment and to the health and safety of POTW workers. The POTW operators stated that such a study and resulting regulation should provide technically-based limits for pollutants such as oil and grease. Many POTW operators feel that the current limits for oil and grease are not based on solid studies of the relationship between laundries' effluent and POTW operating conditions. Some POTW operators believe EPA needs to consider that POTWs face different situations regarding laundries' discharges; the situation presented by a large laundry discharging to a small POTW differs considerably from a small laundry discharging to a large POTW, and thus EPA should make regulations that are flexible enough to accommodate these different situations. Some POTW operators are simply raising their limits on certain pollutants so that industrial laundries discharging to them will not be in violation.

EPA also had in-depth conversations with several POTW operators to try to develop case studies on the nature of their problems with industrial laundry discharges. The three case studies developed did not document substantial problems from industrial laundry discharges that would be reduced by regulation because the POTWs have already implemented new local limits, the industrial laundry facilities have already installed pretreatment, or a combination of the two. These case studies are summarized below.

Three Case Studies

Region VIII South Dakota POTW

This POTW has an annual flow of 18.1 billion liters per year, and receives 43 million liters per year of industrial laundry discharge. The POTW has three major problems with industrial laundries' discharges: 1) oil and grease; 2) pH fluctuations; and 3) metals.

Excessive amounts of oil and grease do not cause problems in the treatment plant, but do clog the collection system. Clogging does not happen often because the POTW is very aware of the issue and is vigilant about ensuring smooth operation of the collection system. However, when there is a backup, the POTW does incur extra labor costs when someone has to conduct maintenance work on the system. Though estimating the cost of this maintenance is difficult, a very rough estimate would be that every visit would be about $200, and for every problem caused, two or three visits might be needed.

For the pH of the discharge, the major problem for the POTW is the wild fluctuations: pH levels can vary from 1-2 to 12-14 within a few minutes. These pH levels create problems for the concrete in the manholes; the pipelines, consisting of both PVC and concrete; and the POTW workers. Highly acidic discharges can eat away at concrete, and both acidic and highly basic discharges can injure POTW workers. A complete manhole rehabilitation project would cost approximately $2,000, half of that for labor, half for materials. If only a pipe were damaged, the total cost would be about $1,000, with labor and materials costing $500 each (depending on the size of the project).

The POTW also has difficulties with metals, in particular, cadmium, lead, and zinc, in industrial laundries' effluent. Last year, the POTW re-defined local limits on all metals. For zinc, the local limit was 1.0 mg/L, but now it is 5.3 mg/L. The laundries are now in compliance, because even without pretreatment, the zinc concentration is approximately 1.5 mg/L. Zinc comes primarily from inks on printers' rags; however, many printers are switching to soy-based inks, which might help lower the zinc concentration. For lead, the limit was 0.2 mg/L, but now it is 0.59 mg/L; with the laundries installing pretreatment, they are in compliance. Lead as well as cadmium mainly originate from metal filings (among other sources) left on rags from machine shops and automotive repair facilities. New regulations from the EPA concerning metals probably would not save this POTW any costs, because it already has all these regulations in place. The industrial laundries discharging to this POTW would like to see regulations from EPA because that would ensure a "level playing field"; that is, some nearby POTWs do not have as strict limits as this POTW, and so the laundries believe that currently they are operating at a disadvantage.

Region III Maryland POTW

This POTW has an annual flow of 247 billion liters per year, and receives a total of 34.8 million liters per year of discharge from five industrial laundries. This POTW was having problems holding the industrial laundries to permitted limits of 100 ppm FOG (Fats, Oil, and Grease) and 2.13 ppm TTO (Total Toxic Organics). The laundries appealed those limits, and thus the POTW derived new limits. The POTW took data for three years from all the industrial laundries in Baltimore City, assumed that all laundries were using Dissolved Air Floatation (DAF), the most affordable system of pretreatment, and calculated new limits for Total Petroleum Hydrocarbons (TPH) and TTO: 237 ppm TPH and 11.39 ppm TTO. The POTW then told the laundries that if they could not meet these new limits, they would have to install a DAF (if they did not already have one.)

From 1989 to 1994/5, the POTW has been concerned about volatile organics from laundries, including: chlorobenzene, chloroform, 1,1,1-trichloroethane, ethyl benzene, methylene chloride, tetrachloroethane, toluene, trichloroethene, and xylene. The POTW is concerned about fumes, with regard to the health and safety of sewer workers. The POTW monitors the atmosphere at all times, and when there are unusually high levels of any pollutant, the general policy is to increase ventilation. This POTW has had no issues with explosivity (TPH is usually around 5 ppm), and no problems to the system caused by backups or breakdowns.

Region III Maryland POTWs

This source spoke for five treatment plants operated by his agency. One plant in particular has experienced problems with total toxic organics (TTOs) from shop towels and printer's rags cleaned by industrial laundries. Industrial laundries have TTO values of greater than 300 ppm in their discharges to the sanitary sewer. The problems at the treatment plant were related to solvent odors in the pump station and general observations of unusual colors and odors in the plant effluent.

The source said treatment plant workers call the pretreatment program staff when they observe unusual colors/odors at the plant. This results in labor and laboratory costs being expended to respond to the color/odor complaints. He mentioned that most of the laundries have some form of pretreatment which allows them to comply with the agency's discharge limits. The laundry most heavily involved in the shop towel/printer's rags business installed pretreatment equipment that significantly reduced the number of complaints about unusual solvents/odors. In the 1980s complaints were received almost weekly. Now complaints are received four to six times per year for one to two hours each time. The treatment plant which received the highest TTO loadings is a relatively small plant (an annual flow of 7.3 billion liters) receiving a discharge of 31.5 million liters from an industrial laundry. He also mentioned concerns regarding explosions in manholes and sewer mains from solvent vapors from industrial laundries, although there have not been any incidents attributable to industrial laundries.

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APPENDIX A

Weighting Techniques for Extrapolating Results from Sample Facilities to the Population Level

A.1 Introduction

In analyzing the benefits to society from the reduced effluent discharges that will result from the proposed Industrial Laundry (IL) regulations, EPA used two techniques to extrapolate results estimated for sample facilities to the population level: a simple linear weighting technique and a differential weighting technique. For the analysis of change in cancer risk, EPA used the linear weighting technique. This linear weighting was possible because the marginal effects on cancer risk of a change in pollutant exposure are assumed to be linearly additive over the facilities, chemicals, and human populations that are affected by changes in pollutant discharges. However, EPA used a different sample weighting technique for those analyses in which the estimated baseline and post-compliance POTW influent flow concentrations, sludge concentrations, or in-waterway concentrations were compared with the corresponding threshold values to ascertain a benefit event. A benefit event is the change in frequency with which interference of processes and contamination of sewage sludge would occur at the POTWs receiving effluent discharges from IL facilities or the change in frequency with which AWQCs are exceeded by IL facility discharges. In those analyses, the standard linear weighting method was used for POTWs (or reaches) to which only one IL sample facility discharges. As a result, for a benefit event on a POTW (or reach) with only one sample, the number of POTWs (or reaches) expected to benefit in a similar fashion at the national level is simply the sample weight of the single facility discharging to the POTW (or reach). However, EPA found more than one sample facility discharging to approximately 18 percent of the sample facility POTWs and, via the POTWs, to about 23 percent of the sample facility reaches.[8] For these POTWs (or reaches) to which more than one facility discharges, EPA used a different procedure for developing national estimates of benefit events that accounts for the presence of more than facility with different sample weights discharging to the reach. This appendix first describes the simple linear weighting technique and then the differential weighting technique used for extrapolating results estimated for sample facilities to the population level.

A.2 Linear Weighting Technique

EPA surveyed 172 IL facilities as the basis for the economic, engineering, and environmental analyses being performed in support of the industrial laundries regulation. These 172 facilities are estimated to represent 1,606 IL facilities nationwide. All sample facilities are indirect dischargers (e.g., each facility discharges to a POTW as opposed to directly discharging to a water body). Thus, to evaluate the impacts of IL discharges on POTW operations, human health, and aquatic life, EPA first associated sample IL facilities with receiving POTWs. Because of incomplete information on the POTWs to which some of the sample facilities discharge, 33 facilities were dropped from the analysis. To account for the lost observations, EPA adjusted the sample weights for the remaining facilities in each affected stratum. The sample weight adjustment has the effect of assigning the

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[8] Note that, among the sample facility discharge sites, this percentage is a lower bound estimate of the frequency of multiple facility discharge sites. While it is not possible for there to be fewer IL facilities on a POTW/reach than are seen in the sample, it is always possible that another, or perhaps several additional, *unsampled and therefore unseen* facilities are present on a POTW/reach on which only one facility was sampled.

sample mass for a lost observation(s) to the remaining observations in the affected stratum. As a result, the analyses encompass 139 sample facilities discharging 72 pollutants of concern to 118 POTWs.

The following steps outline the procedure for extrapolating findings from the sample facility analyses by the linear weighting technique:

$$Y_{ntl} = \sum_{F=1}^{F} Wt_f \times K_{adj} \times Y_{smpl}$$

where:

Y_{ntl}	=	national estimate of the variable of interest (for example, avoided number of cancer cases or the change in frequency of AWQC exceedences in reaches to which only one IL facility discharges),
F	=	total number of facilities analyzed,
Wt_f	=	sample weight applicable to the *f*th facility,
K_{adj}	=	weight adjustment factor accounting for a lost observation(s), and
Y_{smpl}	=	sample estimate of the variable of interest.

To assign weight for the lost observations to the facilities remaining in the analyses, EPA calculated an adjustment factor (K_{adj}) as follows:

$$K_{adj} = \frac{N}{\sum_{f=1}^{F} Wt_f \times X}$$

where:

K_{adj}	=	adjustment factor assigning the sample mass for a lost observation(s) to the remaining observations in the affected stratum,
N	=	total number of facilities in the IL industry (e.g., 1606),
F	=	total number of facilities analyzed (e.g., 172),
Wt_f	=	sample weight applicable to the *f*th facility, and
X_f	=	a variable that is equal to one if a facility was linked to the receiving POTW and is equal to zero if information on the receiving POTW is missing.

As discussed previously, this simple linear extrapolation method was used in the analysis of reduced cancer cases via the fish consumption pathway. This method was also used for extrapolating sample findings to the population in those POTW operation, AWQC comparison, and recreational fishing benefits analyses in which only one sample facility discharges to a POTW or reach.

A.3 Differential Weighting Technique

A key issue is the fact that the IL sample is a sample of facilities, while the unit of analysis in the POTW processes analysis, AWQC comparison analysis, and the recreational fishing benefits analysis is a POTW or a reach. EPA can use the sample weight to estimate the nationwide number of facilities like a sample facility. But because the facility sample weights are not *POTW or reach* sample weights, those weights cannot be used directly to estimate the national occurrence of POTWs (or reaches) associated with a specific characteristic of IL discharges. EPA developed a methodology to account for joint occurrence of facilities on POTWs (reaches) to enable reasonable estimates of the nationwide number of POTWs (reaches) affected by IL facilities, based on the concept of "discharge events."

"Discharge events" are defined for each pollutant of concern discharged by one or more facilities to a POTW (or reach) based on the loadings of the relevant sample facilities. The pollutant loading associated with a discharge event (or *discharge event loading*) is the sum of the loadings from one or more of the facilities that discharge to the POTW (or reach). There are as many discharge events of each type as there are unique sample weights for the facilities discharging to the POTW (or reach). A sample weight is calculated for each separately defined discharge event based on the sample weights of the facilities contributing loadings to the event. Discharge events are calculated as illustrated in Exhibit A-1, and are described more fully below.

For each regulatory option considered, each POTW (or reach) associated with more than one IL facility, and each pollutant of concern discharged by one or more of those facilities, pollutant loadings are ranked in ascending order of facility sample weight. The total loadings from all sample facilities on the POTW (or reach) compose the first event, and this event is assigned the smallest sample weight among the facilities discharging to the reach, Wt_1 in Exhibit A-1. The weight of this facility is then considered to be "used up," and that facility's loadings are not included in the subsequent discharge events defined for the reach. Subsequent combinations of facilities do not include this facility because its smaller sample weight relative to the others means that there are no other population facilities represented by this facility that could jointly occur with the other facilities.

Subsequent events are generated by removing the loadings of each facility in the ranking from a running sum of loadings of all facilities in the ranking. The weight assigned to each subsequent event is the difference between the weight of the next facility in the ranking and the previous facility or, said another way, the remaining *unused* weight of the facility with the smallest weight among the facilities in the particular discharge event.

This methodology generates a set of discharge events (loadings) for each pollutant discharged to the POTW (or reach), along with a weight attached to each event. The event's loading is used to calculate the resulting pollutant concentrations due to the event in the POTW influent flow, sewage sludge, and in the receiving stream. These concentrations are then compared to the relevant threshold values to determine whether the concentrations exceed critical values. If the concentration is greater than a criterion, then an estimated "exceedence" event is identified, and this exceedence event is given the weight of the discharge event for the purpose of establishing national estimates of the number of POTWs (or reaches) on which a threshold value is exceeded.

Exhibit A-1: Construction of Discharge Events for Any Pollutant Discharged to Any Reach		
Event Number	**Loadings and Flows Assigned to Event**	**Weight Assigned to Event**
One	$\sum_{i=1}^{N} \text{Load}_i$	Wt_1
Two	$\sum_{i=1}^{N} \text{Load}_i$	$Wt_2 - Wt_1$
⇓	⇓	⇓
N - 2	$\text{Load}_{N-2} + \text{Load}_{N-1} + \text{Load}_N$	$Wt_{N-2} - Wt_{N-3}$
N - 1	$\text{Load}_{N-1} + \text{Load}_N$	$Wt_{N-1} - Wt_{N-2}$
N	Load_N	$Wt_N - Wt_{N-1}$
Notes: N sample facilities discharge to the POTW (or reach), and are ranked in ascending order of sample weight and indexed by I (1 = facility with smallest weight, N = facility with largest weight); Load_i = loading from facility I; and Wt_i = sample weight of facility I.		

EPA acknowledges that this analytic method is a relatively simplistic approach to a complex analytic situation. However, within the time and resource constraints for addressing this issue and also taking into account that more sophisticated, and more expensive, approaches might not yield significantly different aggregate findings, the Agency believes that the method represents a reasonable approach to addressing the problem.

APPENDIX B

Chemical-Specific Data Used in Analyses

EXHIBIT B-1

CAS Number	Name	Freshwater Aquatic Life Acute Value (ug/l)	Spec.	Ref.	Freshwater Aquatic Life Chronic Value (ug/l)	Spec.	Ref.	Saltwater Aquatic Life Acute Value (ug/l)	Saltwater Aquatic Life Chronic Value (ug/l)	Ref.	Bioconcentration Factor Value (L/kg)	Ref.
	TOTAL PETROLEUM HYDROCARBON (TPH) *				56							
C002	BOD 5-DAY (CARBONACEOUS)											
C004	CHEMICAL OXYGEN DEMAND (COD)											
C007	TOTAL RECOVERABLE OIL AND GREASE **											
C009	TOTAL SUSPENDED SOLIDS											
C012	TOTAL ORGANIC CARBON (TOC)											
59507	4-CHLORO-3-METHYLPHENOL	4050	FM	219	1300	DM	219				79	114
65850	BENZOIC ACID	180000	MF	190	17178	FM	191				15	114
67641	2-PROPANONE	6210000	FM	219	1000000	DM	190				0.39	200
67663	CHLOROFORM	13300	BG	219	6300	DM	219				3.75	1
71556	1,1,1-TRICHLOROETHANE	42300	FM	219	1300	DM	190	31200		(d)	5.6	1
75092	METHYLENE CHLORIDE	330000	FM	190	82500	FM	190				0.91	1
78591	ISOPHORONE	117000	DM	219	11000	FM	219	12900		1	4.38	1
78933	2-BUTANONE	3220000	FM	190	263420	FM	191				1	200
79016	TRICHLOROETHENE	40700	FM	1	100	CF	190	2000		1	10.6	1
84742	DI-N-BUTYL PHTHALATE	850	FM	219	500	DM	219				89	1
85687	BUTYL BENZYL PHTHALATE	2320	FM	219	260	DM	219				414	1
91203	NAPHTHALENE	1600	RT	190	370	CO	190	2350		1	10.5	1
91576	2-METHYLNAPHTHALENE	909	RT	191	309	FM	191				2566	190
98555	ALPHA-TERPINEOL	14533	RT	191	5503	FM	191					
99876	P-CYMENE	6500	DM	190	130	FM	191				770	114
100414	ETHYLBENZENE	9090	FM	219	4600	GA	219	430		1	37.5	1
100516	BENZYL ALCOHOL	10000	BG	190	1000		(c)				4	114
106445	P-CRESOL	7500	RT	190	2570	FM	190				17.6	200
108101	4-METHYL-2-PENTANONE	505000	FM	190	56200	FM	220				2.4	200
108383	M-XYLENE	16000	FM	190	3900	GA	190				208	191
108883	TOLUENE	5500	CO	190	1000	DM	190	6300	5000	1	10.7	1
108907	CHLOROBENZENE	2370	GF	190	2100	RT	190				10.3	1
108952	PHENOL	4200	DM	219	200	RT	219	5800		1	1.4	1
112403	N-DODECANE	18000	DM	(a)	1300	DM	(a)				14500	114
112958	N-EICOSANE	18000	DM	(a)	1300	DM	(a)				100000	191
117817	BIS(2-ETHYLHEXYL) PHTHALATE	400	NA	149	360	NA	149				130	1
117840	DI-N-OCTYL PHTHALATE	690	CF	1	69		(c)				5460	200
122667	1,2-DIPHENYLHYDRAZINE	270	BG	190	27		(c)				24.9	1
124185	N-DECANE	18000	DM	190	1300	DM	190				8800	114
127184	TETRACHLOROETHENE	4990	RT	219	510	DM	219	10200	450	1	30.6	1
142621	HEXANOIC ACID	320000	FM	219	16437	FM	191				16	114
156605	TRANS-1,2-DICHLOROETHENE	220000	DM	190	110000	DM	6				1.6	18
544763	N-HEXADECANE	18000	DM	(a)	1300	DM	(a)				32300	114
593453	N-OCTADECANE	18000	DM	(a)	1300	DM	(a)				10100	114
629594	N-TETRADECANE	18000	DM	(a)	1300	DM	(a)				19500	114
629970	N-DOCOSANE	530000	DM	190	68000	DM	190				100000	191
630013	N-HEXACOSANE	530000	DM	(b)	68000	DM	(b)					
630024	N-OCTACOSANE	530000	DM	(b)	68000	DM	(b)					
638686	N-TRIACONTANE	530000	DM	(b)	68000	DM	(b)					
646311	N-TETRACOSANE	530000	DM	(b)	68000	DM	(b)				100000	191

EXHIBIT B-1

CAS Number	Name	Freshwater Aquatic Life Acute Value (ug/l)	Spec.	Ref.	Freshwater Aquatic Life Chronic Value (ug/l)	Spec.	Ref.	Saltwater Aquatic Life Acute Value (ug/l)	Saltwater Aquatic Life Chronic Value (ug/l)	Ref.	Bioconcentration Factor Value (L/kg)	Ref.
700129	PENTAMETHYLBENZENE	395	RT	191	19	FM	191				2600	17
7429905	ALUMINUM	748	NA	1	87	NA	1				231	1
7439896	IRON				1000		3					
7439921	LEAD	82	NA	1	3.2	NA	1	220	8.5	1	49	18
7439965	MANGANESE				388	RT	15					
7439976	MERCURY	2.4	NA	1	0.012	NA	1	2.1	0.025	1	5500	18
7439987	MOLYBDENUM				27.8	RT	15					
7440020	NICKEL	1400	NA	1	160	NA	1	75	8.3	1	47	1
7440224	SILVER	4.1	NA	1	0.12	NA	1	2.3	0.12	1	0.5	1
7440280	THALLIUM	1400	DM	1	40	FM	1	2130		1	116	1
7440315	TIN				18.6	RT	15					
7440326	TITANIUM				191	RT	15					
7440360	ANTIMONY	88	NA	1	30	NA	1	1500	500	1	1	1
7440382	ARSENIC	360	NA	1	190	NA	1				44	1
7440393	BARIUM	410000	DM	190	2813	RT	15					
7440417	BERYLLIUM	130	GU	1	5.3	DM	1				19	1
7440428	BORON				31.6	RT	15					
7440439	CADMIUM	3.9	NA	1	1.1	NA	1	43	9.3	1	64	1
7440473	CHROMIUM	1700	NA	1	210	NA	1	1100	50	1	16	1
7440484	COBALT	1620	DM	59	49	FM	190					
7440508	COPPER	18	NA	1	12	NA	1	2.9		1	36	1
7440622	VANADIUM	11200	FL	12	9	RT	15					
7440655	YTTRIUM											
7440666	ZINC	120	NA	1	110	NA	1	95	86	1	47	1
7782492	SELENIUM	20	NA	1	5	NA	1	300	71	1	4.8	1
136777612	O- & P- XYLENE ***	2600	RT	190	660	FM	191				208	191

* TPH measured as Silica Gel Treated n-Hexane Extractable Material (SGT-HEM).
** Oil and grease measured as n-Hexane Extractable Material (HEM).
*** Values are for p-xylene.

References:
(a) Data for n-decane are reported for this compound based on structural similarity.
(b) Data for n-docosane are reported for this compound based on structural similarity.
(c) Estimated from acute value using acute-chronic ratio of 10 (U.S. EPA, 1991)
(d) Insufficient data to develop criteria. Value presented is the L.O.E.L. (Lowest Observed Effect Level).

1 U.S. EPA, 1980.
3 U.S. EPA, 1976.
6 Leblanc, 1980.
12 Holdway and Spraque, 1979.
15 Birge et al., 1979.
17 Arthur D. Little, 1986.
18 ICF, Inc., 1985.
59 U.S. Atomic Energy Commission, 1973.
114 Lyman et al., 1990.
149 U.S. EPA, 1993a.
190 U.S. EPA, 1993b.
191 U.S. EPA, 1993c.
200 U.S. EPA, 1989c.
219 U.S. EPA, 1993d.
220 U.S. EPA, 1993e.

Species codes:
- BG Bluegill (Lepomis macrochirus)
- CF Catfish (Hetropneustes fossilis, Ictalurus punctatus)
- CO Coho Salmon (Oncorhychus kisutch)
- DM Water Flea (Daphnia magna)
- GA Green Algae
- GF Goldfish (Carassius auratus)
- FF Finfish
- FL Flagfish (Jordanella floridae)
- FM Fathead minnow (Pimephales promelas)
- NA Not available
- GU Guppy (Poecilia reticulata)
- MF Mosquitofish (Gambusia affinis)
- RT Rainbow Trout (Salmo gairdneri, Oncorhynchus mykiss)

EXHIBIT B-2

CAS Number	Name	Human Health Ingesting Water and Org. Value (ug/l)	Type	Ref.	Human Health Ingesting Org. Only Value (ug/l)	Type	Ref.	Slope Factor (mg/kg/day)-1	Ref.	RfD (mg/kg/day)-1	Ref.	WOE Value	WOE Ref.	Drinking Water Standard Value (ug/l)	Code
	TOTAL PETROLEUM HYDROCARBONS (TPH) *														
C002	BOD 5-DAY (CARBONACEOUS)														
C004	CHEMICAL OXYGEN DEMAND (COD)														
C007	TOTAL RECOVERABLE OIL AND GREASE **														
C009	TOTAL SUSPENDED SOLIDS														
C012	TOTAL ORGANIC CARBON (TOC)														
59507	4-CHLORO-3-METHYLPHENOL	3000	O	1											
65850	BENZOIC ACID	130000	@T		2871800	@T				4	149	D	149		
67641	2-PROPANONE	3500	@T		2800000	@T				0.1	149	D	149		
67663	CHLOROFORM	5.7	@C		470	@C		0.0061	149	0.01	149	B2	149	100	THM
71556	1,1,1-TRICHLOROETHANE	3100	@T		170000	@T				0.09	218	D	149	200	M
75092	METHYLENE CHLORIDE	4.7	@C		1600	@C		0.0075	149	0.06	149	B2	149	5	M
78591	ISOPHORONE	36.3	@C		2588	@C		0.00095	149	0.2	149	C	149		
78933	2-BUTANONE	21000	@T		6500000	@T				0.6	149	D	149		
79016	TRICHLOROETHENE	2.7	C	149	80.7	C	149							5	M
84742	DI-N-BUTYL PHTHALATE	2700	@T		12000	@T				0.1	149	D	149		
85687	BUTYL BENZYL PHTHALATE	3000	@T		5200	@T				0.2	149	C	149		
91203	NAPHTHALENE	1354	@T		41026	@T				0.04	218	D	149		
91576	2-METHYLNAPHTHALENE														
98555	ALPHA-TERPINEOL														
99876	P-CYMENE														
100414	ETHYLBENZENE	3100	@T		29000	@T				0.1	149	D	149	700	M
100516	BENZYL ALCOHOL	10000	@T		810000	@T				0.3	218				
106445	P-CRESOL	1700	@T		31000	@T				0.05	218	C	149		
108101	4-METHYL-2-PENTANONE	1700	@T		220000	@T				0.05	218				
108383	M-XYLENE	42000	@T		100000	@T				2	218			10000	M
108883	TOLUENE	6800	@T		200000	@T				0.2	149	D	149	1000	M
108907	CHLOROBENZENE	680	@T		21000	@T				0.02	149	D	149	100	M
108952	PHENOL	21000	@T		4600000	@T				0.6	149	D	149		
112403	N-DODECANE														
112958	N-EICOSANE														
117817	BIS(2-ETHYLHEXYL) PHTHALATE	1.8	@C		5.9	@C		0.014	149	0.02	149	B2	149	6	M
117840	DI-N-OCTYL PHTHALATE	37.3	@T		39.4	@T				0.02	218				
122667	1,2-DIPHENYLHYDRAZINE	0.04	@C		0.54	@C		0.8	149			B2	149		
124185	N-DECANE														
127184	TETRACHLOROETHENE	0.8	C	1	8.85	C	1	0.051	40	0.01	149	B2	40	5	M
142621	HEXANOIC ACID														
156605	TRANS-1,2-DICHLOROETHENE	700	@T		135000	@T				0.02	149			100	M
544763	N-HEXADECANE														
593453	N-OCTADECANE														
629594	N-TETRADECANE														
629970	N-DOCOSANE														
630013	N-HEXACOSANE														
630024	N-OCTACOSANE														
638686	N-TRIACONTANE														
646311	N-TETRACOSANE														

EXHIBIT B-2

CAS Number	Name	Human Health Ingesting Water and Org. Value (ug/l)	Type	Ref.	Human Health Ingesting Org. Only Value (ug/l)	Type	Ref.	Slope Factor (mg/kg/day)-1	Ref.	RfD (mg/kg/day)-1	Ref.	WOE Value	WOE Ref.	Drinking Water Standard Value (ug/l)	Code
700129	PENTAMETHYLBENZENE														
7429905	ALUMINUM													50	SM
7439896	IRON													300	SM
7439921	LEAD	50	T	1								B2	149	15	TT
7439965	MANGANESE	100	O	149						0.005	149	D	149	50	SM
7439976	MERCURY	0.14	T	1	0.15	T	1			0.0003	218	D	149	2	M
7439987	MOLYBDENUM									0.005	149				
7440020	NICKEL	610	@T		4600	@T				0.02	149			100	M
7440224	SILVER	170	@T		110000	@T				0.005	149	D	149	100	SM
7440280	THALLIUM													2	M
7440315	TIN									0.6	218				
7440326	TITANIUM														
7440360	ANTIMONY	14	@T		4300	@T				0.0004	149			6	M
7440382	ARSENIC ***	0.017	@C		0.14	@C		1.75	149	0.0003	149	A	149	50	M
7440393	BARIUM	1000	T	1						0.07	149			2000	M
7440417	BERYLLIUM	0.0077	@C		0.132	@C		4.3	149	0.005	149	B2	149	4	M
7440428	BORON									0.09	149				
7440439	CADMIUM	14	@T		84	@T				0.0005	149	B1	149	5	M
7440473	CHROMIUM	33000	@T		670000	@T				1	149			100	M
7440484	COBALT														
7440508	COPPER	1300	O	1								D	149	1300	TT
7440622	VANADIUM									0.007	218				
7440655	YTTRIUM														
7440666	ZINC	9100	@T		69000	@T				0.3	149	D	149	5000	SM
7782492	SELENIUM	170	@T		11000	@T				0.005	149	D	149	50	M
136777612	O- & P- XYLENE ****	42000	@T		100000	@T				2	218			10000	M

* TPH measured as Silica Gel Treated n-Hexane Extractable Material (SGT-HEM).

** Oil and grease measured as n-Hexane Extractable Material (HEM).

*** Less stringent state criteria used for ingesting water and organisms: 0.022 (IN); 0.18 (AK, MI, RI); 18 (MT); 50(AL, AZ, CA, CO, DE, FL, GA, IL, IA, KS, LA, MN, MO, NE, NV, NM, NY, OH, PA, TN, TX, VA, WV, WI), 100 (OK).

**** Values are for p-xylene.

References:
1 U.S. EPA, 1980.
40 McGaughy, 1986.
149 U.S. EPA, 1993a.
218 U.S. EPA, 1992b.

Human Health Data Codes:
C Criterion for carcinogenicity protection (Risk level = 10E-6).
T Criterion for systemic toxicity protection.
O Criterion for protection against organoleptic effects.
@C Non-criterion calculated value for carcinogenicity protection.
@T Non-criterion calculated value for systemic toxicity protection.

Drinking Water Standard Codes:
M Maximum Contaminant Level (MCL) established for health-based effect.
Chloroform is part of the Total Trihalomethanes category; m-, o-, and p-xylenes are in Total Xylenes.
SM Secondary Maximum Contaminant Level (SMCL) established for taste or aesthetic effect.
THM Trihalomethanes
TT Treatment Technique Requirements

EXHIBIT B-3

CAS Number	Name	Inhib. Crit. Value (ug/L)	Ref.	POTW Rem. Eff.	Ref.	Land Appl. Ceiling Conc. (mg/kg)	Ref.	Land Appl. Poll. Conc. (mg/kg)	Ref.	Sfc. Imp. Conc. (mg/kg, dry wt)	Ref.
	TOTAL PETROLEUM HYDROCARBON (TPH) *			65	3						
C002	BOD 5-DAY (CARBONACEOUS)			91	3						
C004	CHEMICAL OXYGEN DEMAND (COD)			82	3						
C007	TOTAL RECOVERABLE OIL AND GREASE **			87	3						
C009	TOTAL SUSPENDED SOLIDS			91	3						
C012	TOTAL ORGANIC CARBON (TOC)			71	3						
59507	4-CHLORO-3-METHYLPHENOL	5000	2	63	3						
65850	BENZOIC ACID	10000	2	81	3						
67641	2-PROPANONE	120000	2	84	3						
67663	CHLOROFORM	500000	1	73	3						
71556	1,1,1-TRICHLOROETHANE	360000	1	90	3						
75092	METHYLENE CHLORIDE	150000	2	54	3						
78591	ISOPHORONE	120000	2	62	3						
78933	2-BUTANONE	120000	2	92	3						
79016	TRICHLOROETHENE	20000	1	87	3						
84742	DI-N-BUTYL PHTHALATE	10000	2	75	3						
85687	BUTYL BENZYL PHTHALATE	10000	2	86	3						
91203	NAPHTHALENE	500000	2	95	3						
91576	2-METHYLNAPHTHALENE	5000	2	28	3						
98555	ALPHA-TERPINEOL	1000000	2	95	3						
99876	P-CYMENE	5000	2	99	3						
100414	ETHYLBENZENE	200000	1	94	3						
100516	BENZYL ALCOHOL	1000000	2	78	3						
106445	P-CRESOL	90000	2	72	3						
108101	4-METHYL-2-PENTANONE	120000	2	88	3						
108383	M-XYLENE	5000	2	65	3						
108883	TOLUENE	200000	1	96	3						
108907	CHLOROBENZENE	140000	1								
108952	PHENOL	90000	2	95	3						
112403	N-DODECANE			95	3						
112958	N-EICOSANE			92	3						
117817	BIS(2-ETHYLHEXYL) PHTHALATE	10000	2	60	3						
117840	DI-N-OCTYL PHTHALATE	10000	2	83	3						
122667	1,2-DIPHENYLHYDRAZINE	5000		62	3						
124185	N-DECANE			9	3						

EXHIBIT B-3

CAS Number	Name	Inhib. Crit. Value (ug/L)	Ref.	POTW Rem. Eff.	Ref.	Land Appl. Ceiling Conc. (mg/kg)	Ref.	Land Appl. Poll. Conc. (mg/kg)	Ref.	Sfc. Imp. Conc. (mg/kg, dry wt)	Ref.
127184	TETRACHLOROETHENE	20000	1	85	3						
142621	HEXANOIC ACID	10000	2								
156605	TRANS-1,2-DICHLOROETHENE	150000	2								
544763	N-HEXADECANE			71	3						
593453	N-OCTADECANE			71	3						
629594	N-TETRADECANE			71	3						
629970	N-DOCOSANE			65	3						
630013	N-HEXACOSANE			65	3						
630024	N-OCTACOSANE			65	3						
638686	N-TRIACONTANE			65	3						
646311	N-TETRACOSANE			65	3						
700129	PENTAMETHYLBENZENE	5000	2	91	3						
7429905	ALUMINUM			88	3						
7439896	IRON	5000	1	83	3						
7439921	LEAD	100	1	92	3	840	4	300	4		
7439965	MANGANESE	10000	1	41	3						
7439976	MERCURY	100	1	60	3	57	4	17	4		
7439987	MOLYBDENUM			52	3	75	4				
7440020	NICKEL	5000	1	52	3	420	4	420	4	420	4
7440224	SILVER	30	1	80	3						
7440280	THALLIUM			28	3						
7440315	TIN	9000	1	65	3						
7440326	TITANIUM			69	3						
7440360	ANTIMONY			72	3						
7440382	ARSENIC	40	1	40	3	75	4	41	4	73	4
7440393	BARIUM			35	3						
7440417	BERYLLIUM			61	3						
7440428	BORON	1000	5	14	3						
7440439	CADMIUM	500	1	91	3	85	4	39	4		
7440473	CHROMIUM	1000	1	91	3					600	4
7440484	COBALT			4	3						
7440508	COPPER	1000	1	84	3	4300	4	1500	4		
7440622	VANADIUM	20000	1	42	3						
7440655	YTTRIUM			58	3						
7440666	ZINC	5000	1	77	3	7500	4	2800	4		

EXHIBIT B-3

CAS Number	Name	Inhib. Crit. Value (ug/L)	Ref.	POTW Rem. Eff.	Ref.	Land Appl. Ceiling Conc. (mg/kg)	Ref.	Land Appl. Poll. Conc. (mg/kg)	Ref.	Sfc. Imp. Conc. (mg/kg, dry wt)	Ref.
7782492	SELENIUM			34	3	100	4	100	4		
136777612	O & P-XYLENE ***	5000	2	95	3						

* TPH measured as Silica Gel Treated n-Hexane Extractable Material (SGT-HEM).

** Oil and grease measured as n-Hexane Extractable Material (HEM).

*** Values for p-xylene.

References:

1 CERCLA Site Discharges to POTWs: Guidance Manual. August 1990. U.S. EPA. Office of Emergency and Remedial Response. EPA/540/G-90/005.

2 Guidance Manual for Preventing Interference at POTWs. September 1987. U.S. EPA. Office of Water, Permits Division.

3 Technical Development Document for Proposed Pretreatment Standards for Existing and New Sources for the Industrial Laundries Point Source Category. 1997. U.S. EPA. Office of Water. EPA-821-R-97-007.

4 40 CFR (Code of Federal Regulations) Part 503 Sections 503.13 and 503.23, pp. 664 and 671. July 1, 1996 edition.

5 U.S. EPA, 1997. Review of Boron Sludge Inhibition Value. May 21. More details provided in the public record.

APPENDIX C

Pollutant Decay Rates

EXHIBIT C-1

CAS #	Chemical	1st-order decay (hr-1)	Reference
	TOTAL PETROLEUM HYDROCARBONS (TPH)	0	Assumed zero due to lack of readily available data.
C002	BOD 5-DAY (CARBONACEOUS)	0	Assumed zero due to lack of readily available data.
C004	COD	0	Assumed zero due to lack of readily available data.
C007	TOT. RECOV. OIL AND GREASE	0	Assumed zero due to lack of readily available data.
C009	TOTAL SUSPENDED SOLIDS	0	Assumed zero due to lack of readily available data.
C012	TOTAL ORGANIC CARBON (TOC)	0	Assumed zero due to lack of readily available data.
59507	4-CHLORO-3-METHYLPHENOL	3.43E-02	Tabak et al., 1981, as cited in HSDB, 1994.
65850	BENZOIC ACID	8.02E-03	Banerjee et al., 1984, as cited in HSDB, 1994.
67641	2-PROPANONE	1.65E-02	Average of rates estimated from half-lives presented in Howard et al., 1991.
67663	CHLOROFORM	5.96E-04	Average of rates estimated from half-lives presented in Howard et al., 1991.
71556	1,1,1-TRICHLOROETHANE	1.56E-04	Average of rates estimated from half-lives presented in Howard et al., 1991.
75092	METHYLENE CHLORIDE	2.58E-03	Average of rates estimated from half-lives presented in Howard et al., 1991.
78591	ISOPHORONE	2.58E-03	Average of rates estimated from half-lives presented in Howard et al., 1991.
78933	2-BUTANONE	1.65E-02	Average of rates estimated from half-lives presented in Howard et al., 1991.
79016	TRICHLOROETHENE	1.20E-04	Average of rates estimated from half-lives presented in Howard et al., 1991.
84742	DI-N-BUTYL PHTHALATE	1.55E-02	Average of rates estimated from half-lives presented in Howard et al., 1991.
85687	BUTYL BENZYL PHTHALATE	1.65E-02	Average of rates estimated from half-lives presented in Howard et al., 1991.
91203	NAPHTHALENE	2.96E-02	Average of rates estimated from half-lives presented in Howard et al., 1991.
91576	2-METHYLNAPHTHALENE	2.96E-02	Assumed same rate as for naphthalene, based on structural similarity.
98555	ALPHA-TERPINEOL	0	Assumed zero due to lack of readily available data.
99876	P-CYMENE	2.58E-03	Assumed same rate as for p-xylene, based on structural similarity.
100414	ETHYLBENZENE	6.26E-03	Average of rates estimated from half-lives presented in Howard et al., 1991.
100516	BENZYL ALCOHOL	2.89E-04	HSDB, 1994
106445	P-CRESOL	3.68E-01	Average of rates estimated from half-lives presented in Howard et al., 1991.
108101	4-METHYL-2-PENTANONE	1.65E-02	Average of rates estimated from half-lives presented in Howard et al., 1991.
108383	M-XYLENE	2.58E-03	Average of rates estimated from half-lives presented in Howard et al., 1991.
108883	TOLUENE	4.27E-03	Average of rates estimated from half-lives presented in Howard et al., 1991.
108907	CHLOROBENZENE	3.09E-04	Average of rates estimated from half-lives presented in Howard et al., 1991.
108952	PHENOL	7.15E-02	Average of rates estimated from half-lives presented in Howard et al., 1991.
112403	N-DODECANE	4.62E-03	Haines and Alexander, 1974, as cited in HSDB, 1994.
112958	N-EICOSANE	0	Assumed zero due to lack of readily available data.
117817	BIS(2-ETHYLHEXYL) PHTHALATE	3.52E-03	Average of rates estimated from half-lives presented in Howard et al., 1991.
117840	DI-N-OCTYL PHTHALATE	2.58E-03	Average of rates estimated from half-lives presented in Howard et al., 1991.
122667	1,2-DIPHENYLHYDRAZINE	3.00E-02	Average of rates estimated from half-lives presented in Howard et al., 1991.
124185	N-DECANE	5.31E-04	Walker and Colwell, 1975, as cited in HSDB, 1994.
127184	TETRACHLOROETHENE	1.20E-04	Average of rates estimated from half-lives presented in Howard et al., 1991.
142621	HEXANOIC ACID	4.83E-03	Dore et al., 1975, as cited in HSDB, 1994.
156605	TRANS-1,2-DICHLOROETHENE	0	Assumed zero due to lack of readily available data.
544763	N-HEXADECANE	1.61E-03	Vaishnav and Babeu, 1987, as cited in HSDB, 1994.
593453	N-OCTADECANE	0	Assumed zero due to lack of readily available data.
629594	N-TETRADECANE	0	Assumed zero due to lack of readily available data.
629970	N-DOCOSANE	0	Assumed zero due to lack of readily available data.

EXHIBIT C-1

CAS #	Chemical	1st-order decay (hr-1)	Reference
630013	N-HEXACOSANE	0	Assumed zero due to lack of readily available data.
630024	N-OCTACOSANE	0	Assumed zero due to lack of readily available data.
638686	N-TRIACONTANE	0	Assumed zero due to lack of readily available data.
646311	N-TETRACOSANE	0	Assumed zero due to lack of readily available data.
700129	PENTAMETHYLBENZENE	4.58E-03	Assumed same as rate for benzene (Lyman et al., 1990), based on structural similarity.
7429905	ALUMINUM	0	Assumed zero because inorganic.
7439896	IRON	0	Assumed zero because inorganic.
7439921	LEAD	0	Assumed zero because inorganic.
7439965	MANGANESE	0	Assumed zero because inorganic.
7439976	MERCURY	0	Assumed zero because inorganic.
7439987	MOLYBDENUM	0	Assumed zero because inorganic.
7440020	NICKEL	0	Assumed zero because inorganic.
7440224	SILVER	0	Assumed zero because inorganic.
7440280	THALLIUM	0	Assumed zero because inorganic.
7440315	TIN	0	Assumed zero because inorganic.
7440326	TITANIUM	0	Assumed zero because inorganic.
7440360	ANTIMONY	0	Assumed zero because inorganic.
7440382	ARSENIC	0	Assumed zero because inorganic.
7440393	BARIUM	0	Assumed zero because inorganic.
7440417	BERYLLIUM	0	Assumed zero because inorganic.
7440428	BORON	0	Assumed zero because inorganic.
7440439	CADMIUM	0	Assumed zero because inorganic.
7440473	CHROMIUM	0	Assumed zero because inorganic.
7440484	COBALT	0	Assumed zero because inorganic.
7440508	COPPER	0	Assumed zero because inorganic.
7440622	VANADIUM	0	Assumed zero because inorganic.
7440655	YTTRIUM	0	Assumed zero because inorganic.
7440666	ZINC	0	Assumed zero because inorganic.
7782492	SELENIUM	0	Assumed zero because inorganic.
136777612	O+P XYLENE	2.58E-03	Average of rates estimated from half-lives presented in Howard et al., 1991.

APPENDIX D

Estimated Health Benefits Based on Alternative Fish Consumption Rates

In developing the proposed regulation, EPA considered using alternative assumptions regarding fish consumption rates (see Section 3.2.3). The alternative rates were derived from the combined 1989, 1990 and 1991 USDA Continuing Survey of Food Intakes by Individuals (CSFII). Persons living in subsistence fishing households were assumed to consume 50 grams per day (0.05 kg/day) of fish over 70 years of exposure. This value corresponds to the 95th percentile consumption value from the CSFII for fresh and estuarine fish. The risks to recreational fishing households were estimated based on consumption of 22 grams of fish per day (0.022 kg/day) over a 30-year period. This value corresponds to the 90th percentile consumption value for fresh and estuarine fish from CSFII.

Using the methodology for calculating cancer risk discussed in Section 10.4.2.1 of the *Economic Assessment for Proposed Pretreatment Standards for Existing and New Sources for the Industrial Laundries Point Source Category* (U.S. EPA, 1997, EPA-821-R-97-008), EPA calculated alternative cancer risk estimates using the alternative fish consumption rates. Based on the alternative fish consumption rates, EPA estimated that the CP-IL option would eliminate approximately 0.02 cancer cases per year from a baseline value of about 0.07 cases, representing a reduction of about 30 percent. Options Combo-IL and DAF-IL would also eliminate approximately 0.02 cancer cases per year, representing a reduction of about 28 percent. EPA estimated the value of the avoided cancer cases at $0.041 to $0.23 million per year ($1993).

Exhibit D-1: Estimated Annual Avoided Cancer Cases and Value of Benefits for Industrial Laundry Regulatory Options Based on the Alternative Fish Consumption Rates

Regulatory Options	Fish Consumption	
	Avoided Cancer Cases	Value of Benefit[a] ($ million)
CP-IL	0.02	$0.043 - $0.23
DAF-IL	0.02	$0.041 - $0.22
Combo-IL	0.02	$0.041 - $0.22

[a]Estimated value of avoided cancer case ($1993): $2.1 million - $11.4 million.